TOTAL MAXIMUM DAILY LOAD (TMDL) FOR THE SANTA FE RIVER FROM THE COCHITI PUEBLO TO THE SANTA FE WASTEWATER TREATMENT PLANT FOR CHLORINE AND STREAM BOTTOM DEPOSITS

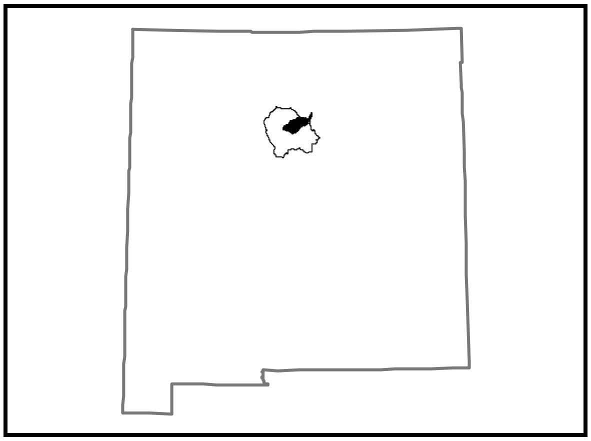

Figure 1. Santa Fe River Watershed, New Mexico

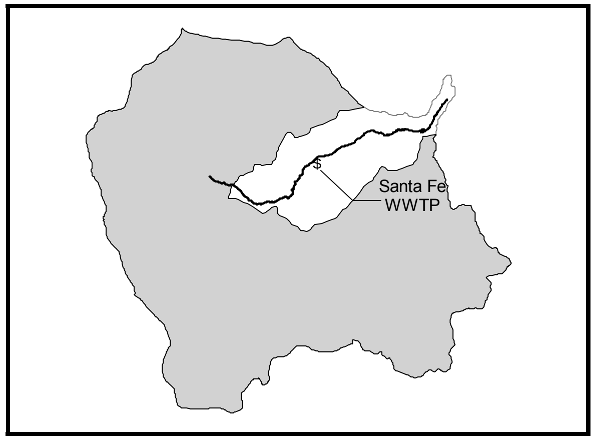

Figure 2. Santa Fe River Study Area

Summary Table

New Mexico Standards Segment	Santa Fe River, 2110
Waterbody Identifier	Santa Fe River from the Cochiti Pueblo to the Santa Fe WWTP
Parameters of Concern	Chlorine, Stream Bottom Deposits
Uses Affected	Marginal Coldwater Fishery
Geographic Location	Upper Rio Grande Basin, Santa Fe River Watershed, Santa Fe River
Scope/size of Watershed	249 mi^2
Land Type	Ecoregions: Arizona-New Mexico Plateau Southern Rockies
Land Use/Cover	Forest Land (57.7%), Range Land (28.9%), Urban or Built-up Land (10.0%), Agricultural Land (2.3%), Other (1.2%)
Identified Sources	Municipal Point Sources, Agriculture, Resource Extraction
Priority Ranking	6
Threatened and Endangered Species	None
TMDL for: Total Residual Chlorine Stream Bottom Deposits	LA + WLA + MOS = TMDL 0.0 lb/day + 0.78 lb/day + 0.0 lb/day = 0.78 lb/day 15% + 0% + 5% = 20% fines 57,568 lb/day of TSS + 2,127 lb/day of TSS + 19,899 lb/day of TSS = 79,594 lb/day of TSS

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to develop TMDL management plans for water bodies determined to be water quality limited. A TMDL documents the amount of a pollutant a water body can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 CFR Part 130 as the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and a margin of safety.

The Santa Fe River Study Area is a subbasin of the Upper Rio Grande Basin, located in north-central New Mexico. Historically (prior to January 1998), stations were located along the Santa Fe River to evaluate water quality standards. As a result of this information, chlorine, stream bottom deposits, total ammonia, and gross alpha were identified as pollutants causing the lack of full support of designated uses. Based on monitoring since restoration of the La Bajada mine, it has been determined that the Santa Fe River currently meets the numeric water quality standards for gross alpha. The field work associated with the La Bajada mine restoration was completed in 1996. Recent monitoring (Fall 1998 through Summer 1999) has also demonstrated that the Santa Fe River now meets water quality standards for total ammonia. Therefore, a TMDL is not developed for gross alpha or total ammonia.

A general implementation plan for activities to be established in the watershed is included in this document. The Surface Water Quality Bureau's Nonpoint Source Pollution Section will further develop the details of this plan. The recommendations in this document will be implemented with full participation of all interested and affected parties. During implementation, additional water quality data will be generated. As a result, targets will be reexamined and potentially revised; this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate or if new standards are adopted, the load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be removed from the TMDL list.

LIST OF ABBREVIATIONS

BMP	best management practice
CCC	chronic criterion concentration
CDM	Camp Dresser and McKee
cfs	cubic feet per second
CWA	Clean Water Act
CWAP	Clean Water Action Plan
CWF	Coldwater Fishery
DMR	discharge monitoring report
EPA	Environmental Protection Agency
FS	[United States Department of Agriculture] Forest Service
HQCWF	High Quality Coldwater Fishery
ISI	Interstitial Space Index
LA	load allocation
mgd	million gallons per day
mg/L	milligrams per liter
mi^2	square miles
MOS	margin of safety
MOU	Memorandum of Understanding
NMED	New Mexico Environment Department
NMSHD	New Mexico State Highway and Transportation Department
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NTU	nephelometric turbidity units
SBD	stream bottom deposits
SU	standard units (unit of measure associated with pH)
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
TSS	total suspended solids
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UWA	Unified Watershed Assessment
WLA	waste load allocation
WQLS	water quality limited segment
WQCC	[New Mexico] Water Quality Control Commission
WQS	Water Quality Standards (20 NMAC 6.1)
4Q3	Four-day average low flow occurring once every 3 years

BACKGROUND INFORMATION

The Santa Fe River study area (249 mi^2) is a subbasin of the Upper Rio Grande Basin, located in north-central New Mexico and is dominated by forest land (57.7%), range land (28.9%), and urban land (10.0%) (Figure 3). Other land uses account for the remaining 3.4 percent of the watershed. The Santa Fe River originates in the northeast portion of the study area on land managed by the Forest Service and flows in a generally southwest direction toward the city of Santa Fe. Upstream of the city of Santa Fe wastewater treatment plant (WWTP), the Santa Fe River is generally a dry arroyo with upstream flow during some snowmelt periods in the spring and after some storm events. Thus, the critical point for application of many numeric water quality standards (e.g., total residual chlorine) is at the point of discharge into the Santa Fe River. In the 12 months ending in June 1999, the WWTP reported an average flow of 5.9 mgd (9.1 cfs) and a maximum daily flow of 7.5 mgd (11.6 cfs) (Appendix A, Table A-1). The draft permit from the U.S. EPA (April 17, 1999) indicates a permitted average design flow of 8.5 mgd (13.2 cfs). Around the city of Santa Fe (the central portion of the study area), most of the land along the Santa Fe River is privately held with some interspersed state-managed land.

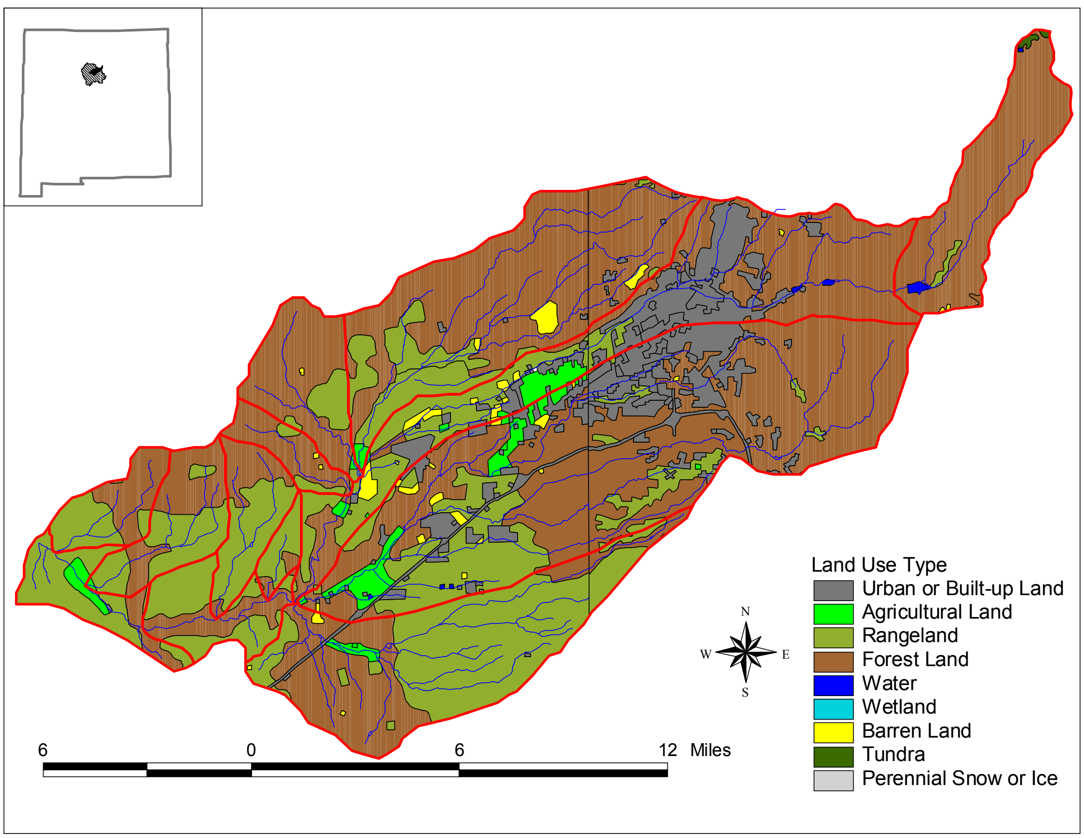

Figure 3. Land Use Classification in Study Area

The Bureau of Land Management and Forest Service manage much of the land along the Santa Fe River in the southwestern portion (below Cañon, New Mexico) of the study area. Currently, the Bureau of Land Management is considering acquisition of land near the confluence of the Santa Fe River with Cienega Creek and the Forest Service is considering land trades with the Cochiti Pueblo.

