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Pre-Impoundment Water Quality Study for the San Miguel Project

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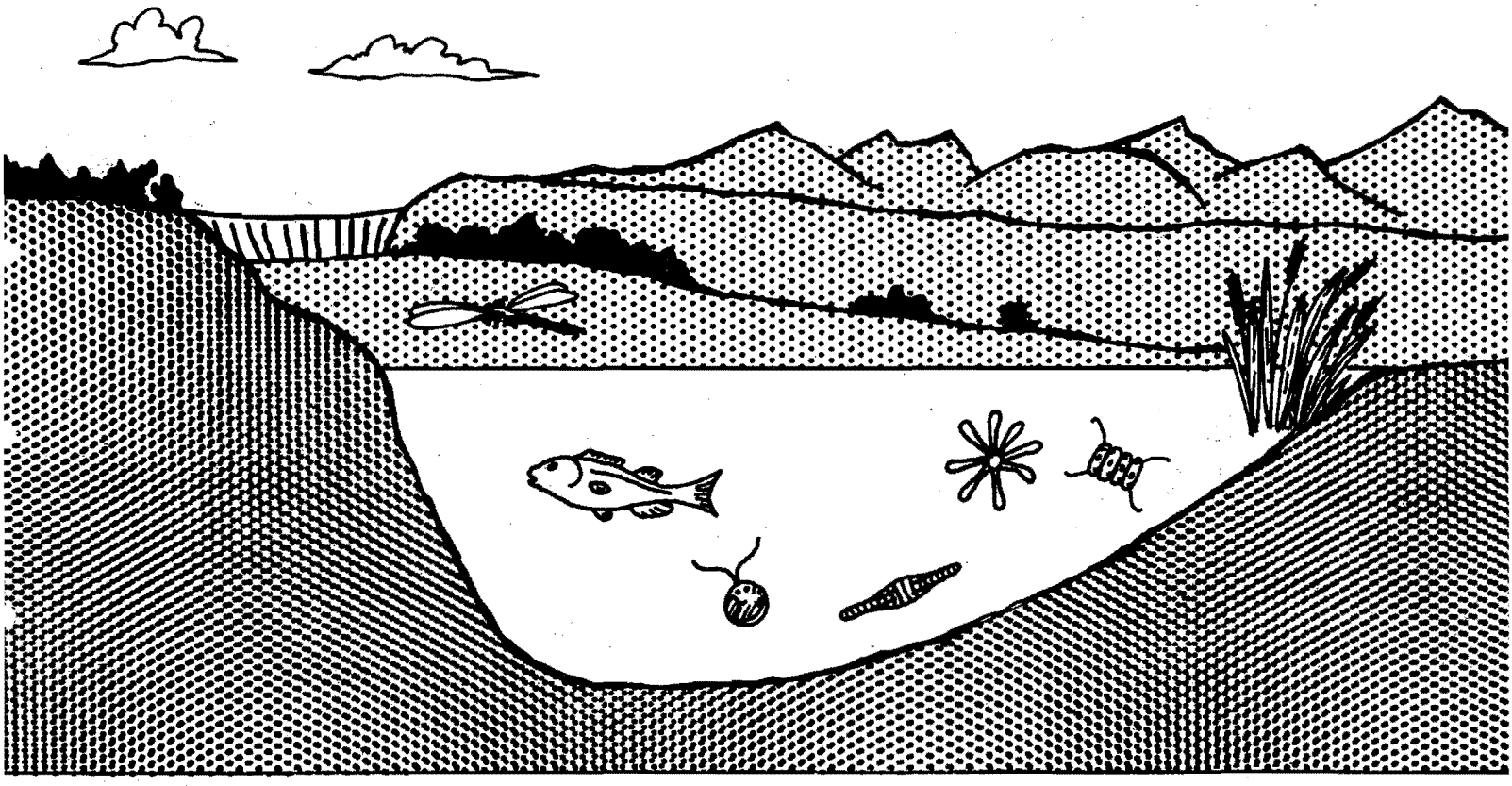

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Introduction

Scope of study

The United States Bureau of Reclamation (USBR) is currently evaluating plans to construct a multipurpose reservoir on the San Miguel River 32 kilometers (20 miles) below Telluride, Colorado. As part of the environmental assessment for this project, the Utah Water Research Laboratory (UWRL) was contracted to conduct an intensive water quality study on the San Miguel River and its tributaries in the vicinity of the project area. In this study water samples were collected during the period from May, 1977, to August, 1978, on a monthly basis from three sites on the San Miguel River and from Leopard Creek. Samples were analyzed for 49 water quality parameters. The data collected during this period were used to evaluate the existing quality of water at each site with respect to various water uses.

Project description

The plans for this project had not been finalized at the time of this writing, but a tentative plan is described in a USBR planning report (USBR, 1978). In this plan, the Saltado Damsite was to be located in the San Miguel Canyon 32 km downstream from Telluride, Colorado (Figure 1). The reservoir will have a total capacity of 3.20×10^7 m^3 (26,000 A.F.) and a surface area of about 154 hectares (380 acres). The project will provide 47×10^6 m^3 (38,211 A.F.) of water for irrigation and 37×10^6 m^3 (30,081 A.F.) for municipal and industrial use per year. In addition to the reservoir, the project will include a nine mile long pipeline to Norwood Hill, a lift station at Norwood Hill and a canal on the Wright's Mesa to conduct water to farmlands. Project features are summarized in Table 1.

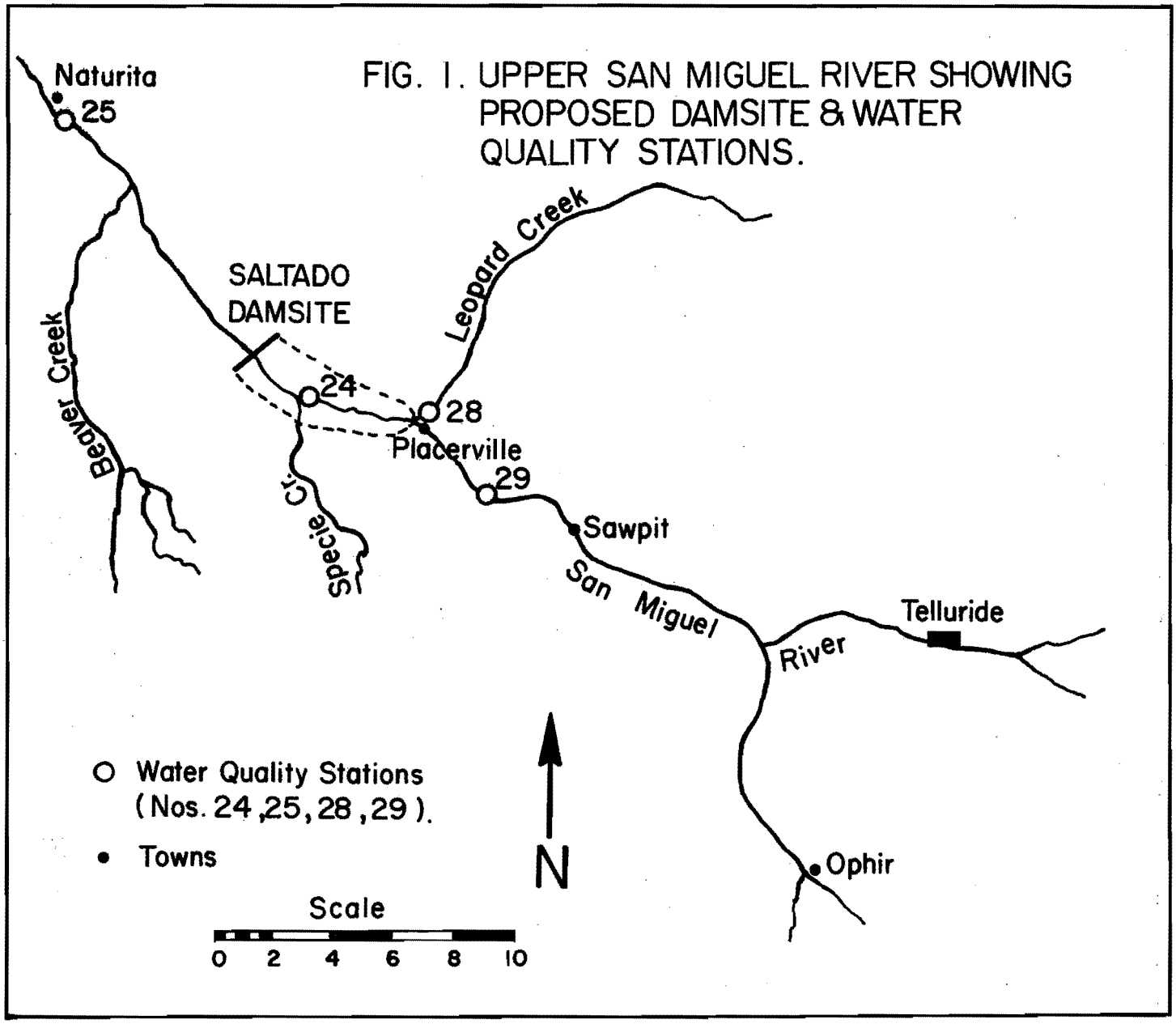

FIG. 1. UPPER SAN MIGUEL RIVER SHOWING PROPOSED DAMSITE & WATER QUALITY STATIONS.

Table 1. San Miguel Project Statistics[1]

Saltado Reservoir	
Height above streambed (ft.)	210
Crest length (feet)	800
Active capacity (acre-feet)	24,000
Inactive capacity (acre-feet)	2,000
Water surface area (acres)	
Total pool	380
Inactive pool	65
Average depth (ft.)	68
Project Supply (acre-feet)	
Irrigation	38,000
Municipal & industrial	30,000
Total	68,000
Economic Analysis	
Average annual costs	2,635,000
Average annual benefits	3,518,000
Total benefits: cost	1.15:1

[1] Source: USBR (1978).

The San Miguel River Watershed

The San Miguel River system originates in the high granite peaks of the San Juan Mountains that surround Telluride, Colorado and empties into the Dolores River, 51 km (81 mi) from its source, at Uravan, Colorado (Figure 1). From the highest point in the watershed, Wilson Peak (el. 4,270 m) to the Saltado Reservoir damsite (el. 2136 m) there is an elevation drop of 2,134 m. Above Telluride cascading mountain streams feed the river. The river between Telluride and the confluence of the South Fork the river runs through a half mile wide valley that is used mostly for grazing. Below the confluence of the South Fork the river valley narrows, and the 40 km section between Placerville and Pinyon Bridge is a narrow canyon. The Saltado Reservoir damsite is located in this canyon.

Many metals mines are still active in the headwaters area and there are numerous tailing ponds on the main branch of the San Miguel River above Telluride and on the South Howard Forks near Ophir. Smith (1977) found the main stem above Telluride and the Howard Fork to be nearly devoid of fish life and attributed this lack of fish fauna to the impact of metals mining activity. Deposits of iron oxides were noted along the Howard Fork. Smith (1977) reported that metal pollution in the San Miguel River was a major problem in the 1950s and 60s but that the upper part of the river is now relatively free from metals problems. Water quality data collected by the Colorado Department of Health (from Smith, 1977) are presented in Appendix A.

Methods

Bottles to be used for sample collection were prepared at the UWRL and sent to Colorado for sample collection via Greyhound bus. Three sample bottles were used for each station. Water to be analyzed for non-metallic constituents (plus calcium and magnesium) were collected in half gallon Nalgene bottles. Two 500 ml polyethylene bottles were used for the collection of samples to be analyzed for metals. One of these was reserved for the analyses of "total" metals and the other reserved for the analyses of "dissolved" metals. All sample bottles were prepared prior to shipment using a rinse with dilute HCl followed by three rinses with high quality distilled water. Prior to shipment, 1.5 ml of 50 percent HNO_3 was added to each sample bottle reserved for the analyses of "total" metals.

In Colorado the staff of the USBR or of the consulting firm cf A and S Consultants, Inc. collected samples from each water quality station. Samples were packed in ice for the return trip to the UWRL and shipped via Greyhound bus. Samples usually arrived in Logan the following afternoon and analyses were begun immediately. Occasionally, samples were held in transit longer due to inclement weather.

Upon receipt at the UWRL a portion of the sample reserved for the analyses of non-metallic constituents and the entire sample reserved for the analyses of dissolved metals was filtered through a 0.45 μ "Millipore" filter. Where necessary samples were filtered through a GF/C glass fiber filter prior to filtration through the Millipore filter. Aliquots to be

used for the analyses of total Kjeldahl nitrogen, dissolved metals, cyanide and NO_3/NO_2 were preserved as outlined in Table 2.