Surface water quality monitoring stations were used to characterize the water quality of the stream reaches (Figure 4). Stations were located to evaluate the impact of the Santa Fe WWTP and Cienega Creek, as well as to determine water quality conditions throughout the targeted portion of the Santa Fe River. Historical monitoring (prior to January 1998) indicated that chlorine, stream bottom deposits, total ammonia, and gross alpha were pollutants causing the lack of full support of designated uses. Based on monitoring since restoration of the La Bajada mine, it has been determined that the Santa Fe River currently meets the numeric water quality standards for gross alpha. The field work associated with the La Bajada mine restoration was completed in 1996. Recent monitoring (Fall 1998 through Summer 1999) has also demonstrated that the Santa Fe River now meets water quality standards for total ammonia. Therefore, a TMDL is not developed for gross alpha or total ammonia.

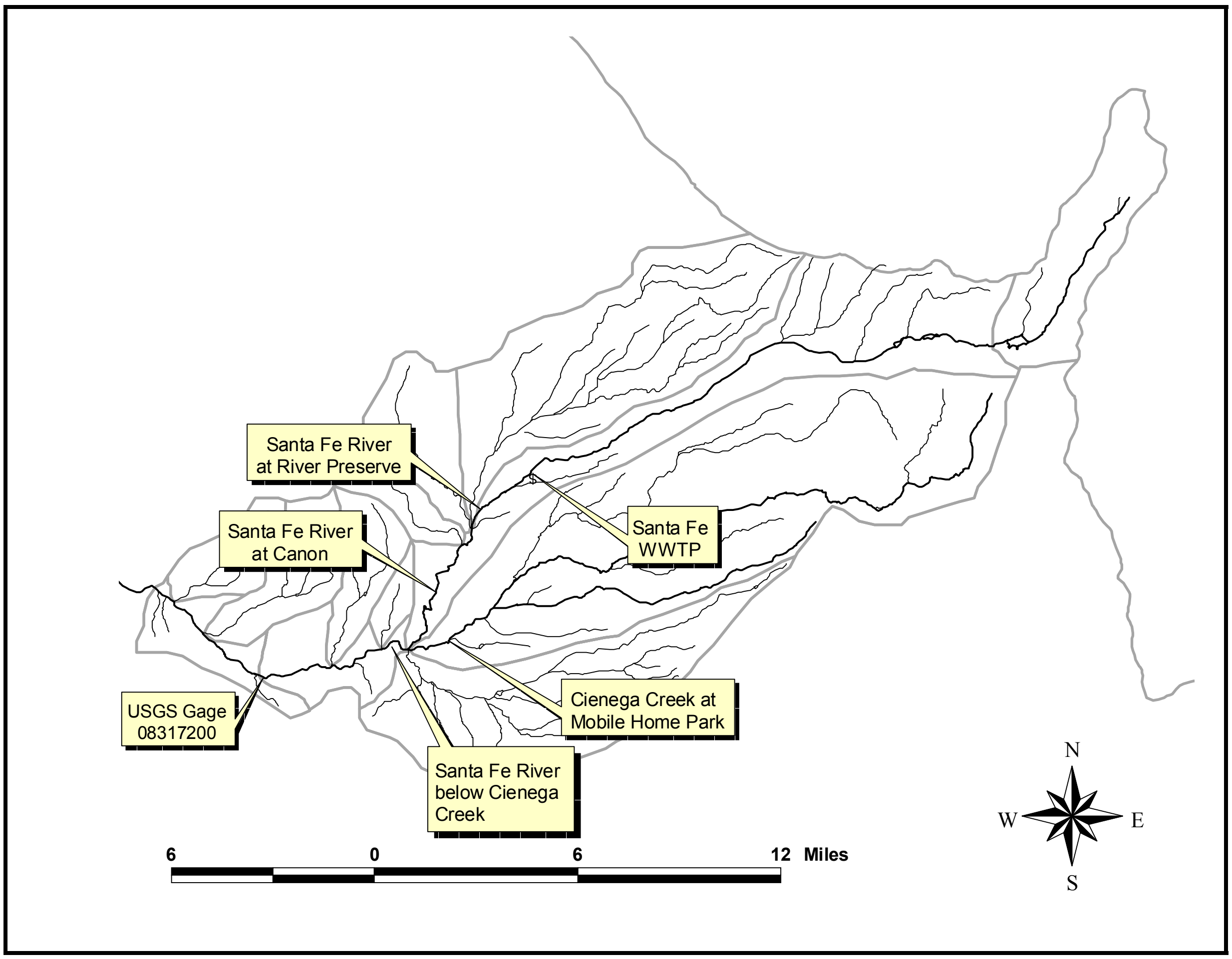

Figure 4. Location of Stream Monitoring Stations in the Study Area

TOTAL RESIDUAL CHLORINE TMDL

Endpoint Identification/Target Loading Capacity

The target value for total residual chlorine was determined based on (1) the presence of numeric criteria, (2) the degree of experience in applying the target values and (3) the ability to easily monitor and produce quantifiable and reproducible results. The standards leading to an assessment of use impairment on the Santa Fe River are the Marginal Coldwater Fishery numeric criteria for total residual chlorine. The numeric criterion for total residual chlorine is 0.011 mg/L. The specific carrying capacity of a receiving water for a given pollutant, defined by a numeric standard, is estimated as:

Combined flow (in mgd) x numeric standard (in mg/L) x 8.34

where 8.34 is a conversion factor used to compute a result in pounds per day. The combined flow is calculated by adding the critical low flow and the average design flow contribution from any point sources. Since the upstream flow during dry conditions at the Santa Fe WWTP is zero, the combined flow is equal to the plant's average design flow of 8.5 mgd. Multiplying 8.5 mgd by the numeric standard and 8.34 yields an estimate that the Santa Fe River can transport approximately 0.78 lb/day of total residual chlorine during critical low-flow conditions without exceeding water quality standards, respectively (Table 1).

Table 1. Estimates of target loading

Parameter	Flow (mgd)	Standard (mg/L)	Estimate of Target Loading (lb/day)
Total residual chlorine	8.5	0.011	0.78

Identification and Description of Existing Pollutant Sources

Point Sources

Total residual chlorine effluent loads from the Santa Fe WWTP were calculated using a plant average design flow of 8.5 mgd and the geometric mean (USEPA, 1994) of total residual chlorine concentrations. The most recent total residual chlorine data are from a CDM (1995) report entitled *Waterbody Survey and Use Assessment for Segment 2-110 of the Santa Fe River*. The geometric mean total residual chlorine concentration using the data from this report is 0.88 mg/L. Based on field monitoring data collected by the New Mexico Environment Department (NMED) since January 1998, it has been determined that field methods for total residual chlorine are unreliable. The unreliable performance of total residual chlorine field methods in ambient waters is likely due to interference from other oxidizing chemicals. Given the known interference associated with total residual chlorine field monitoring, these data might have a large associated error. Nevertheless the calculated average daily load for total residual chlorine from the WWTP is calculated as 62.4 lb/day (Table 2).

Nonpoint Sources

Nonpoint source loads in this watershed are considered to be minimal for total residual chlorine. During critical low-flow conditions, upstream flow is zero and the stream appears to lose water to groundwater and evaporation, as demonstrated by the decreasing flow of 6.95 to 6.65 cfs on June 14, 1999, from just below the Santa Fe WWTP to the River Preserve (see Figure 4). Based on field reconnaissance, there are no upstream sources and no known nonpoint sources of chlorine in this portion of the watershed. Thus, nonpoint sources of total residual chlorine is set to zero.

Table 2. Calculation of loading for total residual chlorine based on historical data

Pollutant Sources Total Residual Chlorine	Flow (mgd)	Concentration (mg/L)	Conversion Factor	Current Loading (lb/day)	Location
Point	8.5	0.88	8.34	62.4	Santa Fe WWTP
Nonpoint	0	0	8.34	0	NA

Note: Current loading = flow x concentration x conversion factor

Waste Load Allocations and Load Allocations

This section describes the calculations to compute the TMDL and associated load allocations and waste load allocation for total residual chlorine.

Load Allocation

The load allocation for total residual chlorine is set to zero since there are no known nonpoint sources of total residual chlorine and upstream flow is zero during critical low-flow conditions.

Waste Load Allocation

The average total residual chlorine load from the treatment facility based on data from 1994-1995 is approximately 62.4 lb/day, exceeding the target loading capacity of 0.78 lb/day. The entire load for total residual chlorine is allocated to the point source discharge. Since the flow used to compute the target loading capacity is the same as the average plant design flow, the effluent concentration of total residual chlorine that will allow attainment of the stream water quality criterion is the same as the numeric criterion of 0.011 mg/L (0.78 lb/day) (Table 3).

Table 3. Total maximum daily load at critical low flow

Parameter	Load Allocation (lb/day)	Waste Load Allocation (lb/day)	Margin of Safety (lb/day)	Total Maximum Daily Load Allocation (lb/day)
Total residual chlorine	0.0	0.78	Implicit	0.78

Consideration of Seasonal Variation

TMDL calculations are protective of standards at critical flows and will therefore be protective of standards at all flows. Thus, the calculations made using the flow described above and using other conservative assumptions as described in the section on Margin of Safety are protective at all times.

Linkage of Water Quality and Pollutant Sources

Discharge and downstream sampling of total residual chlorine in the Santa Fe River by CDM (1995) provide sufficient evidence to link water quality to the Santa Fe WWTP discharge. According to this report, the data collected downstream of the WWTP indicated a decreasing trend in total residual chlorine in the downstream direction. Field reconnaissance did not indicate any other source of total residual chlorine.

Margin of Safety

Regulations require that TMDLs reflect a margin of safety based on uncertainty or variability of data, point and nonpoint source load estimates, and/or modeling analysis. For this TMDL, the margin of safety is implicit in assumptions used in calculating the point source loads. These assumptions include the following:

- Use of treatment plant design capacity for calculation of point source loading,
- Use of 4Q3 critical flows to calculate the allowable load.

Allowance for Future Growth

Current flow at the Santa Fe WWTP averages 5.9 mgd. For all calculations in development of this TMDL, a plant design flow of 8.5 mgd was used. The value of 8.5 mgd is the proposed average design flow in the draft permit from the U.S. EPA (April 17, 1999). Sufficient treatment capacity remains to accommodate an increased flow of 44 percent. Therefore, no specific allowances for future growth will be made.

Implementation Plan

For total residual chlorine, implementation includes the development of a time line, establishing milestones, and achieving final limits as shown in Table 4.

Assurances

National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Clean Water Act (CWA) contain specific and legally enforceable effluent limitations and self-monitoring requirements. It is expected that the WWTP will be required to meet the limits specified in this TMDL. It is also expected that the WWTP's permit would include monitoring requirements for total residual chlorine.

The customary time frame for achieving compliance with new NPDES permit limits is 3 years, with compliance being reached in the fourth year; however, the Santa Fe WWTP has already replaced the chlorination system with an ultraviolet disinfection system and has been using the ultraviolet system exclusively since March 1998. Thus, achieving final limits for total residual chlorine can proceed immediately.

Table 4. Implementation Time line

Implementation Action	Year 1	Year 2	Year 3	Year 4	Year 5
Public Outreach and Involvement	X				
Establish Milestones	X				
Secure Funding	n/a				
Complete construction	n/a				
Achieve final limits	X				

Milestones

Milestones will be used to determine if control actions are being implemented and standards attained. For this TMDL, initial milestones to be established are listed below. Milestones will be reevaluated periodically. Further implementation of this TMDL will be revised based on this reevaluation.

- Monitor pollutant loading.
- Track effectiveness of controls.
- Assess water quality trends in the water body.
- Reevaluate TMDL for attainment of water quality standards.

Monitoring Plan

Pollutant load monitoring for total residual chlorine will be implemented through the NPDES permit.

STREAM BOTTOM DEPOSITS TMDL

Endpoint Identification/Target Loading Capacity

Target values for stream bottom deposits were determined based on (1) the presence of numeric criteria, (2) the degree of experience in applying the target values and (3) the ability to easily monitor and produce quantifiable and reproducible results. The general standard for stream bottom deposits (NMWQCC, 1995) reads as follows: "The stream shall be free of water contaminants from other than natural causes that will settle and adversely inhibit the growth of normal flora and fauna or significantly alter the physical or chemical properties of the bottom. Siltation resulting from the reasonable operation and maintenance of irrigation and flood control facilities is not subject to these standards."

The SWQB has compiled techniques to measure the level of embeddedness of a stream bottom in an SWQB/NMED draft Protocol for the Assessment of Stream Bottom Deposits (SWQB/NMED, 1999a) in order to address the narrative criteria for stream bottom deposits (SBD). The purpose of the Protocol is to provide a reproducible quantification of the narrative criteria for stream bottom deposits. The impact of fine sediment deposits is well documented in the literature. This impact is largely a mechanical action in which the available habitat is reduced for macroinvertebrates and fish species that use the streambed in various life stages. The SWQB Sediment Workgroup evaluated a number of methods described in the literature that would provide information allowing a direct assessment of the impacts to the stream bottom substrate. A final list of monitoring procedures was implemented at a wide variety of sites during the 1998 monitoring season. These procedures included conducting pebble counts (a measurement of percent fines), stream bottom cobble embeddedness, Rosgen (1996) geomorphology, and various biological measures.

The method selected for establishing target levels is based on the relationship between embeddedness, fines, and biological score. Using existing data from New Mexico, a strong relationship (R^2=0.7511) was established between embeddedness and the biological scores from the SWQB/NMED draft Protocol for the Assessment of Stream Bottom Deposits (SWQB/NMED 1999a) sampling from 1998. A strong correlation (R^2= 0.719) was also found when relating embeddedness to percent fines. These relationships show that at the desired biological score (at least 70, per the SWQB Assessment Protocol 1998) the target embeddedness (for fully supporting a designated use) would be 45 percent, and the target fines would be 20 percent. Since this relationship is based on New Mexico streams, percent fines was chosen as the endpoint with a target value of 20 percent. The target value for percent fines is presented in Table 5.

Since it is not currently tractable to perform traditional load (mass per unit time) calculations for percent fines, and therefore cannot be approved as a TMDL, a target load capacity is also developed for total suspended solids. Assuming that the activities that generate varying amounts of suspended sediment will proportionally change or affect turbidity, a relationship between the two variables can be developed.

Recognizing that the stream is not impaired due to turbidity, a relationship ($R^2 = 0.75$) between total suspended solids and turbidity is developed using the data collected from the spring, summer, and fall of 1995 at the USGS gage (#08317200) and above the La Bajada Mine (Figure 5).

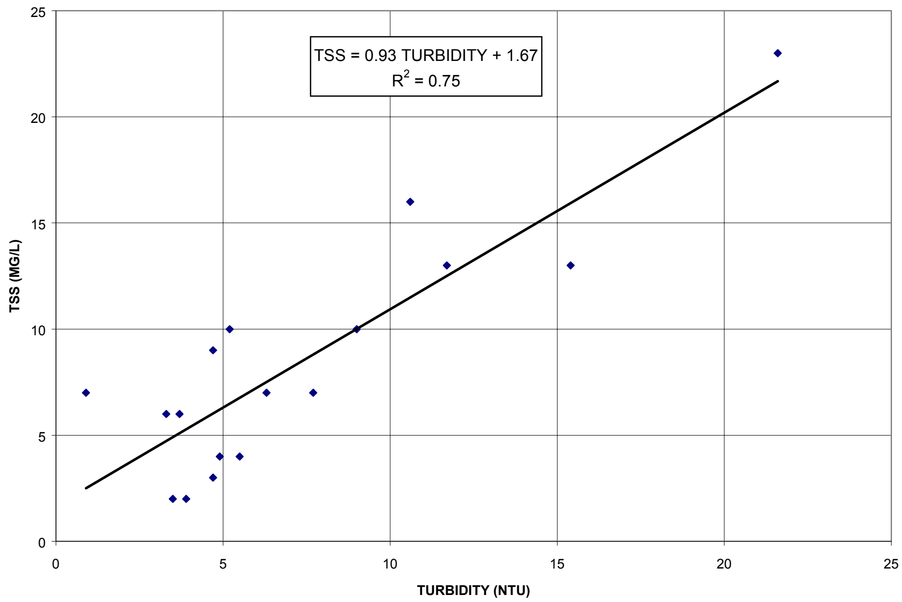

Figure 5. Relationship between Total Suspended Solids and Turbidity in the Santa Fe River

The state's standard leading to an assessment of use impairment for turbidity for the Santa Fe River is 50 NTU. In general, the relationship presented in Figure 5 should not be extended beyond the range of values observed; however, the opportunity to collect such data during the recent monitoring effort was limited due to low flow conditions. Therefore, this equation is applied to compute a target total suspended solids concentration of 48.2 mg/L (0.93 x 50 +1.67). At USGS Gage 08317200, the greatest monthly mean flow from 1970 to 1997 was 198 mgd. As a result, the target load capacity for total suspended solids is estimated as 198 mgd x 48.2 mg/L x 8.34 or 79,594 lb/day (Table 5).

Results from a 1995 biological assessment (CDM, 1995) were used to support the assessment of stream bottom deposits. At five stations (ranging from below the Santa Fe WWTP to the USGS gage), the benthic community was judged to range from slightly to moderately impaired. Note that the assessment criteria used by CDM (1995) are not the same as the state's published critera. The report states that there was a gradual improvement in benthic community condition downstream of the Santa Fe WWTP. This improvement was partially attributed to declining chlorine levels in the downstream direction. The EPT (Ephemeroptera, Plecoptera, Tricoptera) Index indicates some degree of impairment, which might be attributable to stream bottom deposits. Also the geomorphology work performed on June 14, 1999, indicated a percent fines of 27 percent at the River Preserve.