Immediately following sample coding and pre-treatment (filtration and/or preservation), analyses were performed for total phosphorus, orthophosphate, alkalinity, cyanide, nitrate and nitrite. On some occasions the analyses of nitrate/nitrite and cyanide were postponed until the following day. When this was necessary the samples for NO_3/NO_2 and cyanide were preserved.

The analyses of calcium, total hardness, sulfate, chloride, total dissolved solids, total Kjeldahl nitrogen, hexavalent chromium and fluoride were completed within seven days using the methods listed in Table 1.

The data obtained for each water quality station during this study was subjected to statistical analysis to determine the means, maximum, minimum, range, standard deviation and coefficient of variation for each constituent. In addition the water quality data for each station was compared to the proposed Colorado Water Quality Standards for agricultural use, raw water supply and the protection of the aquatic biota (Appendix A). This analysis was based on the number of times in which the concentration of a constituent exceeded the proposed standard for that constituent with respect to the number of times a detectable concentration of the constituent was analyzed (Appendix D). In Tables 6 and 7 the comparison is made on the basis of the total number of samples analyzed since for most constituents if the concentration is below the detection limit of analyses it is below the proposed standards. For some metals (cadmium, mercury, silver, copper and zinc) the proposed standards for the protection of the

Table 1. Analytical methods used in water quality survey.[1]

Analysis	Units/Sensitivity	Method
Non Metallic Constituents		
Total hardness	1 mg/l as $CaCO_3$	EDTA Titrimetric. *S.M.* p. 202
pH		pH electrode. *S.M.* p. 460
Total alkalinity	1 mg/l as $CaCO_3$	Potentiometric. *S.M.* p. 278
Carbonate hardness	1 mg/l as $CaCO_3$	Calculated from $CaCO_3$
Bicarbonate hardness	1 mg/l as $CaCO_3$	Calculated from $CaCO_3$
Total dissolved solids	1 mg/l	Gravimetric. *S.M.* p. 82
Chloride, dissolved	mg/l, 2 place	Titrimetric ($HgNO_3$) *S.M.* p. 304
Sulfate, dissolved	mg/l, 2 place	Turbidimetric ($BaCl_2$) *S.M.* p. 496
Fluoride, dissolved	mg/l, 2 place	Ion selective electrode *S.M.* p. 391
Cyanide, total	mg/l, 2 place	Ion selective electrode *S.M.* p. 372
Phosphorus, total	mg/l, 2 place	Persulfate digestion *S.M.* p. 466
Phosphate, ortho	mg/l, 2 place	Ascorbic acid *S.M.* p. 481
Nitrogen, total organic	mg/l, 2 place	Kjeldahl. *S.M.* p. 437
Nitrate	mg/l, 2 place	Cadmium reduction (automated) *S.M.* p. 620
Metallic Constituents		
Aluminum, total; dissolved	µg/l, 3 place	Atomic absorption (AA) *S.M.* p. 152
Arsenic, total; dissolved	µg/l, 3 place	Atomic Absorption (Vapor generation) *S.M.* p. 159

Table 1. Continued.

Analysis	Units/Sensitivity	Method
Barium, dissolved[2]	µg/l, 2 place	Atomic absorption *S.M.* p. 152
Boron, dissolved	mg/l, 2 place	Carmine. *S.M.* p. 290
Calcium	mg/l, 2 place	Titrimetric (EDTA) *S.M.* p. 189
Cadmium, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Chromium, dissolved[2]	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Chromium, hexavalent	µg/l, 3 place	Colorimetric, *S.M.* p. 192
Copper, total; dissolved	µg/l, 3 place	Atomic absorption *S.M.* p. 148
Iron, total; dissolved	µg/l, 3 place	Atomic absorption *S.M.* p. 148
Lead, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Magnesium, dissolved	mg/l, 2 place	Calculated from calcium and total hardness
Manganese, total; dissolved	µg/l, 3 place	Atomic absorption *S.M.* p. 148
Mercury, total; dissolved	µg/l, 3 place	Atomic absorption (Cold vapor) *S.M.*p. 56
Molybdenum, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Nickel, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Potassium, dissolved	mg/l, 2 place	Flame photometric, *S.M.* p. 234
Selenium, total; dissolved	µg/l, 2 place	Atomic absorption (Vapor generation) *S.M.* p. 159
Silver, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78

Table 1. Continued.

Analysis	Units/Sensitivity	Method
Sodium, dissolved	mg/l, 2 place	Flame photometric, *S.M.* p. 250
Zinc, total; dissolved	µg/l, 3 place	Atomic absorption, *S.M.* p. 148

[1]Sources of analytical methods:

S.M. = *Standard Methods for Examination of Water and Wastewater.* 14th Ed. (1975). APHA.

EPA = USEPA (1976a). *Methods for Chemical Analysis of Water and Wastes.*

[2]These analysis were not included in original contract. Analysis of these constituents began in January, 1978.

Table 2. Methods of storage and preservation of samples used in the water quality survey.

Constitutent	Preservative	Storage
Metals[1]	3 ml 50% "mercury free" HNO_3/1	Several months (refrigerated)
TKN	0.8 ml conc. H_2SO_4/1	Max. of 7 days in dark amber glass bottle (refrigerated)
NO_3-NO_2	1 drop chloroform per 12 ml vials	Max. of 2 days in stoppered vials (refrigerated)
CN^-	pH adjusted to 12 with ionic strength adjuster	Up to 24 hours (refrigerated)

[1]Sample bottles (500 ml) for "total metals" contained 1.5 ml HNO_3 when shipped to field.

aquatic biota are below the detection limits of analyses. Since there may have been instances in which the concentration of one of these metals was less than the detection limit of analysis but still greater than the proposed standard for the protection of the aquatic biota, the comparisons for these metals with the proposed standards in Tables 6 and 7 are enclosed in parenthesis.

Results

The water quality data collected in this study are presented in Appendix B. Statistical analyses of these data, including the mean, maximum, minimum, range, standard deviation and coefficient of variance for each constituent are presented in Appendix C.

The sampling period for this study began in June, 1977, and ended in August, 1978. During this period 44 analyses were to be performed between June, 1977, and December, 1977, and 49 analyses were to be performed between January, 1978 through August, 1978, for a total of 2,976 analyses. One hundred and seventy-six of these analyses (5.9 percent of the total) were omitted because samples were not collected on June 13, 1977 (Round 2). Twenty-four analyses were omitted (0.8 percent of the total) because samples leaked during transit. Finally, 28 water quality analyses were omitted (0.9 percent of the total). Thus, during the entire sampling period, 92.4 percent of the scheduled analyses were performed (Table 4).

In order to check the reliability of these analyses, ion balances were computed for each sample analyzed. The error in each ion balance was calculated as follows:

$$\% \text{ error} = \frac{|\Sigma M^{+n} - \Sigma M^{-n}|}{\Sigma M^{+n} - \Sigma M^{-n}} \times 100 \qquad (1)$$

The ion balance calculations for each sampling period are presented in Table 5. A frequency distribution of the errors in the ion balances for each station is presented in Table 6 and Figure 2. During the entire study, the error in the ion balances was less than 10 percent for approximately 80 percent of the samples.

Table 4. San Miguel water quality survey - Missing parameter values.[a]

Sampling Round	Station	Analysis not performed	Reason for Omission
1	25	Total manganese	Analysis omitted
	28,29	All	No samples received
2	24,25,28,29	All	No samples received
3	25	Boron	Analysis omitted
	28,29	Diss. aluminum; total organic nitrogen	Analysis omitted
4	28,29	Total organic nitrogen	Analysis omitted
9	24,25,28,29	Fluoride	Analysis omitted
10	29	Chloride, fluoride, cyanide, nitrate, nitrite, total org. nitrogen, ortho phosphate, sulfate, TDS, calcium, hex. chromium, total hardness	Sample bottle leaked in transit
13	24,25,28,29	Arsenic (tot.; diss.); selenium (tot.; diss.)	Analysis omitted
16	25	Calcium, hex. chromium, total hardness, chloride, fluoride, nitrate, nitrite, total org. nitrogen, sulfate, TDS	Sample bottle leaked in transit

[a]When total hardness was not determined, magnesium concentration could not be calculated. When alkalinity was not determined, inorganic carbon species (HCO_3^-, $CO_3^=$) could not be determined.

Table 5. Ion balance calculations for the San Miguel water quality study.(1)

STDS = Sum of the constituents (mg/ℓ)
MTDS = Laboratory measured TDS (mg/ℓ)
SC = Sum of cations (meq/ℓ)
SA = Sum of anions (meq/ℓ)
ADIFF = Absolute difference between SC and SA (meq/ℓ)
ERR(%) = (ADIFF)/(SC + SA) x 100
* = Indicated date where one or more constituents have not been recorded.
– = Indicates that the concentration was below detection limit.

SAN MIGUEL PROJECT

STATION 24: SAN MIGUEL NEAR PLACERVILLE

	* 5/25/77	6/16	* 6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/18/78	2/15	3/21	4/18	5/18	6/16	7/19	8/24
CA	0.0	41.0	0.0	52.0	72.0	64.0	77.0	77.0	81.0	70.0	84.0	71.0	68.0	49.0	31.0	34.0	65.0
MG	0.0	5.0	0.0	11.0	2.0	10.0	2.0	4.0	2.0	7.0	12.0	3.0	-1.0	1.0	2.0	3.0	5.0
NA	0.0	3.0	0.0	9.0	7.0	26.0	10.0	5.0	8.0	5.0	6.0	9.0	7.0	3.0	4.0	5.0	5.0
K	0.0	1.0	0.0	1.0	1.0	1.0	1.6	1.1	4.1	0.9	1.0	1.6	1.3	3.0	3.0	2.0	2.0
HCO3	0.0	54.0	0.0	82.0	80.0	78.0	89.0	138.0	94.0	86.0	92.0	88.0	79.0	104.0	48.0	48.0	78.0
CO3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL	0.0	-1.0	0.0	2.0	-1.0	2.0	4.0	2.0	2.0	1.0	1.0	2.0	5.0	-1.0	2.0	2.0	-1.0
SO4	0.0	52.0	0.0	107.0	48.0	81.0	145.0	93.0	105.0	100.0	163.0	90.0	68.0	44.0	55.0	69.0	88.0
STDS	0.0	156.0	0.0	264.0	210.0	262.0	328.6	320.1	296.1	271.9	359.0	264.6	228.3	204.0	145.0	163.0	243.0
MTDS	0.0	162.0	0.0	276.0	214.0	190.0	343.0	270.0	232.0	216.0	304.0	296.0	176.0	174.0	128.0	137.0	210.0
SC	0.000	2.613	0.000	3.917	4.087	5.173	4.483	4.417	4.659	4.309	5.465	4.222	3.731	2.735	1.962	2.212	3.923
SA	0.000	2.163	0.000	3.924	2.599	3.303	4.912	4.753	4.123	3.870	5.262	3.690	3.137	2.996	2.162	2.453	3.392
ADIFF	0.000	0.451	0.000	0.007	1.488	1.870	0.429	0.336	0.537	0.439	0.203	0.532	0.594	0.262	0.199	0.241	0.531
ERR(%)	0.000	9.435	0.000	0.095	22.253	22.062	4.567	3.661	6.112	5.369	1.896	6.722	8.651	4.563	4.835	5.166	7.262

SAN MIGUEL PROJECT

STATION 25: SAN MIGUEL AT NATURITA

	* 5/25/77	6/16	* 6/30	7/19	8/24	9/21	10/19	11/15	* 12/13	1/18/78	2/15	3/21	4/18	5/18	6/16	7/19	* 8/24
CA	0.0	56.0	0.0	179.0	137.0	122.0	112.0	228.0	110.0	77.0	95.0	97.0	50.0	44.0	37.0	50.0	0.0
MG	0.0	9.0	0.0	15.0	44.0	56.0	18.0	53.0	0.0	14.0	27.0	18.0	-1.0	2.0	2.0	5.0	0.0
NA	0.0	6.0	0.0	59.0	27.0	49.0	20.0	62.0	23.0	12.0	19.0	21.0	9.0	4.0	6.0	8.0	33.0
K	0.0	1.0	0.0	4.0	3.0	2.0	2.2	2.6	4.6	1.1	1.3	2.0	1.5	4.6	4.0	2.0	4.0
HCO3	0.0	77.0	0.0	204.0	73.0	145.0	119.0	191.0	129.0	101.0	135.0	122.0	80.0	102.0	61.0	58.0	194.0
CO3	0.0	0.0	0.0	15.0	0.0	6.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL	0.0	-1.0	0.0	10.0	5.0	6.0	6.0	14.0	6.0	4.0	7.0	6.0	10.0	-1.0	2.0	1.0	0.0
SO4	0.0	52.0	0.0	606.0	72.0	410.0	231.0	711.0	253.0	145.0	270.0	181.0	43.0	42.0	65.0	82.0	0.0
STDS	0.0	205.0	0.0	1092.0	361.0	796.0	508.2	1273.6	525.6	354.1	563.3	447.0	193.5	198.6	177.0	206.0	231.0
MTDS	0.0	286.0	0.0	1474.0	680.0	648.0	463.0	1210.0	498.0	291.0	496.0	467.0	170.0	154.0	144.0	206.0	0.0
SC	0.000	4.008	0.000	12.835	11.707	12.877	7.996	18.500	6.607	5.544	7.821	7.286	2.925	2.652	2.374	3.305	1.538
SA	0.000	2.623	0.000	17.279	3.100	11.725	7.359	19.258	8.017	5.152	8.706	6.378	2.777	2.914	2.630	2.895	3.880
ADIFF	0.000	1.385	0.000	4.444	8.607	1.152	0.637	0.757	1.410	0.392	0.885	0.908	0.147	0.263	0.256	0.410	2.342
ERR(%)	0.000	20.895	0.000	14.758	58.127	4.681	4.149	2.006	9.639	3.668	5.355	6.645	2.587	4.720	5.108	6.612	43.232

Table 5. (cont'd) Ion balance calculations for the San Miguel water quality study.[1]

STDS = Sum of the constituents (mg/ℓ)
MTDS = Laboratory measured TDS (mg/ℓ)
SC = Sum of cations (meq/ℓ)
SA = Sum of anions (meq/ℓ)
ADIFF = Absolute difference between SC and SA (meq/ℓ)
ERR(%) = (ADIFF)/(SC + SA) x 100
* = Indicated date where one or more constituents have not been recorded.
– = Indicates that the concentration was below detection limit.