Table 5. Calculation of target loads

Location	Flow (mgd)[a]	Standard for Stream Bottom Deposits (% fines) [b]	Conversion Factor	Target Load Capacity (% fines)
Santa Fe River	198	20	n/a	20
		Standard for Total Suspended Solids (mg/L)[c]	**Conversion Factor**	**Target Load Capacity (lb/day)**
		48.2	8.34	79,594

[a]Flow is the greatest monthly mean flow at USGS gage 08317200 collected from 1970 to 1997.
[b]This value is based on a narrative standard. The background values for stream bottom deposits were taken from the SWQB/NMED draft Protocol for the Assessment of Stream Bottom Deposits (1999a).
[c]This value was calculated using the relationship established between TSS and turbidity (TSS = 0.93 x turbidity +1.67, R^2 = 0.75). The turbidity standard is 50 NTU.

During the 1995 water quality assessment (CDM, 1995), several total suspended solids samples were taken. It would be preferable to examine the total suspended solids associated with turbidity results greater than 50 NTU; however, no corresponding turbidity data were taken. Therefore, samples in which the total suspended solids exceeded 48.2 mg/L, including 65.4 and 54.2 mg/L (April 13, 1995), 76.2 and 64.6 mg/L (December 19, 1994), and 61.6 and 59.6 mg/L (October 25, 1994), were considered. All of these samples were taken on the Santa Fe River above and below the confluence with Cienega Creek. The geometric mean of these data is 63.3 mg/L. Table 6 summarizes the measured loads in the Santa Fe River.

A small portion of the total suspended solids measured at in-stream stations can be attributed to the Santa Fe WWTP. The Santa Fe WWTP is permitted for 30 mg/L, the geometric mean of discharge monitoring report (DMR) data from July 1998 to June 1999 is 1.0 mg/L; and the geometric mean of DMR data from January 1995 to December 1995 is 6.3 mg/l. The 1995 average load based on DMR data was 319 lb/day; during the 12–month period ending June 1999, the average total suspended solids loading was 49.5 lb/day. This load is not directly presented in Table 6 since that would result in double counting relative to the in-stream data presented in the previous paragraph.

Other background loads could not be calculated in this watershed. Although a reference site (Big Tesuque Creek above Highway 285 bridge) was selected in the early biological study (CDM, 1995), it does not have stream channel morphology and flow comparable to those of the Santa Fe River. It is assumed that a portion of the load allocation is made up of natural background loads. In future water quality surveys, finding a suitable reference reach will be a priority.

Table 6. Calculation of measured loads

Location	Flow (mgd)[a]	Measured Stream Bottom Deposits (% fines)	Conversion Factor	Measured Load (% fines)
Santa Fe River	198	27	n/a	27 percent
		Measured Total Suspended Solids (mg/L)[b]	**Conversion Factor**	**Measured Load (lb/day)**
		63.3	8.34	104,529

[a]Flow is the greatest monthly mean flow at USGS gage 08317200 collected from 1970 to 1997.
[b]The geometric mean of total suspended solids observations greater than 48.2 mg/L was computed.

Waste Load Allocations and Load Allocations

Waste Load Allocation

The Santa Fe WWTP is the only known point source of total suspended solids. The waste load allocation for the WWTP is based on its current permit limit of 30 mg/L. Applying the average plant design flow (8.5 mgd) results in a waste load of 2,127 lb/day.

Load Allocation

To calculate the load allocation, the waste load allocation and margin of safety were subtracted from the target capacity (TMDL) using the following equation, and the results are presented in Table 7:

$$LA = TMDL - WLA - MOS$$

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the target load (Table 5) and the measured load (Table 6) plus the MOS. They are shown in Table 8.

The following calculations were used to determine *actual* load reductions:

Target Load = target load capacity (TLC) – margin of safety (MOS)
Load Reduction = measured load (ML) – target load (TL)

Table 7. Calculation of TMDL for stream bottom deposits

Location	WLA (% fines)	LA (% fines)	MOS (25%) (% fines)	TMDL (% fines)
Santa Fe River	0	15	5	20
	WLA (lb/day of TSS)	**LA (lb/day of TSS)**	**MOS (25%) (lb/day of TSS)**	**TMDL (lb/day of TSS)**
	2,127	57,568	19,899	79,594

Table 8. Calculation of load reductions for stream bottom deposits

Location	Target Load Capacity (% fines)	Measured Load (% fines)	Margin of Safety (% fines)	Load Reduction (% fines)
Santa Fe River	20	27	5	12
	Target Load Capacity (lb/day of TSS)	**Measured Load (lb/day of TSS)**	**Margin of Safety (lb/day of TSS)**	**Load Reduction (lb/day of TSS)**
	79,594	104,529	19,899	44,834

Identification and Description of Pollutant Source(s)

The magnitude, location, and potential sources of pollutant sources are summarized in Table 9.

Table 9. Pollutant source summary

Pollutant Sources	Magnitude	Location	Potential Sources (% from each)
Point: Stream Bottom Deposits (% fines) (as TSS in lb/day)	0 2,127	Santa Fe WWTP	0% 2.7%
Nonpoint: Stream Bottom Deposits (% fines) (as TSS in lb/day)	15 57,568	Santa Fe River	75% (fines), 72.3% (TSS) Road Maintenance/Runoff Recreation Streambank Modification/Destabilization Removal of Riparian Vegetation Natural Agriculture Resource Extraction
Margin of Safety: Stream Bottom Deposits (% fines) (as TSS in lb/day)	5 19,899		25% for both

Linkage of Water Quality and Pollutant Sources

Where available data are incomplete or where the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates using the best available information.

SWQB fieldwork includes an assessment of the potential sources of impairment (SWQB/NMED, 1999b). The Pollutant Source(s) Documentation Protocol provides an approach for a visual analysis of the source along an impaired reach. Although this procedure is subjective, SWQB believes that it provides the best available information for the identification of potential sources of impairment in this watershed. Table 9 identifies and quantifies potential sources of nonpoint source impairments along each reach as determined by field reconnaissance and assessment. A further explanation of the sources follows.

The main source of impairment along the Santa Fe River appears to be delivery of sediment from runoff. This includes the flushing of arroyos after precipitation events, head-cutting from increased channelized flows from urban areas, removal of riparian vegetation, and related streambank destabilization. Agricultural practices occur along these reaches, mostly in the form of grazing, and might contribute to the removal of riparian vegetation and streambank destabilization. Prior to the La Bajada mine restoration project (in 1996), increased sediment from this site was documented. Because the soil throughout the watershed is highly erosive, some natural inputs do occur along the reach. Thus, it is important to consider the land directly adjacent to the river as well as upland and upstream areas in a more holistic watershed approach to implementing this TMDL.

Margin of Safety

TMDLs should reflect a margin of safety based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. For this TMDL, there will be no margin of safety for point sources since it is minimal. However, for the nonpoint sources the margin of safety is estimated to be an addition of 25 percent of the TMDL. This margin of safety incorporates errors in calculating NPS loads. A level of uncertainty does exist in the relationship between embeddedness, fines, and biological score. In this case, the percent fines is based on a narrative standard and there is also a potential to have errors in measurements of nonpoint source loads due to equipment accuracy, time of sampling, and other factors. Accordingly, a conservative margin of safety increases the TMDL by 25 percent.

Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during 1994, 1995, and 1999 in a variety of flow conditions. It is assumed that if the critical conditions are met, coverage of any potential seasonal variation will also be met.

Monitoring Plan

Pursuant to Section 106(e)(1) of the federal Clean Water Act, the SWQB has established appropriate monitoring methods, systems, and procedures to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the New Mexico Water Quality Act, the SWQB has developed and implemented a comprehensive water quality monitoring strategy for the surface waters of the state. The monitoring strategy establishes the methods for identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used to progress toward three basic monitoring objectives—to develop water quality-based pollution controls, to evaluate the effectiveness of such controls, and to conduct water quality assessments.

The SWQB uses a rotating basin system approach to water quality monitoring. In this system, a select number of watersheds are intensively monitored each year with an established return frequency of every 5 years.

The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document *Quality Assurance Project Plan for Water Quality Management Programs* (QAPP), is updated annually.

Current priorities for monitoring in the SWQB are driven by the 303(d) list of streams requiring TMDLs. Short-term efforts are directed toward those waters which are on the EPA TMDL consent decree (Forest Guardians and Southwest Environmental Center v. Carol Browner, Administrator, US EPA, Civil Action 96-0826 LH/LFG, 1997) list and which are due within the first 2 years of the monitoring schedule. Once assessment monitoring is completed, those reaches still showing impacts and therefore requiring a TMDL will be targeted for more intensive monitoring. The methods of data acquisition include fixed-station monitoring; intensive surveys of priority water bodies, including biological assessments; and compliance monitoring of industrial, federal, and municipal dischargers and are specified in the Assessment Protocol (SWQB/NMED, 1998).