SAN MIGUEL PROJECT

STATION 29: SAN MIGUEL AT SAW PIT

	* 5/25/77	* 6/16	* 6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/18/78	* 2/15	3/21	4/18	5/18	6/16	7/19	8/24
CA	0.0	0.0	0.0	63.0	73.0	68.0	77.0	86.0	87.0	67.0	0.0	77.0	88.0	54.0	32.0	35.0	70.0
MG	0.0	0.0	0.0	7.0	2.0	11.0	11.0	-1.0	16.0	6.0	0.0	15.0	3.0	-1.0	2.0	2.0	4.0
NA	0.0	0.0	0.0	9.0	6.0	23.0	20.0	5.0	7.0	5.0	5.0	8.0	6.0	4.0	2.0	4.0	5.0
K	0.0	0.0	0.0	1.0	1.0	1.0	1.5	1.1	4.0	0.9	0.9	1.6	1.1	1.8	3.0	2.0	2.0
HCO3	0.0	0.0	0.0	79.0	69.0	67.0	68.0	78.0	74.0	87.0	36.0	79.0	84.0	64.0	42.0	44.0	64.0
CO3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL	0.0	0.0	0.0	1.0	1.0	2.0	2.0	7.0	2.0	1.0	0.0	1.0	6.0	-1.0	2.0	2.0	-1.0
SO4	0.0	0.0	0.0	113.0	41.0	124.0	119.0	177.0	168.0	92.0	0.0	120.0	176.0	65.0	60.0	54.0	123.0
STDS	0.0	0.0	0.0	273.0	193.0	296.0	298.5	354.1	360.0	268.9	41.9	301.6	366.1	168.8	143.0	143.0	275.0
MTDS	0.0	0.0	0.0	252.0	216.0	216.0	316.0	268.0	275.0	277.0	0.0	276.0	294.0	191.0	124.0	122.0	230.0
SC	0.000	0.000	0.000	4.137	4.094	5.324	5.656	4.537	6.229	4.677	0.241	5.465	4.927	2.915	1.925	2.136	4.091
SA	0.000	0.000	0.000	3.961	2.262	3.978	3.894	5.443	5.034	3.684	0.720	4.197	5.555	2.833	2.146	2.061	3.941
ADIFF	0.000	0.000	0.000	0.176	1.832	1.346	1.762	0.906	1.195	0.994	0.479	1.359	0.628	0.261	0.221	0.075	0.150
ERR(%)	0.000	0.000	0.000	2.170	28.824	14.470	18.446	9.074	10.606	5.073	49.920	14.193	5.992	5.071	5.419	1.798	1.865

SAN MIGUEL PROJECT

STATION 28: LEOPARD CREEK

	* 5/25/77	6/16	* 6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/18/78	2/15	3/21	4/18	5/18	6/16	7/19	8/24
CA	0.0	0.0	0.0	80.0	72.0	76.0	83.0	82.0	77.0	71.0	75.0	96.0	83.0	51.0	57.0	69.0	64.0
MG	0.0	0.0	0.0	20.0	16.0	20.0	5.0	9.0	14.0	14.0	11.0	-1.0	-1.0	3.0	0.0	3.0	14.0
NA	0.0	0.0	0.0	15.0	18.0	44.0	16.0	9.0	13.0	10.0	15.0	13.0	6.0	4.0	0.0	11.0	9.0
K	0.0	0.0	0.0	2.0	2.0	2.0	2.5	1.4	4.8	1.3	1.4	2.0	1.6	2.5	3.0	3.0	3.0
HCO3	0.0	0.0	0.0	174.0	203.0	205.0	169.0	169.0	185.0	193.0	186.0	164.0	79.0	104.0	132.0	141.0	160.0
CO3	0.0	0.0	0.0	3.0	7.0	4.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL	0.0	0.0	0.0	3.0	4.0	3.0	3.0	3.0	2.0	5.0	2.0	2.0	9.0	-1.0	3.0	4.0	-1.0
SO4	0.0	0.0	0.0	60.0	71.0	69.0	75.0	63.0	60.0	53.0	39.0	45.0	32.0	39.0	62.0	60.0	46.0
STDS	0.0	0.0	0.0	337.0	393.0	423.0	353.5	358.4	355.8	347.3	329.4	322.0	210.6	203.5	269.0	291.0	307.0
MTDS	0.0	0.0	0.0	276.0	266.0	260.0	358.0	306.0	280.0	252.0	274.0	259.0	83.0	187.0	219.0	256.0	254.0
SC	0.000	0.000	0.000	5.343	5.743	7.403	5.313	5.259	5.062	5.163	5.336	5.407	4.444	3.030	3.070	4.245	5.225
SA	0.000	0.000	0.000	4.874	5.791	5.701	5.026	5.216	5.006	5.105	4.568	4.273	2.500	2.892	4.015	4.162	4.278
ADIFF	0.000	0.000	0.000	0.469	0.048	1.702	0.287	0.043	0.677	0.058	0.767	1.134	1.943	0.138	0.340	0.083	0.947
ERR(%)	0.000	0.000	0.000	4.591	0.416	12.985	2.774	0.412	6.330	0.563	7.530	11.712	27.939	2.324	4.419	0.748	9.466

Figure 2. Frequency distribution of errors in the ion balances for the San Miguel water quality study.

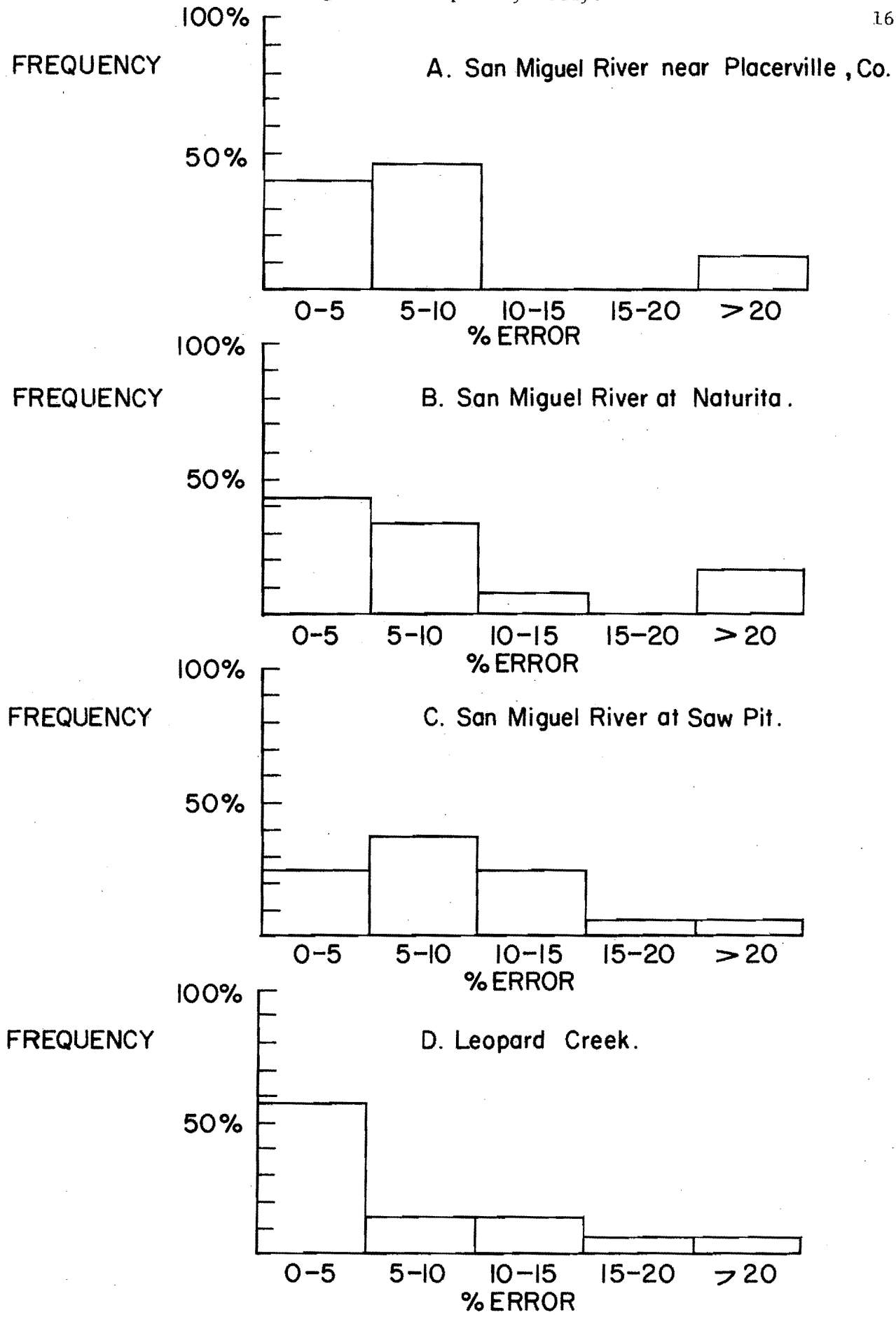

Table 6. Frequency distribution of errors in ion balances for the San Miguel water quality survey.(1)

Station # 29: San Miguel River at Sawpit

Err(%)	Number	% of total
0 - 5	3	23.1
5 - 10	5	38.5
10 - 15	3	23.1
15 - 20	1	7.7
>20	1	7.7
Missing Data	1	
Total	14	

Station #28: Leopard Cr.

Err(%)	Number	% of total
0 - 5	8	57.1
5 - 10	3	21.4
10 - 15	2	14.3
15 - 20	0	0
>20	1	7.1
Missing Data	0	
Total	14	

Station # 24: San Miguel River at Placerville

Err(%)	Number	% of total
0 - 5	6	40
5 - 10	7	46.7
10 - 15	0	0
15 - 20	0	0
>20	2	13.3
Missing Data	0	
Total	15	

Station # 25: San Miguel River at Naturita

Err(%)	Number	% of total
0 - 5	6	42.9
5 - 10	5	35.7
10 - 15	1	7.1
15 - 20	0	0
>20	2	14.3
Missing Data	1	
Total	15	

(1)See Figure 2.

Discussion

The water in the San Miguel River above the proposed damsite (Stations #24 and #29) is moderately hard to hard, having a total hardness of 85 - 195 mg/l as $CaCO_3$ and has a pH between 7.0 and 9.0. The salinity at these two stations never exceeded 500 mg/l.

The water quality of the San Miguel River at Naturita is influenced by irrigation return flows. The water from this site has a higher salinity ($\bar{x}$ = 513 mg/l) and is much harder ($\bar{x}$ = 382 mg/l as $CaCO_3$) than water from the upstream stations.

Leopard Creek has a composition similar to that of the main stem of the San Miguel River at Placerville, having an average salinity of 252 mg/l and an average total hardness of 274 mg/l as $CaCO_3$.

The data in Tables 7 - 11 indicate that the proposed Colorado Water Quality Standards for many metals and cyanide were exceeded in the San Miguel River during numerous occasions during the study period. Although no constituents exceeded the standards for Class II water supply or agricultural use more than half the time, the concentrations of total cadmium, dissolved aluminum and total mercury exceeded the proposed standards for the protection of aquatic biota over 50 percent of the time at all three of the on-river water quality stations. Several other metals, including total copper, total iron, total lead and total zinc frequently exceeded the proposed standards for the protection of the aquatic biota. Bioassays conducted at the UWRL using the Algal Assay Procedure: Bottle Test (EPA, 1971) indicate that heavy metal toxicity controlled algal growth in water from the San Miguel River (site undefined) in March, 1977, and from the San Miguel River at Sawpit during May, 1978. Heavy metal toxicity did not suppress algal growth at other times or at other sites.

Table 7. Constituents that exceeded the proposed Colorado Water Quality Standards in the San Miguel River at Sawpit, Col.[1]

Parameter (All metals "total" unless specified)	Water Use: Class II Water Supply N/T[2]	Class II Water Supply %	Agriculture N/T[2]	Agriculture %	Aquatic Biota N/T[2]	Aquatic Biota %
Aluminum (dissolved)	-	-	-	-	13/14	93
Barium	1/10	10	-	-	-	-
Cadmium[3]	4/14	29	4/14	29	(9/14)	(64)
Copper[3]	0/14	0	0/14	0	(7/14)	(50)
Iron (total)	-	-	-	-	5/14	36
Lead	0/10	0	0/10	0	3/10	30
Manganese (dissolved)	5/14	36	-	-	-	-
Manganese (total)	-	-	1/14	7	0/14	0
Mercury[3]	2/14	14	-	-	(11/14)	(79)
Silver[3]	0/14	0	-	-	(1/14)	(7)
Zinc[3]	0/14	0	0/14	0	12/14	86
Total cyanide	0/14	0	0/14	0	8/14	57

(1) Proposed Colorado Water Quality Standards in Appendix B.

(2) N/T = number of samples exceeding standard compared with total number of samples analyzed.

(3) Parenthesis indicate that the proposed standard was below the detection limit of analyses.

Table 8. Constituents that exceeded the proposed Colorado Water Quality Standards in the San Miguel River at Placerville.[1]

Parameter (All metals "total" unless specified)	Water Use					
	Class II Water Supply		Agriculture		Aquatic Biota	
	N/T[2]	%	N/T[2]	%	N/T[2]	%
Aluminum (dissolved)	-	-	-	-	13/15	87
Barium	1/10	10	-	-	-	-
Cadmium[3]	4/10	40	4/10	40	(10/10)	(100)
Copper[3]	0/15	0	0/15	0	(9/15)	(60)
Iron (total)	—	—	—	—	6/15	40
Lead	0/10	0	0/10	0	3/10	30
Manganese (dissolved)	4/15	27	-	-	-	-
Manganese (total)			3/15	20	0/15	0
Mercury[3] (total)	2/15	13	-	-	(13/15)	(87)
Nickel	-	-	0/15	0	2/15	13
Selenium	1/15	7	0/15	0	0/15	0
Zinc[3]	0/15	0	0/15	0	(11/15)	(73)
Total Cyanide	-	-	-	-	10/15	67

[1] Proposed Colorado Water Quality Standards in Appendix B.

[2] N/T = number of samples exceeding standard compared with total number of samples analyzed.

[3] Parenthesis indicate that the proposed standard was below the detection limit of analyses.

Table 9. Constituents that exceeded the proposed Colorado Water Quality Standards in the San Miguel River at Naturita.[1]

Parameter (All metals "total" unless specified)	Water Use: Class II Water Supply		Agriculture		Aquatic Biota	
	N/T[2]	%	N/T[2]	%	N/T[2]	%
Aluminum (dissolved)	-	-	-	-	13/15	87
Cadmium[3]	4/10	40	4/10	40	(6/10)	(60)
Copper[3]	0/15	0	0/15	0	(5/15)	(33)
Iron (total)	-	-	-	-	4/15	27
Lead	2/10	20	0/10	0	3/10	30
Manganese (Dissolved)	3/15	20	-	-	-	-
Manganese (total)	-	-	2/15	13	0/15	0
Mercury[3] (total)	0/15	0	-	-	(12/15)	(80)
Nickel	-	-	1/15	7	0/15	0
Silver[3]	0/15	0	-	-	(4/15)	(27)
Zinc[3]	0/15	0	0/15	0	(6/15)	(40)
Total Cyanide	0/15	0	0/15	0	9/15	60
Sulfate	5/14	36	-	-	-	-

(1) Proposed Colorado Water Quality Standards in Appendix B.

(2) N/T = number of samples exceeding standard compared with total number of samples analyzed.

(3) Parenthesis indicate that the proposed standard was below the detection limit of analyses.

Table 10. Constituents that exceeded the proposed Colorado Water Quality Standards in Leopard Creek.(1)

Parameter (All metals "total" unless specified)	Water Use: Class II Water Supply N/T(2)	%	Agriculture N/T(2)	%	Aquatic Biota N/T(2)	%
Aluminum (dissolved)	-	-	-	-	13/14	93
Cadmium(3)	3/14	21	3/14	21	(6/14)	(43)
Copper(3)	0/14	0	0/14	0	(7/14)	(50)
Iron (total)	-	-	-	-	3/14	21
Manganese (total)	-	-	1/14	7	0/14	0
Mercury(3)	2/14	14	-	-	(11/14)	(79)
Silver(3)	0/14	0	-	-	(1/14)	(7)
Zinc(3)	0/14	0	0/14	0	(6/14)	(43)
Total Cyanide	0/14	0	0/14	0	8/14	57

(1) Proposed Colorado Water Quality Standards in Appendix B.

(2) N/T = number of samples exceeding standard compared with total number of samples analyzed.

(3) Parenthesis indicate that the proposed standard was below the detection limit of analyses.

Table 11. Summary of constituents that exceeded the proposed Colorado Water Quality Standards in the San Miguel River and Leopard Creek.

Station & Water Use		Frequency standard exceeded			
		<25%	26 - 50%	51 - 75%	75 - 100%
#29	San Miguel River at Sawpit				
	Class II Water Supply	Ba, Hg	diss. Mn	-	-
	Agricultural Use	Mn	Cd	-	-
	Aquatic Biota	Ag	Fe, Pb, Cu	Cd, CN^-	diss. Al, Hg, Zn
#28	Leopard Creek				
	Class II Water Supply	Cd, Hg	-	-	-
	Agricultural Use	Cd, Mn	-	-	-
	Aquatic Biota	Fe, Ag	Cd, Cu, Zn	CN^-	Hg, diss. Al
#24	San Miguel River at Placerville				
	Class II Water Supply	Ba, Hg, Se	diss. Mn, Cd	-	-
	Agricultural Use	Mn	Cd	-	-
	Aquatic Biota	Ni	Fe, Pb	Cu, CN^-	diss. Al, Cd, Hg, Zn
#25	San Miguel River at Naturita				
	Class II Water Supply	Pb, diss. Mn	Cd, $SO_4^=$	-	-
	Agricultural Use	Mn, Ni	Cd		
	Aquatic Biota		Cu, Fe, Pb, Ag, Zn	Cd, CN^-	diss. Al, Hg

(1) Proposed Colorado Water Quality Standards in Appendix B. All metals "total" unless specified.

Concentrations of dissolved manganese, total barium, total mercury, total selenium, total cadmium, total lead and sulfate in the San Miguel River exceeded the proposed Colorado Water Quality Standards for raw water supply during one or more sampling periods. Only dissolved manganese exceeded the raw water supply standards at all three water quality stations. Unlike most metals, for which standards are established on the basis of toxicity, the standard for dissolved manganese is based on the unpleasant taste and staining associated with high concentrations of this metal (EPA, 1976). The standard of 50 µg/l for dissolved manganese was exceeded 36 percent of the time for the San Miguel River at Sawpit, 27 percent of the time for the San Miguel River at Placerville, and 20 percent of the time for the San Miguel at Naturita. The only non-metallic constituent to exceed the proposed raw water supply standard was sulfate, which exceeded the proposed standard of 500 mg/l during 36 percent of the sampling sessions at the Naturita site. The high concentrations of sulfate in the San Miguel River at Naturita are probably the result of irrigation return flows entering the San Miguel River below Placerville. The standard for sulfate is based on the fact that a high concentration of sulfate in drinking water has a cathartic effect on some people.

With respect to agricultural use, concentrations of total cadmium and total manganese were found to exceed the proposed standard at all three on-river sites during one or more sampling periods. These metals are directly toxic to plants, although their toxicity depends on soil conditions, plant species and other water quality characteristics. In addition to direct toxicity, cadmium, like some other metals, may be accumulated by plants and present a potential hazard to human consumers.

The water quality in Leopard Creek is very similar to that in the main stem of the San Miguel River. The standards for metals were exceeded less frequently in Leopard Creek than in the main stem of the river. Based on these data, it does not seem that the water from Leopard Creek causes any degradation of the main stem of the San Miguel River. Smith (1977) has suggested that Leopard Creek may serve as a spawning area for rainbow trout living in the proposed reservoir.

The concentration of heavy metals in the San Miguel River and the fact that there is considerable metals mining activity in the headwaters area suggests that mining activity is responsible for the presence of metals in the river. This conclusion is not conclusively proven by this study since background water quality data for the river are not available. As previously noted, the San Miguel River was considered to be polluted as the result of metals mining in the 1950s and 60s to the extent that the fisheries in the river was "greatly depressed" (Smith, 1977).

APPENDIX A

Water Quality Data Compiled by the Colorado Division of Health, 1973-1975

Table A-1. Water Quality Analysis: San Miguel River at Norwood, Colorado.(1)

(Lat. 38° 09' 00", Long. 108° 13' 00")

Analysis	Sampling Time	No. of Samples	Measured Units	Mean	Range
Temperature	09/71-03/75	20	DEG F	45.8	32-69
Dissolved Oxygen	09/71-03/75	17	MG/L	10.0	6.6-12.2
BOD	09/71-03/75	11	MG/L	1.1	0.4-2.0
pH	09/71-03/75	15	UNITS	8.5	7.4-9.0
Turbidity	09/71-03/75	16	FTU	19.7	2.0-90
Conductance	09/71-03/75	20	MICROMHO	374.6	200-470
Dissolved Solids	04/74-03/75	5	MG/L	328.0	261-387
Hardness (CACO3)	09/71-03/75	15	MG/L	187.3	91-249
Sulfate	09/71-03/75	13	MG/L	102.8	70-138
Na-Adsor Ratio	09/71-03/75	15	----	0.2	0.1-0.4
Arsenic	09/71-03/75	12	UG/L	0	----
Boron	09/71-03/75	15	UG/L	6.0	0-40
Cadmium	09/71-03/75	12	UG/L	0	----
Calcium	09/71-03/75	14	MG/L	164.5	79-214
Chloride	09/71-03/75	15	MG/L	8.8	3-40
Chromium	09/71-03/75	12	UG/L	0	----
Copper	09/71-03/75	12	UG/L	0	----
Cyanide	09/71-03/75	12	MG/L	0.000	----
Fluoride	09/71-03/75	14	MG/L	0.3	0.1-0.5
Magnesium	09/71-03/75	14	MG/L	6.6	2-10
Nitrogen (NH3)	09/71-03/75	17	MG/L	0.04	0.000-0.2
Nitrogen (NO2)	09/71-03/75	17	MG/L	0.005	0.000-0.035
Nitrogen (NO3)	09/71-03/75	17	MG/L	0.5	0.000-5
Phosphate (PO4)	09/71-08/73	11	MG/L	0.08	0.00-0.3
Sodium	09/71-03/75	15	MG/L	6.3	2-12

(1) Data complied by the Water Quality Central Division, Colorado Department of Health.

Table A-2. Water Quality Analysis: San Miguel River at Uravan, Colorado.(1)

Analysis	Sampling Time	No. of Samples	Measured Units	Mean	Range
Discharge	08/69-08/73	25	CFS	317.6	18-2550
Temperature	08/69-08/73	25	DEG C	10.2	0-22
pH	08/69-08/73	25	UNITS	7.2	6.3-8.0
Conductance	08/69-08/73	25	MICROMHO	1192.9	269-2160
Dissolved Solids	08/69-08/73	25	MG/L	808.8	165-2110
Hardness (CACO3)	08/69-08/73	25	MG/L	478.3	110-1200
Hardness (Non-CACO3)	08/69-08/73	25	MG/L	382.8	25-1100
Bicarbonate	08/69-08/73	25	MG/L	117.5	58-190
Alkalinity	12/71-08/73	8	MG/L	112.0	65-156
Sulfate	08/69-08/73	25	MG/L	449.0	49-1300
Na-Adsorb Ratio	08/69-08/73	25	----	1.1	0.4-2.0
Calcium	08/69-08/73	25	MG/L	100.1	30-240
Chloride	08/69-08/73	25	MG/L	54.9	5.6-170
Fluoride	11/72	1	MG/L	0.4	----
Magnesium	08/69-08/73	25	MG/L	55.4	8.1-150
NO2-NO3	11/70-08/73	12	MG/L	3.1	0.27-11
Potassium	08/69-08/73	25	MG/L	5.3	1.8-13
Silica	11/70-08/73	12	MG/L	7.6	5.8-9.0
Sodium	08/69-08/73	25	MG/L	56.6	11-160

(1) U.S.G.S. data.