Pebble counts are used to develop a particle size distribution curve of the bed surface material. The method described by Wolman (1954) was selected for inclusion in the parameter suite evaluated during the sample season. The advantage of this procedure is that it is relatively quick to perform and is reproducible. In streams dominated by fine sediments, coarser particles that provide beneficial habitat tend to become surrounded or buried in fines, leading to a loss of suitable habitat. Cobble embeddedness is a measure of the extent to which these coarser particles are buried by the finer sediments and has both biological and physical significance (USEPA, 1991). The sampling procedure chosen for New Mexico streams is that devised by Skille and King (1989). This technique uses 60-cm diameter hoops as the basic sampling unit. The use of hoops rather than individual particles as the basic unit of measure reduces the variability of the sample. Software obtained from the Idaho Bureau of Reclamation allows for the evaluation of the data (Burton, 1990). Values calculated and reported by the software are percent embeddedness, the Interstitial Space Index (ISI), and percent free matrix cobble.

Also available in the software is a sample size evaluator that helps in determining whether a sufficient sample size has been collected to statistically define the population. The advantage of this procedure is that it is quantifiable. The major disadvantage is in the substantial effort required to complete the data collection.

Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the water body and can be revisited every 5 years. This approach gives an unbiased assessment of the water body and establishes a long-term monitoring record for simple trend analyses. This information will provide time-relevant information for use in 305(b) assessments and to support the need for developing TMDLs.

This approach provides

- A systematic, detailed review of water quality data and efficient use of monitoring resources.
- Information at a scale where implementation of corrective activities is feasible.
- An established order of rotation and predictable sampling in each basin, which allows for enhanced coordinated efforts with other programs.
- Program efficiency and an improved basis for management decisions.

It should be noted that a basin will not be ignored during its 4-year sampling hiatus. The rotating basin program will be supplemented with other data collection efforts, which will be classified as field studies. This time will be used to analyze the data collected, to conduct field studies to further characterize identified problems, and to develop and implement TMDLs. Both types of monitoring, long-term and field studies, can contribute to the Section 305(b) and Section 303(d) listing processes.

The following schedule is for sampling seasons through 2002. Sampling will be done in a consistent manner to support the New Mexico Unified Watershed Assessment (UWA) and the Nonpoint Source Management Program. This sampling regime allows characterization of seasonal variation through sampling in spring, summer, and fall for each of the watersheds.

1998 - Jemez, Chama (above El Vado), Cimarron (above Springer), Santa Fe, San Francisco
1999 - Chama (below El Vado), middle Rio Grande, Gila, Red River
2000 - Mimbres, Dry Cimarron, upper Pecos (headwaters to Ft. Sumner), upper Rio Grande (part1)
2001 - Upper Rio Grande (part 2), lower Pecos (Roswell south), Closed Basins, Zuni
2002 - Canadian Basin, lower Rio Grande, San Juan, Rio Puerco

Implementation Plan

Management Measures

Management measures are "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint source pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives" (USEPA, 1993). A combination of best management practices (BMPs) will be used to implement this TMDL. For this watershed the focus will be on sediment control. BMPs in this area might include proper road maintenance practices and drainage controls, improved grazing management practices, riparian plantings, and hydrogeomorphic river restoration. The SWQB will work with the USDA Forest Service, the Bureau of Land Management, the city of Santa Fe, the New Mexico State Highway and Transportation Department, and private landowners in implementing these BMPs throughout the watershed.

Already the restoration of the La Bajada mine site has been accomplished (1996) to reduce a previously documented gross alpha impairment. This restoration has the added benefit of reduced soil erosion to the Santa Fe River. Cattle have been restricted from grazing near the Santa Fe River on parts of the land near the Santa Fe County Municipal Airport.

Stakeholder and public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholder participation will include choosing and installing BMPs, as well as potential volunteer monitoring. Stakeholders in this process will include SWQB, USDA Forest Service, the Bureau of Land Management, the New Mexico State Highway and Transportation Department, local government, private landowners, environmental groups, and the public.

Table 10. Implementation Time line

Implementation Actions	Year 1	Year 2	Year 3	Year 4	Year 5
Public Outreach and Involvement	X	X	X	X	X
Establish Milestones	X				
Secure Funding	X		X		
Implement Management Measures (BMPs)		X	X		
Monitor BMPs		X	X	X	
Determine BMP Effectiveness				X	X
Reevaluate Milestones				X	X

Assurances

New Mexico's Water Quality Act does not contain enforceable prohibitions directly applicable to nonpoint sources of pollution. The act does authorize the Water Quality Control Commission to "promulgate and publish regulations to prevent or abate water pollution in the state" and to require permits. The Water Quality Act (20 NMAC 6.2) (NMWQCC 1995a) also states in §74-6-12(a):

> *The Water Quality Act (this article) does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights.*

In addition, The State of New Mexico water quality standards (see Section 1100E and Section 1105C) (NMWQCC 1995b) states:

> *These water quality standards do not grant the Commission or any other entity the power to create, take away or modify property rights in water.*

New Mexico policies are in accordance with the federal Clean Water Act §101(g):

> *It is the policy of Congress that the authority of each state to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce, and eliminate pollution in concert with programs for managing water resources.*

NMED nonpoint source water quality improvement work uses a voluntary approach. This provides technical support and grant money for the implementation of best management practices and other NPS prevention mechanisms through Section 319 of the Clean Water Act. Since this TMDL will be implemented through NPS control mechanisms, the New Mexico Nonpoint Source Program is targeting efforts to this watersheds. The Nonpoint Source Program coordinates with the Nonpoint Source Taskforce. The Nonpoint Source Taskforce is the New Mexico statewide focus group representing federal and state agencies, local governments, tribes and pueblos, soil and water conservation districts, environmental organizations, industry, and the public. This group meets on a quarterly basis to provide input on the Section 319 program process, to disseminate information to other stakeholders and the public regarding nonpoint source issues, to identify complimentary programs and sources of funding, and to help review and rank Section 319 proposals.

To ensure reasonable assurances for implementation in watersheds with multiple landowners, including federal, state and private, NMED has established memoranda of understanding (MOUs) with several federal agencies, in particular the Forest Service and the Bureau of Land Management. These MOUs provide for coordination and consistency in dealing with nonpoint source issues.

New Mexico's Clean Water Action Plan has been developed in a coordinated manner with the state's 303(d) process. All Category I watersheds identified in New Mexico's Unified Watershed Assessment process are totally coincident with the impaired waters list for 1996 and 1998 approved by EPA. The state has given a high priority for funding assessment and restoration activities to these watersheds. The time required to attain standards for all reaches is estimated to be approximately 15 years. This is based on a 5-year time frame implementing several watershed projects that may not be starting immediately or may be in response to earlier projects. The cooperation of private landowners and Federal Agencies will be pivotal in the implementation of this TMDL.

Milestones

Milestones will be used to determine if control actions are being implemented and standards attained. For this TMDL several milestones will be established that will vary based on the BMPs implemented at each site. Examples of milestones include achieving a percentage reduction in stream bottom deposits within a certain time frame, updating or developing MOUs with other state and federal agencies by 2001 to ensure protection and restoration in this watershed, and increasing education and outreach activities regarding sediment erosion in this watershed, particularly for private landowners.

Milestones will be reevaluated periodically, depending on what BMP was implemented. Further implementation of this TMDL will be revised based on the reevaluation. The process will involve monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the water body, and reevaluating the TMDL for attainment of water quality standards.

PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL. See Appendix B for a flow chart of the public participation process. The draft TMDL was made available for a 30-day comment period starting November 9, 1999. Response to comments will be attached as an Appendix to this document. The draft document notice of availability was extensively advertised through newsletters, e-mail distribution lists, web page postings (http://www.nmenv.state.nm.us), and press releases to area newspapers.

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APPENDICES

Appendix A. Discharge and Ambient Monitoring Data

Table A-1. Permit Compliance Limits and Discharge Monitoring Report Data for the Santa Fe WWTP

Table A-2a. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Table A-2b. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Appendix B. Public Participation

Table A-1. Permit Compliance Limits and Discharge Monitoring Report Data for the Santa Fe WWTP