Table A-3. Water Quality Analysis: San Miguel River at Confluence with Dolores River. (1)

(Lat. 38° 24' 00" Long. 108° 45' 00")

Analysis	Sampling Time	No. of Samples	Measured Units	Mean	Range
Temperature	06/70-11/74	28	DEG F	53.8	32-76
Dissolved Oxygen	06/70-11/74	24	MG/L	8.3	4.2-11.3
pH	06/70-11/74	22	UNITS	8.3	7.4-9.1
Turbidity	06/70-11/74	23	FTU	111.6	4.2-800
Conductance	06/70-11/74	28	MICROMHO	1106.2	413-2400
Dissolved Solids	03/74-11/74	4	MG/L	932.2	423-1137
Hardness (CACO3)	06/70-11/74	20	MG/L	428.4	122-760
Sulfate	06/70-11/74	19	MG/L	401.0	112-745
Na-Adsor Ratio	06/70-11/74	20	----	1.1	0.4-1.9
Arsenic	06/70-11/74	18	UG/L	0	----
Boron	06/70-11/74	19	UG/L	63.2	0-160
Cadmium	06/70-11/74	18	UG/L	0.2	0-2
Calcium	06/70-11/74	19	MG/L	283.7	124-488
Chloride	06/70-11/74	21	MG/L	49.2	7-151
Chromium	06/70-11/74	18	UG/L	0	----
Copper	06/70-11/74	18	UG/L	0	----
Cyanide	06/70-11/74	18	MG/L	0.0002	0.000-0.003
Fluoride	06/70-11/74	19	MG/L	0.5	0.1-0.9
Magnesium	06/70-11/74	19	MG/L	37.9	12-80
Nitrogen (NH3)	06/70-11/74	26	MG/L	13.0	0.000-41
Nitrogen (NO2)	06/70-11/74	26	MG/L	0.5	0.000-2.5
Nitrogen (NO3)	06/70-11/74	26	MG/L	2.6	0.2-11
Phosphate (PO4)	06/70-09/73	21	MG/L	0.1	0.00-0.3
Sodium	06/70-11/74	20	MG/L	54.2	14-98

(1) Data compiled by the Water Quality Central Division, Colorado Department of Health.

APPENDIX B

Proposed Colorado Water Quality Standards

Table B-1 Proposed Colorado water quality standards: Class II water supply.

Parameter	Standard
Physical	
D.O. (mg/ℓ)[1]	Aerobic[2]
pH	5.0-9.0
Suspended solids and turbidity	[3]
Temperature	X
TDS (mg/ℓ)	Y
Biological	
Algae[4]	Free of toxic and objectionable algae
Fecal coliforms (#/100 mℓ)	1,000
Inorganics	
Ammonia (mg/ℓ as N)	0.5
Total residual chlorine (mg/ℓ)	X
Cyanide (mg/ℓ)	0.2
Fluoride (mg/ℓ)	[5]
Nitrate (mg/ℓ as N)	10
Nitrite (mg/ℓ as N)	1.0
Sulfide as H_2S (mg/ℓ)	0.05
Boron (mg/ℓ)	X
Chloride (mg/ℓ)	250
Magnesium (mg/ℓ)	125
Sodium adsorbtion ratio	X
Sulfate (mg/ℓ)	250
Phosphorus (mg/ℓ as P)	Bioassay[6]
Toxic Metals (mg/ℓ)	
Aluminum	X
Arsenic	0.05
Barium	1.0
Beryllium	X
Cadmium	0.01
Chromium	0.05
Copper	1.0
Iron	0.3 (soluble)
Lead	0.05
Manganese	0.05 (soluble)
Mercury	0.002
Molybdenum	Y
Nickel	X

X = numerical limit generally not needed for protection of classified use.
Y = limit may be required but there is insufficient data for setting a general standard.

Table B-1 Continued.

Parameter	Standards
Toxic Metals (mg/ℓ)	
Selenium	0.01
Silver	0.05
Thallium	X
Zinc	5.0
Organics[7] ($\frac{\mu g}{\ell}$)	
Chlorinated pesticides[8]	
Aldrin[9]	Y
Chlordane[9]	Y
Dieldrin[8]	Y
DDT[9]	Y
Endrin	0.2
Heptachlor[9]	Y
Lindane	4
Methoxychlor	Y
Mirex	100
Toxaphene	5
Organophosphate pesticides[8]	
Demeton	Y
Endosulfan	Y
Guthion	Y
Malathion	Y
Parathion	Y
Chlorophenoxy Herbicides	
2, 4-D	100
2, 4, 5-TP	10
PCB's[10]	Y
Phenol	1
Radiological[11] (pCi/ℓ)	
Alpha[11, 12]	15
Beta[11, 12]	50
Cesium 134	80
Plutonium	15
Radium 226 and 228[12, 13]	5
Strontium 90[12, 13]	8
Thorium 230 and 232	60
Tritium	20,000
Uranium (total, mg/ℓ)	5

[1]Where dissolved oxygen levels less than the standard occur naturally, a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]An effluent shall be regulated to maintain aerobic conditions, and a guideline of 2.0 mg/ℓ dissolved oxygen in an effluent should be maintained, unless demonstrated otherwise.

[3]Suspended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blue-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams, lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, nor allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[5]Fluoride limits vary from 2.4 mg/ℓ at 12.0 C and below, to 1.4 mg/ℓ between 26.3 C and 32.5 C, based upon the annual average of the maximum daily air temperature (see *National Interim Primary Drinking Water Regulations* for specific limitations).

[6]Phosphorus standards are to be determined by an algal bioassay using the method described in the latest edition of *Standard Methods for the Examination of Water and Wastewater.*

[7]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[8]Numerical limits in tables based on experimental evidence of toxicity. No point source discharges of organic pesticides shall be permitted to state waters.

[9]The persistence, bioaccumulation potential, and carcinogenicity of these organic compounds cautions human exposure to a minimum (EPA).

[10]Every reasonable effort should be made to minimize human exposure (EPA).

[11]Concentrations given are maximum permissible concentrations above naturally occurring or "background" concentrations except where otherwise noted.

[12]If Alpha or Beta are measured in excess of 15 or 50 pCi/ℓ respectively, it will be necessary to determine by specific analysis the particular radionuclide or radionuclides responsible for the elevated level. Particular radionuclides should not exceed the limit given in the table. If an elevated level of Alpha or Beta emissions is caused by radionuclides, the Division should be consulted.

[13]Maximum permissible concentrations including naturally occurring or background contributions.

Table B-2 Proposed Colorado water quality standards (non-metallic): Protection of Aquatic Biota.

Parameter	Cold Water Biota	Warm Water Biota
Physical		
D.O. (mg/ℓ)[1]	6.0 7.0 (spawning)[2]	5.0
pH	6.5 - 9.0	6.5 - 9.0
Suspended solids and turbidity	[3]	[3]
Temperature (°C)	Maximum 20°C w/ 3° increase[4]	Maximum 30°C w/ 3° increase[4]
TDS (mg/ℓ)	Y	Y
Biological		
Algae[5]	Free from objectionable and toxic algae	Same as Cold Water
Fecal coliforms	X	X
Inorganics		
Ammonia (mg/ℓ as N)	0.02 unionized	0.10 unionized
Total residual chlorine (mg/ℓ)	0.002	0.01
Cyanide (mg/ℓ)	0.005	0.005
Fluoride (mg/ℓ)	X	X
Nitrate (mg/ℓ as N)	X	X
Nitrite (mg/ℓ as N)	0.05	0.5
Sulfide as H_2S (mg/ℓ)	0.002 undissociated	0.002 undissociated
Boron (mg/ℓ)	X	X
Chloride (mg/ℓ)	X	X
Magnesium (mg/ℓ)	X	X
Sodium adsorbtion ratio	X	X
Sulfate (mg/ℓ)	X	X
Phosphorus (mg/ℓ as P)	Bioassay[6]	Bioassay[6]
Organics[7] ($\frac{\mu g}{\ell}$)		
Chlorinated Pesticides[8]		
Aldrin[9]	0.003	0.003
Chlordane	0.01	0.01
Dieldrin[9]	0.003	0.003
DDT	0.001	0.001
Endrin	0.004	0.004
Heptachlor	0.001	0.001
Lindane	0.01	0.01
Methoxychlor	0.03	0.03
Mirex	0.001	0.001
Toxaphene	0.005	0.005

Table B-2 Continued.

Parameter	Cold Water Biota	Warm Water Biota
Organophosphate Pesticides[8]		
Demeton	1	1
Endosulfan	0.003	0.003
Guthion	0.01	0.01
Malathion	1	1
Parathion	0.04	0.04
Chlorophenoxy Herbicides		
2, 4-D	Y	Y
2, 4, 5-TP	Y	Y
PCB's	0.001	0.001
Phenols	1	1
Radiological[10] in (pCi/ℓ)		
Alpha (excluding uranium and radium[11])	15	15
Beta (excluding Sr^{90} [11]	50	50
Cesium 134	80	80
Plutonium 238, 239, and 240	15	15
Radium 226 and 228	5	5
Strantium 90[12]	8	8
Thorium 230 and 232	60	60
Tritium	20,000	20,000
Uranium (total)[13]	--	--

X = numerical limit generally not needed for protection of classified use.

Y = limit may be required but there is insufficient data for setting a general standard.

[1]Where dissolved oxygen levels less than the standard occur naturally a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]A 7 mg/ℓ standard, during periods of spawning of coldwater fish, shall be set on a case by case basis as defined in the NPDES permit for those dischargers whose effluent would affect fish spawning.

[3]Suspended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Temperature shall maintain a normal pattern of diurnal and seasonal fluctuations with no abrupt changes and shall have no increase in temperature of a magnitude, rate and duration deemed deleterious to the resident aquatic life. Generally, a maximum 3°C increase over a minimum of a 4-hour period, lasting for 12 hours maximum, is deemed acceptable for discharges fluctuating in volume or temperature. Where temperature increases cannot be maintained within this range using BMP, BATEA, and BPWITT control measures, the Division will determine whether the resulting temperature increases preclude an Aquatic Life classification.

[5]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blue-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, nor allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[6]Phosphorus standards are to be determined by an algal bioassay using the method described in the latest edition of *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association.

[7]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[8]Numerical limits in tables based on experimental evidence of toxicity. No point source discharges of organic pesticides shall be permitted to state waters.

[9]Aldrin and dieldrin in combination should not exceed 0.000003 mg/ℓ.

[10]Concentrations given are maximum permissible concentrations above naturally occurring or "background" concentrations except where otherwise noted.

[11]If Alpha or Beta are measured in excess of 15 of 50 pCi/ℓ respectively, it will be necessary to determine by specific analysis the particular radionuclide or radionuclides responsible for the elevated level. Particular radionuclides should not exceed the limit given in the table. If an elevated level of Alpha or Beta emissions is caused by radionuclides, the Division should be consulted.

[12]Maximum permissible concentrations including naturally occurring or background contribution.

[13]See Uranium in Table B-3 for aquatic life limitations.

Table B-3 Proposed Colorado water quality standards (metallic): Protection of Aquatic Biota.

Parameter	Water Hardness[1] - Cold and Warm Water Biota				
	0-100	100-200	200-300	300-400	over 400
Toxic Metals[2] (mg/ℓ)					
Aluminum (soluble)	0.1	0.1	0.1	0.1	0.1
Arsenic	0.05	0.05	0.05	0.05	0.05
Barium	X	X	X	X	X
Beryllium	0.01	0.3	0.6	0.9	1.1
Cadmium	0.004	0.001	0.005	0.01	0.015
Chromium	0.1	0.1	0.1	0.1	0.1
Copper	0.01	0.01	0.01	0.02	0.04
Iron	1.0	1.0	1.0	1.0	1.0
Lead[3]	0.004	0.025	0.050	0.100	0.150
Manganese	1.0	1.0	1.0	1.0	1.0
Mercury	0.00005	0.00005	0.00005	0.00005	0.00005
Molybdenum	X	X	X	X	X
Nickel	0.05	0.10	0.20	0.30	0.40
Selenium	0.05	0.05	0.05	0.05	0.05
Silver	0.00010	0.00010	0.00015	0.00020	0.00025
Thallium	0.15	0.15	0.15	0.15	0.15
Uranium	0.03	0.2	0.4	0.8	1.4
Zinc	0.05	0.05	0.10	0.30	0.60

X = numerical limit generally not needed for protection of classified use.

[1]Concentrations of total alkalinity or other chelating agents attributable to municipal, industrial or other discharges or agriculatural practices should not alter the total alkalinity or other chelating agents of the receiving water by more than 20 percent. Where the complexing capacity of the receiving water is altered by more than 20 percent or where chelating agents are released to the receiving water which are not naturally characteristic of that water, specific effluent limitations on pertinent parameters will be established. In no case shall instream modification or alteration of total alkalinity or other chelating agents be permitted without Commission authorization.

[2]Bioassay procedures may be used to establish criteria or standards for a particular situation. Requirements for bioassay procedures outlined in Section 3.1.10, Colorado Water Quality Standards, May 2. 1978.

[3]For bioassay lead concentration is based on soluble lead measurements (*i.e.* non-filterable lead using a 0.45 micron filter).

Table B-4 Proposed Colorado water quality standards: Agricultural Use.

Parameter	Standard
Physical	
D.O. (mg/ℓ)[1]	Aerobic[2]
pH	X
Suspended solids and turbidity	[3]
Temperature	X
TDS (mg/ℓ)	Y
Biological	
Algae[4]	Free of toxic and objectionable algae
Fecal coliforms (#/100 mℓ)	1,000
Inorganics	
Ammonia (mg/ℓ as N)	X
Total residual chlorine (mg/ℓ)	X
Cyanide (mg/ℓ)	0.2
Fluoride (mg/ℓ)	X
Nitrate (mg/ℓ as N)	100[5]
Nitrite (mg/ℓ as N)	10[5]
Sulfide as H_2S (mg/ℓ)	X
Boron (mg/ℓ)[2]	0.75
Chloride (mg/ℓ)	X
Magnesium (mg/ℓ)	X
Sodium adsorbtion ratio	X
Sulfate (mg/ℓ)	X
Phosphorus (mg/ℓ as P)	X
Toxic Metals (mg/ℓ)	
Aluminum	X
Arsenic	0.1
Barium	X
Beryllium	0.1
Cadmium	0.01
Chromium	0.0
Copper	0.2
Iron	X
Lead	0.1
Manganese	0.2
Mercury	X
Molybdenum	Y
Nickel	0.2

X = numerical limit generally not needed for protection of classified use.

Y = limit may be required but there is insufficient data for setting a general standard.

Table B-4 Continued.

Parameter	Standard
Toxic Metals (mg/ℓ)	
Selenium	0.02
Silver	X
Thallium	X
Zinc	2.0
Organics[6], ($\frac{\mu g}{\ell}$)	
Chlorinated Pesticides[7]	
Aldrin[8]	Y
Chlordane[8]	Y
Dieldrin[8]	Y
DDT[8]	Y
Endrin	Y
Heptachlor[8]	Y
Lindane	Y
Methoxychlor	Y
Mirex	Y
Toxaphene	Y
Organophosphate Pesticides[7]	
Demeton	Y
Endosulfan	Y
Guthion	Y
Malathion	Y
Parathion	Y
Chlorophenoxy Herbicides	
2, 4-D	Y
2, 4, 5-TP	Y
PCB's[9]	Y
Phenol	Y
Radiological[10] (pCi/ℓ)	
Alpha[11, 12]	15
Beta[11, 12]	50
Cesium	80
Plutonium	15
Radium 226, and 228[12]	5
Strontium 90[12]	8
Thorium 230 and 232	60
Tritium	20,000
Uranium (total, mg/ℓ)	5

[1]Where dissolved oxygen levels, less than the standard, occur naturally, a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]An effluent shall be regulated to maintain aerobic conditions, and a guideline of 2.0 mg/ℓ dissolved oxygen in an effluent should be maintained, unless demonstrated otherwise.

[3]Suspended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blut-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams, lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, or allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[5]In order to provide a reasonable margin of safety to allow for unusual situations such as extremely high water ingestion or nitrite formation in slurries, the NO_3-N plus NO_2-N content in drinking waters for livestock and poultry should be limited to 100 ppm or less, and the NO_2-N content alone be limited to 10 ppm or less.

[6]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[7]Numerical limits in tables based on experimental evidence of toxicity. No point source discharges of organic pesticides shall be permitted to state waters.

[8]The persistence, bioaccumulation potential, and carcinogenicity of these organic compounds cautions human exposeure to a minimum (EPA).

[9]Every reasonable effort should be made to minimize human exposure (EPA).

[10]Concentrations given are maximum permissible concentrations above naturally occurring or "background" concentrations except where otherwise noted.

[11]If Alpha or Beta are measured in excess of 15 or 50 pCi/ℓ respectively, it will be necessary to determine by specific analysis the particular radionuclide or radionuclides responsible for the elevated level. Particular radionuclides should not exceed the limit given in the table. If an elevated level of Alpha or Beta emissions is caused by radionuclides, the Division should be consulted.

[12]Maximum permissible concentrations including naturally occurring or background contributions.

Table B-5 Proposed Colorado water quality standards: Recreational Use.

Parameter	Standard	
	Class I (Primary Contact)	Class II (Secondary Contact)
Physical		
D.O.[1] ($\frac{mg}{\ell}$ D.O.)	Aerobic[2]	Aerobic[2]
pH	6.5-9.0	X
Suspended solids and turbidity	X	X
Temperature	X	X
TDS (mg/ℓ)	X	X
Biological		
Algae[4]	Free of objectionable and toxic algae	Free of objectionable and toxic algae
Fecal coliforms (#/100 mℓ)	200	1,000
Inorganics		
Ammonia ($\frac{mg}{\ell}$ as N)	X	X
Chloride (mg/ℓ)	X	X
Cyanide (mg/ℓ)	X	X
Fluoride (mg/ℓ)	X	X
NO_3 (mg/ℓ as N)	X	X
NO_2 (mg/ℓ as N)	X	X
Sulfide as H_2S (mg/ℓ)	X	X
Boron (mg/ℓ)[2]	X	X
Chloride (mg/ℓ)	X	X
Magnesium (mg/ℓ)	X	X
SAR	X	X
Sulfate (mg/ℓ)	X	X
Phosphorus (mg/ℓ as P)	Bioassay[5]	Bioassay[5]
Toxic Metals (mg/ℓ)		
Aluminum	X	X
Arsenic	X	X
Barium	X	X
Beryllium	X	X
Cadmium	X	X
Chromium	X	X
Copper	X	X
Iron	X	X
Lead	X	X
Manganese	X	X
Mercury	X	X
Molybdenum	X	X
Nickel	X	X
Selenium	X	X

Table B-5 Continued.

Parameter	Standard	
	Class I (Primary Contact)	Class II (Secondary Contact)
Toxic Metals (mg/ℓ)		
Silver	X	X
Thallium	X	X
Uranium	X	X
Zinc	X	X
Organics[6]		
Chlorinated Pesticides[7]		
Aldrin[8]	Y	Y
Chlordane[8]	Y	Y
Dieldrin[8]	Y	Y
DDT[8]	Y	Y
Endrin	Y	Y
Heptachlor[8]	Y	Y
Lindane	Y	Y
Methoxychlor	Y	Y
Mirex	Y	Y
Toxaphene	Y	Y
Organophosphate Pesticides[7]		
Demeton	Y	Y
Endosulfan	Y	Y
Guthion	Y	Y
Malathion	Y	Y
Parathion	Y	Y
Chlorophynoxy Herbicides		
2, 4-D	Y	Y
2, 4, 5-TP	Y	Y
PCB's[9]	Y	Y
Phenol	Y	Y
Radiological		
Alpha	X	X
Beta	X	X
Cesium 134	X	X
Plutonium 238, 239, and 240	X	X
Radium 226 and 228	X	X
Strantium	X	X
Thorium 230 and 232	X	X
Tritium	X	X
Uranium (total)	X	X

X = numerical limit generally not needed for protection of classified use.
Y = limit may be required but there is insufficient data for setting a general standard.

[1]Where dissolved oxygen levels, less than the standard, occur naturally, a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]An effluent shall be regulated to maintain aerobic conditions, and a guideline of 2.0 mg/ℓ dissolved oxygen in an effluent should be maintained, unless demonstrated otherwise.

[3]Suspsended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blue-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams, lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, nor allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[5]Phosphorus standards are to be determined by an algal bioassay using the method described in the latest edition of *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association.

[6]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[7]Numerical limits in tables based on experimental evidence of toxicity. No point source discharge of organic pesticides shall be permitted to state waters.

[8]The persistence, bioaccumulation potential, and carcinogenicity of these organic compounds cautions human exposure to a minimum (EPA).

[9]Every reasonable effort should be made to minimize human exposure (EPA).

APPENDIX C

Raw Water Quality Data

Table C-1. Water quality parameter codes.

A. METALLIC CONSTITUENTS
(µg/l unless noted)

101. Aluminium, Dissolved
102. Aluminium, Total
103. Barium, Dissolved
104. Barium, Total
105. Cadmium, Dissolved
106. Cadmium, Total
107. Calcium (mg/l)
108. Chromium, Hexavalent
109. Chromium, Total
110. Copper, Dissolved
111. Copper, Total
112. Hardness, Total
113. Iron, Dissolved
114. Iron, Total
115. Lead, Dissolved
116. Lead, Total
117. Magnesium (mg/l)
118. Manganese, Dissolved
119. Manganese, Total
120. Mercury, Dissolved
121. Mercury, Total
122. Molybdenum, Dissolved
123. Molybdenum, Total
124. Nickel, Dissolved
125. Nickel, Total
126. Potassium (mg/l)
127. Selenium, Dissolved
128. Selenium, Total
129. Silver, Dissolved
130. Silver, Total
131. Sodium (mg/l)
132. Zinc, Dissolved
133. Zinc, Total

B. NON-METALLIC CONSTITUENTS
(mg/l unless noted)

201. Alkalinity, Total
202. Arsenic, Dissolved (µg/l)
203. Arsenic, Total (µg/l)
204. Bicarbonate Hardness
205. Boron
206. Carbonate Hardness
207. Chloride
208. Cyanide
209. Fluoride
210. Nitrogen, Nitrate
211. Nitrogen, Nitrite
212. Nitrogen, Total Organic
213. Phosphorus, Ortho
214. Phosphorus, Total
215. Sulfate
216. Total Dissolved Solids

Table C-2. Water quality data for the San Miguel River at Sawpit, Col.