Permit Compliance Limits and Discharge Monitoring Report Data	pH		Total Suspended Solids			Total Nitrate Nitrogen (as N)			Total Kjeldahl Nitrogen (as N)		Flow		Fecal Coliform		5-Day Carbonaceous BOD		
	Minimum (SU)	Maximum (SU)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (mgd)	Maximum Daily Maximum (mgd)	30-day Geometric Mean (#/100ml)	Maximum 7-day Geometric Mean (#/100ml)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)
Permit Limit	6.0	9.0	1626	30	45	542	10	15					500	500	1355	25	40
1995-Jan	7.11	7.32	314.9	6.4	6.5	59	1.2	2.2	3.2	3.6	5.9	6.4	20.1	29.1	182.1	3.7	3.7
1995-Feb	7.02	7.19	328	6.9	7.2	175.9	3.7	5.1	2.7	3.7	5.7	6.7	23.6	30.4	171.1	3.6	3.9
1995-Mar	6.94	7.19	343.4	7.1	7.6	48.4	1	2.3	2.7	3.2	5.8	6.6	31.3	43.1	174.1	3.6	3.9
1995-Apr	6.87	7.16	367.6	7.6	8.6	140.3	2.9	3.7	3	3.3	5.8	6.7	54.5	153.9	188.7	3.9	4.3
1995-May	6.99	7.19	237.7	5	7.2	109.3	2.3	4	2.4	2.9	5.7	6.8	3.7	5.7	142.6	3	3.6
1995-Jun	6.94	7.12	196.2	4.2	4.1	32.7	0.7	0.7	2.3	2.5	5.6	7.19	5.2	4.3	126.1	2.7	2.8
1995-Jul	7.03	7.15	318.3	7.2	11.6	84	1.9	2.4	2.6	3.2	5.3	6.6	4.3	19.4	181.2	4.1	6.1
1995-Aug	7.01	7.26	645.5	12.9	19.6	65.1	1.3	2.5	3.4	4.8	6	7.2	8	38	280.2	5.6	8.1
1995-Sep	7.04	7.22	228.9	4.5	5	81.4	1.6	2.4	1.8	1.9	6.1	7	3.3	9.8	127.2	2.5	2.9
1995-Oct	7.11	7.32	260.8	5.3	6.2	142.7	2.9	4.7	2.2	2.2	5.9	6.8	4.1	8	123	2.5	3.2
1995-Nov	7.19	7.33	222.3	4.3	4.6	206.8	4	4.1	1.8	2.4	6.2	7.3	1.9	2.6	87.9	1.7	2
1995-Dec	7.03	7.27	367.6	7.6	9.7	188.7	3.9	6.7	2.3	3.3	5.8	6.4	11.1	22	116.1	2.4	3.4
1996-Jan	7.03	7.31	442.9	9	10.3	187	3.8	5.2	1.8	2.4	5.9	6.6	3.8	6.1	147.6	3	4
1996-Feb	6.99	7.2	485.8	9.1	9.4	213.5	4	6.3	2.6	2.8	6.4	6.8	10	18.6	224.2	4.2	5.4
1996-Mar	6.89	7.16	290	5.7	8.9	127.2	2.5	6.7	2.3	2.8	6.1	6.9	3.7	7.4	208.6	4.1	4.4
1996-Apr	6.96	7.2	229.7	5.1	5.6	76.6	1.7	3.4	1.8	2	5.4	6.3	2.5	2.9	126.1	2.8	3.2
1996-May	6.88	7.14	467	11.2	13.1	79.2	1.9	2.7	3	3.4	5	5.7	4.6	9.2	200.2	4.8	5.8
1996-Jun	7.01	7.26	316.9	7.6	12.5	79.2	1.9	3.9	1.9	3	5	7.8	3.5	5.1	125.1	3	3.9

Table A-1. Permit Compliance Limits and Discharge Monitoring Report Data for the Santa Fe WWTP

Permit Compliance Limits and Discharge Monitoring Report Data	pH		Total Suspended Solids			Total Nitrate Nitrogen (as N)			Total Kjeldahl Nitrogen (as N)		Flow		Fecal Coliform		5-Day Carbonaceous BOD		
	Minimum (SU)	Maximum (SU)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (mgd)	Maximum Daily Maximum (mgd)	30-day Geometric Mean (#/100ml)	Maximum 7-day Geometric Mean (#/100ml)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)
Permit Limit	6.0	9.0	1626	30	45	542	10	15					500	500	1355	25	40
1996-Jul	7.18	7.36	382.1	7.9	17	82.2	1.7	3.8	1.7	1.8	5.8	7.5	2.9	4.3	116.1	2.4	2.7
1996-Aug	7.02	7.26	186.8	4	5.1	42	0.9	1.8	1.6	1.7	5.6	6.7	1.4	2.2	84.1	1.8	2
1996-Sep	7.1	7.23	151.4	3.3	3.7	73.4	1.6	2.5	1.5	1.7	5.5	6.4	2	5.5	82.6	1.8	1.9
1996-Oct	7.04	7.31	225.2	5	6.6	94.6	2.1	5.4	2	2.3	5.4	6.3	2.4	2.9	108.1	2.4	3.3
1996-Nov	7.06	7.31	393.2	8.8	9.5	75.2	1.7	2.6	2.4	2.7	5.3	5.8	2.5	5.3	185.7	4.2	4.8
1996-Dec	6.99	7.36	759.5	15.7	23.2	33.9	0.7	1.8	3.2	3.7	5.8	6.5	3.2	5	324.1	6.7	7.9
1997-Jan	7.06	7.31	270.9	5.6	8.1	33.9	0.7	1.6	1.7	1.9	5.8	6.1	2.2	3	169.3	3.5	5.4
1997-Feb	6.85	7.19	236.2	4.8	5.3	88.6	1.8	1.7	1.8	1.8	5.9	6.3	3.6	8.4	157.5	3.2	4.3
1997-Mar	6.65	7.07	324.3	7.2	8.3	9	0.2	2.5	2.2	2.4	5.4	6.1	2.4	6.1	193.7	4.3	5
1997-Apr	6.65	7.05	429.7	9.2	10	28	0.6	1.4	2.6	2.9	5.6	6.4	2.7	4.6	219.5	4.7	5.6
1997-May	6.79	7.07	327	7	8.5	18.7	0.4	0.5	2.2	2.8	5.6	6.6	2.6	4.4	172.8	3.7	4.4
1997-Jun	6.86	7.19	294.8	6.2	7.3	4.8	0.1	0.1	2.3	2.7	5.7	6.7	2.2	3.2	152.1	3.2	4
1997-Jul	6.85	7.14	165.2	3.6	4.2	9.2	0.2	0.2	1.7	2	5.5	8.1	2.9	7.2	105.5	2.3	2.6
1997-Aug	6.85	7.12	123.9	2.7	3.1	13.8	0.3	0.7	2	2.7	5.5	7.4	1.3	1.9	82.6	1.8	2.1
1997-Sep	6.88	7.11	105.8	2.78	3.1	15.7	0.4	0.9	1.8	2.3	4.7	6.4	1.3	1.6	58.8	1.5	1.7
1997-Oct	7.07	7.33	296.2	6.7	8.7	17.7	0.4	1.1	2.7	3.5	5.3	6.9	1.7	2.2	141.5	3.2	4.4
1997-Nov	7.11	7.39	160.1	3	7.4	16	0.3	0.7	2.2	2.5	6.4	7.3	1.4	2	117	2.2	3.5
1997-Dec	7.03	7.48	30.5	0.6	0.6	45.8	0.9	1.9	2.1	2	6.1	7.2	1	1.2	96.7	1.9	2.2

Table A-1. Permit Compliance Limits and Discharge Monitoring Report Data for the Santa Fe WWTP

Permit Compliance Limits and Discharge Monitoring Report Data	pH		Total Suspended Solids			Total Nitrate Nitrogen (as N)			Total Kjeldahl Nitrogen (as N)		Flow		Fecal Coliform		5-Day Carbonaceous BOD		
	Minimum (SU)	Maximum (SU)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)	30-Day Average (mgd)	Maximum Daily Maximum (mgd)	30-day Geometric Mean (#/100ml)	Maximum 7-day Geometric Mean (#/100ml)	30-Day Average (lb/day)	30-Day Average (mg/L)	Maximum 7-Day Average (mg/L)
Permit Limit	6.0	9.0	1626	30	45	542	10	15					500	500	1355	25	40
1998-Jan	6.99	7.52	73.8	1.5	2.8	98.4	2	5.6	1.5	4.1	5.9	6.3	1.1	1.6	9.8	0.2	0.7
1998-Feb	7.06	7.48	132.9	2.7	5.8	39.4	0.8	1.1	1.4	1.7	5.9	6.4	4.2	21.5	19.7	0.4	0.7
1998-Mar	7.14	7.52	249.3	4.9	5.5	20.3	0.4	0.6	1.9	2	6.1	6.8	43.8	57	50.9	1	1.3
1998-Apr	7.13	7.41	104.3	2.5	3.8	41.7	1	1.2	1.2	1.5	5	6	16.5	35	20.9	0.5	1.2
1998-May	6.89	7.38	66.6	1.9	2.6	28	0.8	1	1.4	1.8	4.2	5.6	21.8	62.8	17.5	0.5	0.9
1998-Jun	7.14	7.33	93.4	2.8	3.5	43.4	1.3	3	3.8	8.2	4	5.3	26	48.4	20	0.6	0.7
1998-Jul	7.04	7.37	45	1	1.6	54	1.2	1.3	2.2	3	5.4	6.6	15.2	27.1	27	0.6	0.8
1998-Aug	7.05	7.36	72.6	1.5	2	24.2	0.5	1.6	8.1	14.7	5.8	6.9	22	51.7	29	0.6	0.8
1998-Sep	7.1	7.34	65.4	1.4	2.4	18.7	0.4	0.5	6.5	13.2	5.6	6.7	11.8	29.7	32.7	0.7	1
1998-Oct	7.05	7.35	43.5	0.9	1.5	72.6	1.5	3	1.9	4.6	5.8	6.8	4.9	31.3	14.5	0.3	0.5
1998-Nov	7.24	7.43	36.2	0.7	0.8	51.7	1	1.6	1.5	2.3	6.2	6.5	2.3	5.2	10.3	0.2	0.3
1998-Dec	7.16	7.42	41.4	0.8	1.1	41.4	0.8	1.2	1.8	2.4	6.2	6.9	1.7	2.6	5.2	0.1	0.1
1999-Jan	7.17	7.38	48.4	1	1.1	48.4	1	1	1.6	2.3	5.8	6.5	1.7	1.8	4.8	0.1	0.2
1999-Feb	7.13	7.32	55.1	1.1	1.2	15	0.3	0.4	1.9	3.6	6	6.2	1.3	2.7	25	0.5	1.3
1999-Mar	7.1	7.5	36.8	0.7	0.8	15.8	0.3	0.4	1.2	1.3	6.3	7.5	1.3	2.1	52.5	1	1.2
1999-Apr	7.1	7.3	48	0.9	1	16	0.3	0.4	1.4	1.7	6.4	7.2	1.1	1.4	53.4	1	1.1
1999-May	7	7.3	51.7	1	1.1	15.5	0.3	0.4	1.5	1.7	6.2	7.4	1.5	2.3	51.7	1	1.2
1999-Jun	7.1	7.3	50	1.2	1.4	8.3	0.2	0.2	1.6	2.4	5	6.5	1.9	2.4	41.7	1	1.1

Table A-2a. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Date	Time	Water Temperature (ºC)	Field Conductivity Corrected to 25 ºC (uhmo)	Dissolved Oxygen (mg/L)	Field pH (SU)	Field Turbidity (NTU)	Total Phosphorus (mg/L)	Nitrate + Nitrite as Nitrogen (mg/L)	Total Ammonia as Nitrogen (mg/L)	Total Inorganic Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Organic Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Organic Carbon (mg/L)
At Santa Fe WWTP														
1998-10-06	1508						0.790	1.260	1.38	2.64C	2.710	1.33C	3.97C	
1998-10-07	1026	22.00			7.05									
1998-10-07	1027													
1998-10-07	1028													
Santa Fe River below WWTP														
1998-11-17	1510	18.9	782	5.6	7.71	3.20								
1998-11-18	0930	18.2	773	6.5	7.46	3.07	0.553	0.336	0.1k	.436C	1.080	.98C	1.416C	5k
1998-11-19	1420	18.6	771	5.9	8.04	1.50	0.188	0.942	0.188	1.13C	1.290	1.102C	2.232C	5k
1998-11-20	1355	18.1	784	5.8	7.81	2.20	0.197	0.690	0.409	1.099C	1.300	.891C	1.99C	7.76
1998-12-01	1315	18.4	757	7.1	7.73	4.28								
1999-04-13	0915	17	748	7.1	7.95	1.01	3.94	0.1k	0.1k	0.2k	1.07	0.97k	1.17k	8
1999-04-14	1230	18.1	723	9.4	7.45	1.43	0.31	0.1k	0.1k	0.2k	0.97	0.87k	1.07k	6.6
1999-04-14	1250	18.1	7.23	9.4	7.45	1.43	0.31	0.1k	0.1k	0.2k	0.96	0.86k	1.06k	8.7
1999-04-15	1205	17.6	715	9.4	8.26	1.15	1	0.1k	0.1k	0.2k	0.96	0.86k	1.06k	7.2
1999-04-16	0900	16.4	726	8.7	7.77	1.44	3.83	0.1k	0.1k	0.2k	1.03	0.93k	1.13k	14.6
1999-04-16	0910	16.4	726	8.7	7.77	1.44	3.81	0.1k	0.1k	0.2k	1.08	0.98k	1.18k	7.1
Santa Fe River at River Preserve														
1998-10-06	1524						1.290	1.430	0.611	2.04C	1.960	1.349C	3.39C	
1998-10-06	1529													
1998-10-07	1105	21.00			8.39									
1998-11-17	1430	17.7	778	7.8	8.17	2.59	0.256	0.894	0.1k	.994C	0.962	.862C	1.856C	5k
1998-11-18	0940	14.6	766	8.6	8.38	1.79	0.543	0.287	0.1k	0.387C	0.924	.824C	1.211C	5k

Table A-2a. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Date	Time	Water Temperature (ºC)	Field Conductivity Corrected to 25 ºC (uhmo)	Dissolved Oxygen (mg/L)	Field pH (SU)	Field Turbidity (NTU)	Total Phosphorus (mg/L)	Nitrate + Nitrite as Nitrogen (mg/L)	Total Ammonia as Nitrogen (mg/L)	Total Inorganic Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Organic Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Organic Carbon (mg/L)
1998-11-19	1110	17.1	680	8.3	8.57	0.00	0.532	0.251	0.1k	0.351C	0.954	.854C	1.205C	5k
1998-11-20	1345	17.5	768	8.3	8.64	1.82	0.208	0.546	0.1k	.646C	1.030	.93C	1.576C	7.29
1999-04-13	0955	14.3	730	14.6	8.99	1.01	3.28	0.1k	0.1k	0.2k	0.97	0.87k	1.07k	7.5
1999-04-14	1130	18.8	707	16.9	9.03	1.04	1.57	0.1k	0.1k	0.2k	1.02	0.92k	1.12k	5.6
1999-04-15	1120	14.3	708	15.2	9.17	1.12	4.18	0.1k	0.1k	0.2k	1.01	0.91k	1.11k	7.9
1999-04-16	0950	12	707	17.8	9.31	0.67	2.91	0.1k	0.1k	0.2k	0.89	0.79k	0.99k	9.3
Santa Fe River at Canon														
1998-11-17	1150	14.1	690	9.2	8.85	3.68	0.631	0.628	0.1k	.728C	0.742	.642C	1.37C	5k
1998-11-18	1230	13.4	697	9	8.73	5.83	0.448	0.659	0.1k	.759C	0.599	.499C	1.258C	5k
1998-11-19	1045	10.3	659	8.7	8.79	2.79	0.635	0.696	0.1k	.796C	0.700	.6C	1.396C	5k
1998-11-20	1315	11.7	696	8.4	8.88	7.81	0.371	0.728	0.1k	.828C	0.868	.768C	1.596C	5.81
1999-04-13	1215	17.3	635	13.9	9.55	2.14	1.15	0.1k	0.1k	0.2k	0.71	0.61k	0.81k	5.3
1999-04-14	1115	14.4	631	13.7	9.01	1.26	0.93	0.1k	0.1k	0.2k	0.71	0.61k	0.81k	6.8
1999-04-15	1055	10.8	630	13.1	9.49	1.31	1.59	0.1k	0.1k	0.2k	0.7	0.6k	0.80k	5.51
1999-04-16	1150	12.5	620	13.2	9.55	0.96	1.62	0.1k	0.1k	0.2k	0.69	0.59k	0.79k	6.67
Cienega Creek at Mobile Home Park														
1998-11-17	1125	7.1	715	9.2	8.1	7.55	0.05k	0.172	0.1k	.272C	0.316	.216C	.488C	5k
1998-11-18	1300	8.5	653	7.9	8.11	4.23	0.05k	0.143	0.1k	.243C	0.236	.136C	.379C	5k
1998-11-19	1010	5.1	716	9	8.09	5.45	0.063	0.171	0.1k	.271C	0.236	.136C	.407C	5k
1998-11-20	1000	4.4	706	9.4	7.63	5.52	0.05k	0.179	0.1k	.279C	0.319	.219C	.498C	5k
1999-04-13	1250	13	708	10	8.64	5.33	0.05k	0.1k	0.1k	0.2k	0.26	0.16k	0.36k	5k
1999-04-14	1050	8.9	701	10.2	8.16	6.12	0.03k	0.1k	0.1k	0.2k	0.19	0.09k	0.29k	5k
1999-04-15	1020	6.9	694	9.4	8.36	5.18	0.03k	0.1k	0.1k	0.2k	0.24	0.14k	0.34k	5k
1999-04-16	1210	8.30	709	10.60	8.57	4.48	0.05k	0.1k	0.1k	0.2k	0.22	0.12k	0.32k	5k

Table A-2a. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Date	Time	Water Temperature (ºC)	Field Conductivity Corrected to 25 ºC (uhmo)	Dissolved Oxygen (mg/L)	Field pH (SU)	Field Turbidity (NTU)	Total Phosphorus (mg/L)	Nitrate + Nitrite as Nitrogen (mg/L)	Total Ammonia as Nitrogen (mg/L)	Total Inorganic Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Organic Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Organic Carbon (mg/L)
Santa Fe River Below Cienega														
1998-11-17	1330	12.4	660	8.2	8.74	8.11	0.438	0.367	0.1k	.467C	0.396	.296C	.763C	5k
1998-11-18	1045	9.1	717	9.3	8.49	7.68	0.311	0.595	0.1k	.695C	0.503	.403C	1.098C	5k
1998-11-19	1300	11.3	704	8.1	8.71	4.50	0.478	0.457	0.1k	0.557C	0.564	.464C	1.021C	5k
1998-11-20	1115	7.2	712	8.6	8.69	5.01	0.261	0.567	0.1k	.667C	0.609	.509C	1.176C	5k
1998-12-01	1230	9.8	681	10.3	8.79	5.19								
1999-04-13	1045	13.2	692	12.8	9.06	2.14	0.43	0.1k	0.1k	0.2k	0.71	0.61k	0.81k	5k
1999-04-14	1340	17.8	667	11.4	9.13	1.99	0.7	0.1k	0.1k	0.2k	0.65	0.55k	0.75k	5k
1999-04-15	1300	15.2	664	13.2	9.45	2.19	0.75	0.1k	0.1k	0.2k	0.58	0.48k	0.68k	5k
1999-04-16	1030	9.1	677	12.4	8.98	2.03	1.33	0.1k	0.1k	0.2k	0.68	0.58k	0.78k	7.4
Santa Fe River at USGS														
1998-11-17	1030	7.6	735	9.5	8.62	13.30	0.560	0.669	0.1k	.769C	0.567	.467C	1.23C	5k
1998-11-18	1340	10.3	724	8.7	8.74	8.76	0.417	0.548	0.1k	.648C	0.554	.454C	1.102C	5k
1998-11-19	0923	4.1	734	10	8.63	10.70	0.723	0.667	0.1k	.767C	0.642	.542C	1.309C	6.19
1998-11-20	0930	3.4	728	10.2	8.39	8.23	0.336	0.881	0.1k	.981C	0.780	.680C	1.661C	5.35
1998-12-01	1000	5.5	722	11	8.61	11.10								
1999-04-13	1330	18.4	506	8.8	8.76	3.54	0.53	0.1k	0.1k	0.2k	0.72	0.62k	0.82k	5k
1999-04-14	0940	10.7	712	9.4	8.55	3.04	1.52	0.1k	0.1k	0.2k	0.69	0.59k	0.79k	5k
1999-04-15	0945	7	683	11	8.48	4.04	0.68	0.1k	0.1k	0.2k	0.69	0.59k	0.79k	5k
1999-04-16	1250	13.2	691	9.1	9.1	3.55	1.16	0.1k	0.1k	0.2k	0.69	0.59k	0.79k	6.03