SAN MIGUEL PROJECT

STATION 29: SAN MIGUEL AT SAW PIT

COLF	5/25/77	6/16	6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/18/78	2/15	3/21	4/13	5/18	6/16	7/19	8/24
101				320.	390.	260.	260.	130.	51.	100.	380.	140.	280.	167.	810.	210.	260.
102				2090.	490.	630.	270.	130.	900.	400.	460.	130.	1260.	4000.	3410.	1310.	670.
103								-100.	-100.	-100.	-100.	-100.	-100.	-100.	-100.	-100.	-100.
104								-100.	-100.	200.	-100.	-100.	307.	1161.	-100.	-100.	-100.
105				-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.
106				12.	19.	14.	14.	-3.	-3.	3.	-3.	9.	5.	5.	-3.	-3.	9.
107				63.	73.	68.	77.	86.	87.	67.		77.	88.	54.	32.	55.	70.
108				2.	-1.	3.	-1.	5.	4.	3.		4.	3.	5.	-1.	-1.	6.
109										-20.	-20.	-20.	-20.	-20.	-20.	-20.	-20.
110				-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.
111				35.	-10.	64.	-10.	-10.	-10.	19.	-10.	-10.	-10.	76.	29.	21.	61.
112				188.	188.	216.	230.	217.	294.	192.		256.	233.	131.	87.	94.	194.
113				44.	38.	-21.	33.	-21.	39.	-21.	-21.	-21.	36.	55.	52.	61.	32.
114				1598.	321.	356.	161.	243.	449.	536.	591.	101.	718.	4073.	4900.	1190.	1290.
115								-1.	-1.	-1.	-1.	-1.	2.	3.	-1.	3.	-1.
116								-1.	-1.	3.	-1.	-1.	26.	32.	29.	15.	-1.
117				7.	2.	11.	11.	-1.	10.	6.		15.	3.	-1.	2.	2.	4.
118				30.	30.	44.	44.	34.	34.	16.	19.	32.	241.	80.	93.	120.	67.
119				58.	36.	73.	44.	60.	77.	81.	91.	45.	113.	82.	407.	190.	65.
120				0.8	-0.2	-0.2	0.3	0.2	-0.2	-0.2	-0.2	0.2	0.3	-0.2	0.3	0.4	1.0
121				1.0	-0.2	0.4	0.1	0.3	-0.2	-0.2	0.4	0.3	0.6	1.0	0.3	0.6	0.1
122				10.	7.	-5.	6.	-5.	5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.
123				22.	9.	3.	6.	-5.	5.	5.	13.	-5.	18.	-5.	-5.	6.	519.
124				-6.	-6.	-6.	-6.	-6.	-6.	-6.	-6.	-6.	-6.	-6.	-6.	-6.	-6.
125				47.	-6.	101.	62.	24.	-6.	-6.	-6.	-6.	-6.	11.	-6.	-6.	-6.
126				1.0	1.0	1.0	1.5	1.1	4.0	0.9	0.9	1.0	1.1	1.8	3.0	2.0	2.0
127				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	-1.
128				-1.	2.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	1.	2.
129				-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.
130				-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	12.	-9.	-9.	-9.	-9.	-9.
131				9.	6.	23.	20.	5.	7.	5.	5.	8.	6.	4.	2.	4.	5.
132				-5.	54.	95.	122.	97.	87.	56.	76.	30.	207.	76.	68.	170.	61.
133				362.	340.	520.	514.	185.	305.	79.	110.	30.	207.	691.	397.	665.	435.
201				79.	69.	67.	68.	78.	74.	88.	56.	76.	89.	64.	42.	44.	69.
202				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	-1.
203				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		7.	5.	-1.
204				74.	69.	67.	68.	78.	74.	87.	56.	79.	84.	64.	42.	44.	69.
205				0.38	0.79	0.46	0.25	-0.05	-0.05	-0.05	-0.05	1.08	0.25	0.59	-0.05	0.29	-0.05
206																	
207				1.	1.	2.	2.	7.	2.	1.		1.	5.	-1.	2.	2.	-1.
208				-0.01	-0.01	0.02	0.18	0.13	-0.01	0.01		0.01	-0.01	-0.01	0.01	0.02	0.02
209				0.10	0.11	0.12	0.10	0.12	0.20			-0.01	0.02	-0.01	-0.01	0.01	0.03
210				0.46	0.19	0.33	0.39	0.37	0.43	0.37		0.31	0.40	0.30	0.59	0.24	0.27
211				0.006	0.007	0.012	0.002	0.007	0.006	0.005		0.006	0.004	0.005	0.005	0.005	0.005
212						1.1	-0.1	-0.1	-0.1	0.2		-0.1	0.6	0.4	0.2	-0.1	0.6
213				0.002	0.005	0.005	0.007	0.011	0.013	0.020		0.027	0.009	0.008	0.005	0.002	0.003
214				0.023	0.040	0.036	0.023	0.034	0.044	0.131	0.334	0.045	0.060	0.148	0.033	0.029	0.020
215				113.	41.	124.	114.	177.	168.	92.		120.	178.	65.	60.	54.	125.
216				252.	216.	216.	316.	488.	275.	277.		276.	294.	191.	124.	122.	230.

Table C-3. Water quality data for the San Miguel River at Placerville, Col.

SAN MIGUEL PROJECT

STATION 25: SAN MIGUEL AT NATURITA

CODE	5/25/77	6/16	6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/18/78	2/15	3/21	4/18	5/13	6/10	7/19	8/24
101		490.		740.	260.	310.	151.	221.	56.	143.	251.	-50.	308.	112.	1090.	205.	533.
102		930.		2040.	880.	893.	243.	4642.	588.	3606.	399.	1087.	1805.	19000.	7510.	1491.	533.
103								182.	-100.	-100.	-100.	-100.	-100.	-100.	-100.	-100.	-100.
104								104.	-100.	456.	-100.	-100.	-100.	651.	-100.	-100.	-100.
105		-3.		-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	3.
106		34.		16.	19.	8.	8.	-3.	-3.	8.	-3.	-3.	-3.	5.	4.	-3.	10.
107		58.		179.	137.	122.	112.	228.	110.	77.	95.	97.	50.	28.	37.	50.	
108		-1.		1.	-1.	-1.	-1.	2.	2.	2.	2.	-1.	5.	7.	3.	-1.	
109										-20.	-20.	-20.	-20.	-20.	-20.	-20.	-20.
110		11.		16.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.
111		39.		35.	26.	127.	-10.	36.	-10.	43.	-10.	-10.	-10.	66.	61.	-10.	-10.
112		180.		908.	524.	538.	356.	789.	355.	208.	347.	317.	120.	117.	102.	165.	687.
113		64.		36.	-21.	-21.	-21.	-21.	22.	-21.	-21.	-21.	122.	53.	64.	53.	58.
114		848.		953.	459.	226.	317.	248.	360.	2092.	184.	507.	122.	15030.	8110.	1198.	185.
115								-1.	-1.	-1.	-1.	-1.	1.	-1.	-1.	2.	-1.
116								-1.	-1.	2.	-1.	-1.	11.	57.	32.	55.	-1.
117		9.		15.	44.	56.	18.	53.		14.	27.	18.	-1.	2.	2.	5.	
118		17.		46.	64.	44.	42.	154.	46.	23.	43.	-5.	37.	24.	22.	26.	55.
119				108.	80.	92.	21.	111.	44.	34.	39.	41.	65.	582.	555.	92.	55.
120		-0.2		0.2	0.3	-0.2	1.3	0.8	-0.2	0.3	1.1	0.3	0.3	0.2	0.2	-0.2	1.1
121		-0.2		1.8	0.4	0.3	1.4	0.9	-0.2	0.3	1.1	0.3	0.5	0.2	0.4	-0.2	1.0
122		11.		19.	18.	11.	6.	7.	-5.	11.	-5.	-5.	-5.	-5.	-5.	-5.	5.
123		12.		25.	19.	28.	7.	9.	-5.	11.	15.	-5.	-5.	-5.	-5.	8.	6.
124		-6.		-6.	6.	-6.	8.	44.	-6.	9.	-6.	-6.	-6.	-6.	-6.	-6.	-6.
125		58.		23.	43.	207.	34.	51.	-6.	9.	26.	-6.	-6.	21.	15.	-6.	-6.
126		1.0		4.0	3.0	2.0	2.2	2.6	4.6	1.1	1.3	2.0	1.5	4.6	4.0	2.3	4.0
127		-1.		-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	-1.
128		-1.		-1.	2.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	1.	2.
129		-9.		-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.
130		-9.		-9.	-9.	-9.	13.	-9.	-9.	13.	-9.	20.	-9.	-9.	-9.	-9.	18.
131		8.		59.	27.	49.	20.	62.	23.	12.	19.	21.	9.	4.	5.	5.	33.
132		23.		8.	16.	7.	12.	18.	9.	18.	-5.	6.	15.	27.	28.	82.	10.
133		268.		212.	435.	354.	288.	1518.	83.	279.	-5.	66.	15.	518.	405.	102.	-5.
201		77.		219.	73.	149.	119.	203.	129.	191.	135.	122.	89.	102.	61.	58.	198.
202		-1.		-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	-1.
203		-1.		1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		19.	-1.	-1.
204		77.		204.	73.	145.	119.	191.	129.	101.	135.	122.	89.	102.	61.	58.	198.
205		0.20			0.75	0.83	0.11	0.38	0.12	-0.05	-0.05	1.11	0.15	0.65	0.32	-0.05	0.20
206		0		15.	0	6.	0	12.	0	0	0	0	0	0	0	0	0
207		-1.		10.	5.	6.	6.	14.	6.	8.	7.	6.	10.	-1.	2.	1.	
208		-0.01		-0.01	0.01	-0.01	0.10	0.14	-0.01	0.01	0.02	0.01	-0.01	-0.01	0.01	0.02	0.02
209		0.12		0.41	0.30	0.37	0.15	0.39	0.26		0.18	0.01	-0.01	-0.01	-0.01	0.1	
210		0.05		0.17	0.08	0.05	0.06	0.10	0.28	0.20	0.09	0.04	0.14	0.13	1.39	0.15	
211		0.002		0.004	0.003	0.006	-0.001	0.004	0.005	0.005	0.004	0.003	0.003	0.003	0.006	0.004	
212		0.2		0.6	0.4	0.9	-0.1	-0.1	0.5	1.0	-0.1	0.2	-0.1	1.8	1.1	0.2	
213		0.003		0.001	0.001	-0.001	0.004	0.003	0.004	0.006	0.002	0.004	0.011	0.019	0.012	0.008	0.003
214		0.056		0.036	0.027	0.015	0.023	0.025	0.014	0.072	0.016	0.033	0.030	0.534	0.037	0.023	0.030
215		52.		606.	72.	410.	231.	711.	253.	105.	279.	181.	43.	42.	65.	92.	
216		286.		1474.	680.	648.	463.	1210.	498.	291.	496.	467.	178.	150.	141.	204.	

Table C-4. Water quality data for the San Miguel River at Naturita, Col.

SAN MIGUEL PROJECT

STATION 241 SAN MIGUEL NEAR PLACERVILLE

CODE	5/25/77	6/16	6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/18/78	2/15	3/21	4/18	5/19	6/15	7/19	8/20
101		400.		520.	370.	380.	106.	161.	<50.	122.	246.	85.	224.	165.	784.	387.	942.
102		1900.		5500.	740.	428.	121.	1127.	215.	204.	375.	194.	1053.	1210.	4140.	1431.	842.
103								<100.	<100.	<100.	<100.	<100.	<100.	119.	<100.	<100.	<100.
104								<100.	112.	114.	<100.	<100.	<100.	202.	207.	382.	<100.	<100.
105		<3.		<3.	<3.	4.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.
106		17.		<3.	23.	6.	16.	6.	<3.	5.	<3.	<3.	10.	7.	3.	<3.	6.
107		41.		52.	72.	64.	77.	77.	81.	70.	84.	71.	63.	39.	31.	34.	65.
108		<1.		2.	<1.	4.	<1.	4.	2.	2.	2.	4.	2.	5.	<1.	2.	2.
109										<20.	<20.	<20.	<20.	<20.	<20.	<20.	<20.
110		<10.		<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	15.	<10.
111		31.		33.	16.	36.	<10.	66.	<10.	<10.	<10.	<10.	<10.	67.	52.	40.	20.
112		122.		178.	188.	202.	202.	209.	211.	205.	260.	191.	164.	126.	85.	98.	181.
113		23.		52.	<21.	104.	<21.	<21.	<21.	<21.	<21.	<21.	<21.	75.	64.	284.	31.
114		1787.		3461.	544.	377.	188.	1414.	108.	191.	384.	69.	509.	11331.	5500.	1580.	224.
115								3.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	7.	<1.
116								3.	<1.	<1.	<1.	<1.	2.	38.	40.	33.	<1.
117		5.		11.	2.	10.	2.	4.	2.	7.	12.	3.	<1.	1.	2.	3.	5.
118		15.		9.	20.	48.	20.	40.	15.	12.	16.	30.	72.	55.	70.	115.	80.
119		203.		80.	33.	51.	21.	111.	49.	34.	39.	41.	65.	552.	417.	130.	46.
120		<0.2		1.1	0.4	1.1	0.4	<0.2	<0.2	<0.2	0.2	0.3	0.4	<0.2	0.5	0.2	1.9
121		0.3		2.3	0.4	1.1	0.7	0.3	<0.2	0.3	0.2	0.4	0.7	<0.2	0.5	1.2	3.2
122		13.		7.	5.	11.	6.	<5.	<5.	<5.	5.	<5.	<5.	<5.	<5.	<5.	<5.
123		14.		38.	10.	11.	6.	<5.	<5.	5.	7.	<5.	5.	<5.	<5.	0.	<5.
124		<6.		<6.	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<6.
125		100.		134.	<6.	50.	<6.	24.	<6.	<6.	7.	<6.	30.	25.	12.	<6.	<6.
126		1.0		1.0	1.0	1.0	1.6	1.1	4.1	0.9	1.0	1.6	1.3	3.0	3.0	2.0	2.0
127		<1.		<1.	<1.	<1.	12.	4.	<1.	<1.	<1.	<1.	<1.	<1.		<1.	<1.	<1.
128		<1.		<1.	2.	12.	7.	<1.	<1.	<1.	<1.	<1.	<1.			<1.	1.	1.
129		<0.		<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.
130		<0.		<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.	<0.
131		3.		0.	7.	26.	10.	5.	8.	5.	6.	4.	7.	3.	0.	5.	5.	
132		56.		<5.	36.	140.	67.	66.	36.	58.	58.	<5.	47.	69.	52.	140.	151.	
133		580.		319.	435.	292.	208.	199.	36.	55.	58.	<5.	314.	620.	285.	225.	86.	
201		54.		82.	80.	78.	69.	138.	94.	88.	92.	88.	93.	84.	89.	89.	78.	
202		<1.		<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.		<1.	<1.	<1.	
203		<1.		<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.		11.	3.	<1.	
204		54.		82.	80.	78.	69.	138.	94.	88.	92.	88.	90.	104.	85.	86.	74.	
205		0.05			1.35	0.48	0.10	<0.05	<0.05	0.13	<0.05	0.03	0.37	0.07	<0.05	0.05	<0.05	
206		0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
207		<1.		2.	<1.	2.	4.	2.	2.	1.	1.	2.	5.	<1.	2.	2.	<1.	
208		<0.01		<0.01	0.01	<0.01	0.12	0.14	<0.01	0.01	0.04	0.01	<0.01	0.01	0.01	0.02	0.02	
209		0.03		0.10	0.12	0.10	0.09	0.12	0.17		0.15	<0.01	<0.01	<0.01	<0.01	0.01	0.03	
210		0.15		0.34	0.20	0.19	0.19	0.43	0.20	0.20	0.26	0.12	0.10	0.26	0.27	0.21	0.08	
211		0.003		0.006	0.006	0.013	0.010	0.005	0.004	0.004	0.008	0.004	0.004	0.003	0.005	0.003	0.004	
212		0.5		0.5	0.5	0.5	0.1	0.1	<0.1	0.1	0.4	0.2	1.2	<0.1	0.1	0.1	0.7	
213		0.002		0.003	0.001	0.005	0.002	0.004	<0.001	0.007	0.009	0.010	0.003	0.012	0.004	0.007	0.003	
214		0.030		0.003	0.047	0.027	0.016	0.054	0.024	0.039	0.040	0.033	0.052	0.360	0.022	0.036	0.014	
215		52.		107.	48.	81.	145.	93.	105.	100.	143.	90.	69.	48.	55.	49.	88.	
216		162.		276.	214.	190.	343.	270.	232.	216.	304.	298.	176.	174.	126.	137.	210.	