Table A-2b. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Date	Time	Water Temperature (ºC)	Field pH (SU)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Total Hardness as $CaCO_3$ (mg/L)	Dissolved Calcium (mg/L)	Dissolved Magnesium (mg/L)	Dissolved Potassium (mg/L)	Dissolved Sodium (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate as HCO_3 (mg/L)	Total Chloride (mg/L)	Dissolved Sulfate (mg/L)
At Santa Fe WWTP														
1998-10-06	1508													
1998-10-07	1026	22.00	7.05		3k									
1998-10-07	1027													
1998-10-07	1028													
Santa Fe River below WWTP														
1998-11-17	1510	18.9	7.71	510	3k	110	36.2	4.79	12.7	106	253	309	62.8	39.7
1998-11-18	0930	18.2	7.46	492	5	110	36.2	4.79	13	105	255	311	60.9	39.2
1998-11-19	1420	18.6	8.04	488	6	109	36.2	4.63	12.2	100	256	313	60.6	37.8
1998-11-20	1355	18.1	7.81	538	22	112	37.2	4.62	12.9	105	253	309	65.9	38.4
1998-12-01	1315	18.4	7.73											
1999-04-13	0915	17	7.95	500	3k	130	41.2	6.46	16.2	110	231	282	64.4	37.9
1999-04-14	1230	18.1	7.45	468	3k	121	39.3	5.61	15.2	107	222	271	64.4	38.7
1999-04-14	1250	18.1	7.45	480	3	122	39.7	5.52	14.7	106	224	273	64	38.7
1999-04-15	1205	17.6	8.26	458	3k	119	38.2	5.76	14.5	100	223	272	64.1	38.3
1999-04-16	0900	16.4	7.77	476	3k	122	38	6.53	16.2	102	214	261	65.4	37.7
1999-04-16	0910	16.4	7.77	482	3k	122	38.3	6.54	16.6	102	216	264	67	37.3
Santa Fe River at River Preserve														
1998-10-06	1524				21k									
1998-10-06	1529			536	5	85.7	27.1	4.38	12.5	91.1	226	275	62.8	34.3
1998-10-07	1105	21.00	8.39											
1998-11-17	1430	17.7	8.17	500	3k	110	36.4	4.66	12.4	104	270	329	63.6	40.1
1998-11-18	0940	14.6	8.38	520	3k	109	36	4.69	12.7	106	254	305	61.6	39.7

Table A-2b. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Date	Time	Water Temperature (ºC)	Field pH (SU)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Total Hardness as $CaCO_3$ (mg/L)	Dissolved Calcium (mg/L)	Dissolved Magnesium (mg/L)	Dissolved Potassium (mg/L)	Dissolved Sodium (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate as HCO_3 (mg/L)	Total Chloride (mg/L)	Dissolved Sulfate (mg/L)
1998-11-19	1110	17.1	8.57	526	3k	112	37.3	4.72	12.9	102	262	315	60.7	38.5
1998-11-20	1345	17.5	8.64	532	10	107	35.2	4.64	12.4	104	248	296	65.5	39
1999-04-13	0955	14.3	8.99	504	3k	127	40.9	6.08	14.8	108	222	254	64.7	37.2
1999-04-14	1130	18.8	9.03	468	3k	122	39.2	5.81	15	107	234	250	63.4	38.3
1999-04-15	1120	14.3	9.17	470	3k	124	38.9	6.45	15.7	102	216	244	64.1	36.9
1999-04-16	0950	12	9.31	470	3k	125	39.7	6.24	15	104	225	244	65.9	36.9
Santa Fe River at Canon														
1998-11-17	1150	14.1	8.85	462	3k	128	42.6	5.31	10.4	86.7	244	287	54.7	35.9
1998-11-18	1230	13.4	8.73	450	10	121	39.8	5.18	9.93	86.4	240	282	55.1	36.3
1998-11-19	1045	10.3	8.79	468	3k	128	42.5	5.28	10.5	83.5	238	271	53.5	34.9
1998-11-20	1315	11.7	8.88	492	8	124	40.5	5.48	10	91.7	235	275	58	35.9
1999-04-13	1215	17.3	9.55	432	3k	137	44.8	6.07	11.2	88	214	213	56.7	33.4
1999-04-14	1115	14.4	9.01	420	3k	135	43.7	6.22	10.9	87.4	214	225	55.7	33.2
1999-04-15	1055	10.8	9.49	422	3k	134	43.2	6.4	11.1	83.5	214	231	55	33.3
1999-04-16	1150	12.5	9.55	416	3k	133	42.7	6.4	11.3	85	205	213	56.2	32.2
Cienega Creek at Mobile Home Park														
1998-11-17	1125	7.1	8.1	480	3k	260	81.9	13.6	5k	48.8	272	329	25.3	75.6
1998-11-18	1300	8.5	8.11	480	5	239	72.3	14.2	5k	51.8	258	310	25.7	77
1998-11-19	1010	5.1	8.09	484	3k	259	81.3	13.7	5k	47	275	333	24.6	73.9
1998-11-20	1000	4.4	7.63	516	6	257	79.8	14	5k	51.3	263	317	25.4	76.1
1999-04-13	1250	13	8.64	442	3k	244	73.3	14.8	5k	57.8	244	298	21.2	75.3
1999-04-14	1050	8.9	8.16	480	6	224	65.6	14.7	5k	56.2	264	322	21.7	73.5
1999-04-15	1020	6.9	8.36	454	6	231	68	14.8	5k	55.4	253	309	22	72.5
1999-04-16	1210	8.30	8.57	466	4	218	62.4	15.2	5k	56	256	312	21.7	74.9

Table A-2b. Ambient Water Quality Monitoring During October/November 1998 and April 1999

Date	Time	Water Temperature (ºC)	Field pH (SU)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Total Hardness as $CaCO_3$ (mg/L)	Dissolved Calcium (mg/L)	Dissolved Magnesium (mg/L)	Dissolved Potassium (mg/L)	Dissolved Sodium (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Bicarbonate as HCO_3 (mg/L)	Total Chloride (mg/L)	Dissolved Sulfate (mg/L)
Santa Fe River Below Cienega														
1998-11-17	1330	12.4	8.74	472	4	163	51.9	8.19	8.42	79.1	253	297	47.6	49.4
1998-11-18	1045	9.1	8.49	474	3	154	48.9	7.68	8.44	79.5	244	291	49.3	47.6
1998-11-19	1300	11.3	8.71	470	3k	163	51.8	8.15	8.34	75.6	257	300	46.6	47.1
1998-11-20	1115	7.2	8.69	492	5	166	52.5	8.45	8.66	84.3	248	293	48.8	49.2
1998-12-01	1230	9.8	8.79											
1999-04-13	1045	13.2	9.06	450	3k	166	52.1	8.82	9.74	87.6	235	263	51.5	44.3
1999-04-14	1340	17.8	9.13	456	3k	175	54.6	9.42	9	82.3	235	247	47.4	47.2
1999-04-15	1300	15.2	9.45	440	3k	173	53.9	9.35	8.71	81.2	239	258	47.4	46.7
1999-04-16	1030	9.1	8.98	450	3k	168	52.5	8.97	9.43	84.8	234	267	51.8	44
Santa Fe River at USGS														
1998-11-17	1030	7.6	8.62	472	9	147	47.3	7.07	9.47	87.4	253	301	54.1	46.3
1998-11-18	1340	10.3	8.74	472	7	149	47.5	7.33	9.07	81.9	245	286	52.1	47.8
1998-11-19	0923	4.1	8.63	484	16	144	46	7	9.38	85.8	249	298	54.2	45
1998-11-20	0930	3.4	8.39	516	12	143	45.7	7.08	8.73	84.8	250	298	55	45.4
1998-12-01	1000	5.5	8.61											
1999-04-13	1330	18.4	8.76	460	3k	163	51	8.74	10.5	93.2	240	266	54.6	43.9
1999-04-14	0940	10.7	8.55	476	3k	169	53.2	8.83	10.2	91.7	241	286	54.2	42.5
1999-04-15	0945	7	8.48	448	3k	167	52.2	8.9	9.53	90.9	243	287	53.1	43.2
1999-04-16	1250	13.2	9.1	456	4	162	50.5	8.72	9.8	88.9	234	265	53.9	43.1

APPENDIX B. PUBLIC PARTICIPATION