Table C-5. Water quality data for Leopard Creek

SAN MIGUEL PROJECT

STATION 2R: LEOPARD CREEK

CODE	5/25/77	6/16	6/30	7/14	8/24	9/21	10/19	11/15	12/13	1/18/78	2/15	3/21	4/16	5/14	6/15	7/19	8/24
101				210.	420.	260.	134.	131.	54.	103.	330.	154.	278.	651.	1460.	424.	215.
102				700.	850.	625.	183.	131.	202.	190.	330.	184.	1139.	3400.	1460.	5011.	636.
103								-100.	104.	105.	-100.	-100.	-100.	-100.	-100.	-100.	-100.
104								-100.	142.	154.	116.	-100.	-100.	421.	127.	594.	109.
105				-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	3.	-3.	-3.	-3.	-3.
106				14.	21.	-3.	12.	-3.	-3.	4.	-3.	-3.	3.	5.	7.	-3.	-3.
107				60.	72.	76.	83.	82.	77.	71.	75.	96.	83.	51.	57.	69.	64.
108				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	6.	6.	-1.	2.	2.
109										-20.	-20.	-20.	-20.	-20.	-20.	-20.	-20.
110				-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.
111				-10.	12.	50.	84.	-10.	-10.	-10.	-10.	-10.	-10.	33.	34.	34.	11.
112				233.	280.	274.	229.	241.	255.	234.	233.	208.	99.	138.	168.	181.	273.
113				28.	27.	-21.	-21.	-21.	-21.	-21.	-21.	-21.	184.	96.	50.	165.	65.
114				263.	501.	352.	143.	127.	307.	179.	135.	213.	528.	2797.	841.	4040.	1144.
115								-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	2.	-1.
116								-1.	-1.	-1.	-1.	-1.	-1.	16.	-1.	6.	-1.
117				20.	16.	20.	5.	9.	14.	14.	11.	-1.	-1.	3.	6.	3.	14.
118				7.	16.	26.	13.	18.	10.	14.	-5.	20.	33.	22.	10.	15.	9.
119				42.	22.	44.	32.	19.	28.	29.	9.	36.	24.	243.	37.	93.	55.
120				0.3	0.3	-0.2	0.9	-0.2	-0.2	-0.2	-0.2	0.3	0.5	-0.2	0.2	0.4	1.9
121				3.4	0.3	0.2	1.2	-0.2	0.4	-0.2	0.4	0.3	0.6	-0.2	0.3	0.4	2.9
122				20.	-5.	10.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.
123				24.	-5.	11.	-5.	6.	-5.	-5.	8.	-5.	-5.	-5.	-5.	7.	767.
124				-6.	-6.	-6.	14.	-6.	-6.	-6.	-6.	-6.	-6.	-6.	7.	-6.	-6.
125				17.	-6.	98.	32.	16.	-6.	-6.	-6.	-6.	-6.	16.	11.	-6.	20.
126				2.1	2.1	2.0	2.5	1.4	4.8	1.3	1.4	2.0	1.6	2.5	3.0	5.0	5.0
127				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	-1.
128				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	1.	2.
129				-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.
130				-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.
131				15.	16.	44.	16.	9.	13.	10.	15.	13.	6.	4.	6.	11.	9.
132				-5.	14.	5.	10.	-5.	-5.	-5.	-5.	-5.	-5.	12.	-5.	16.	-5.
133				170.	290.	430.	293.	40.	-5.	-5.	-5.	-5.	15.	-5.	203.	-5.	351.	-5.
201				177.	210.	207.	169.	141.	165.	193.	166.	164.	79.	104.	132.	141.	166.
202				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	-1.
203				1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	5.	-1.
204				174.	203.	205.	169.	169.	185.	193.	166.	164.	79.	104.	132.	141.	166.
205				1.23	1.10	-0.05	0.18	-0.05	0.21	-0.05	0.12	0.77	0.22	1.12	0.45	0.29	-0.05
206				5.	7.	4.		2.									
207				3.	4.	3.	3.	3.	2.	5.	2.	2.	9.	-1.	3.	4.	-1.
208				-0.01	0.01	0.02	0.19	0.16	-0.01	-0.01	-0.01	0.01	-0.01	-0.01	0.01	0.02	0.02
209				0.07	0.11	0.10	0.09	0.10	0.16		0.18	-0.01	0.01	-0.01	-0.01	0.01	0.02
210				0.20	0.07	0.04	7.20	0.11	0.07	0.01	0.04	0.03	0.20	0.17	0.13	0.16	0.06
211				0.005	0.006	0.009	0.004	0.002	0.004	0.002	0.002	0.001	0.005	0.003	0.005	0.005	0.005
212						1.2	1.1	-0.1	-0.1	0.1	0.2	0.1	-0.1	0.8	0.6	0.3	0.4
213				0.003	0.001	-0.001	0.025	0.002	0.002	0.006	0.002	0.006	0.022	0.018	0.006	0.026	0.001
214				0.013	0.006	0.018	0.074	0.010	0.004	0.006	0.021	0.012	0.049	0.128	0.037	0.050	0.010
215				60.	71.	69.	75.	64.	60.	53.	39.	45.	32.	39.	62.	60.	46.
216				270.	220.	260.	350.	300.	260.	252.	274.	259.	83.	187.	214.	258.	254.

APPENDIX D

Statistical Analyses of Water Quality Data

Table D-1. Statistical analysis of water quality data for the San Miguel River at Sawpit.

SAN MIGUEL PROJECT

STATION 291 SAN MIGUEL AT SAW PIT

CODE	CONSTITUENT	MEAN	VARIANCE	S.D.	C OF V	MAX	MIN	RANGE	N
	***** GROUP A: METALLIC CONSTITUENTS *****								
101	ALUMINIUM, DISSOLVED (UG/L)	262.3	.3483E+05	186.6	71.2	614.	51.	563.	14
102	ALUMINIUM, TOTAL (UG/L)	1163.4	.1448E+07	1203.4	103.4	4000.	134.	3866.	14
103	BARIUM, DISSOLVED (UG/L)	0.0	0.	0.0	0.	0.	0.	0.	0
104	BARIUM, TOTAL (UG/L)	557.3	.2760E+06	525.3	94.3	1161.	204.	957.	3
105	CADMIUM, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
106	CADMIUM, TOTAL (UG/L)	10.0	.2725E+02	5.2	52.2	19.	3.	16.	6
107	CALCIUM (MG/L)	67.5	.3233E+03	18.0	26.7	98.	32.	66.	13
108	CHROMIUM, HEXAVALENT (UG/L)	4.1	.3111E+01	1.8	42.9	8.	2.	6.	9
109	CHROMIUM, TOTAL (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
110	COPPER, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
111	COPPER, TOTAL (UG/L)	43.6	.5286E+03	23.0	52.8	76.	19.	57.	7
112	HARDNESS, TOTAL AS CACO3 (MG/L)	194.5	.3650E+04	60.4	31.1	299.	87.	207.	13
113	IRON, DISSOLVED (UG/L)	42.3	.1263E+03	11.2	26.5	61.	30.	31.	9
114	IRON, TOTAL (UG/L)	1120.5	.1754E+07	1324.6	118.2	4073.	101.	3972.	14
115	LEAD, DISSOLVED (UG/L)	2.7	.3333E+00	0.6	21.7	3.	2.	1.	3
116	LEAD, TOTAL (UG/L)	21.6	.1353E+03	11.6	53.9	32.	3.	29.	5
117	MAGNESIUM (MG/L)	7.4	.3165E+02	5.6	76.4	18.	2.	16.	11
118	MANGANESE, DISSOLVED (UG/L)	62.1	.3712E+04	60.9	98.0	241.	10.	231.	14
119	MANGANESE, TOTAL (UG/L)	103.9	.9226E+04	96.1	92.5	857.	56.	371.	14
120	MERCURY, DISSOLVED (UG/L)	0.44	.8839E-01	0.30	67.96	1.0	0.2	0.8	6
121	MERCURY, TOTAL (UG/L)	1.34	.3205E+01	1.79	133.95	5.1	0.3	5.8	11
122	MOLYBDENUM, DISSOLVED (UG/L)	7.0	.4667E+01	2.2	30.9	10.	5.	5.	4
123	MOLYBDENUM, TOTAL (UG/L)	60.6	.2598E+05	161.2	266.0	519.	3.	516.	10
124	NICKEL, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
125	NICKEL, TOTAL (UG/L)	49.0	.1237E+04	35.2	71.8	101.	11.	90.	5
126	POTASSIUM (MG/L)	1.6	.8179E+00	0.9	55.3	4.	1.	3.	14
127	SELENIUM, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
128	SELENIUM, TOTAL (UG/L)	1.7	.3333E+00	0.6	34.6	2.	1.	1.	3
129	SILVER, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
130	SILVER, TOTAL (UG/L)	12.0	0.	0.0	0.0	12.	12.	0.	1
131	SODIUM (MG/L)	7.8	.3710E+02	6.1	78.2	23.	2.	21.	14
132	ZINC, DISSOLVED (UG/L)	94.2	.2414E+04	49.1	52.1	207.	30.	177.	13
133	ZINC, TOTAL (UG/L)	315.1	.3736E+05	193.3	61.3	691.	30.	661.	14
	***** GROUP B: NON-METALLIC CONSTITUENTS *****								
201	ALKALINITY, TOTAL AS CACO3 (MG/L)	67.2	.2554E+03	16.0	23.8	94.	36.	58.	14
202	ARSENIC, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
203	ARSENIC, TOTAL (UG/L)	6.0	.2000E+01	1.4	23.6	7.	5.	2.	2
204	BICARBONATE HARDNESS AS CACO3 (MG/L)	67.1	.2523E+03	15.9	23.7	87.	36.	51.	14
205	BORON (MG/L)	0.500	.8137E-01	0.285	57.051	1.06	0.25	0.83	8
206	CARBONATE AS CACO3 (MG/L)	0.0	0.	0.0	0.0	1.	0.	0.	0
207	CHLORIDE (MG/L)	2.5	.4273E+01	2.1	84.2	7.	1.	6.	11
208	CYANIDE (MG/L)	0.050	.4000E-02	0.066	132.665	0.18	0.01	0.17	6
209	FLUORIDE (MG/L)	0.090	.3075E-02	0.061	67.158	0.20	0.01	0.19	9
210	NITROGEN, NITRATE (MG/L)	0.353	.9990E-02	0.100	28.308	0.50	0.10	0.40	13
211	NITROGEN, NITRITE (MG/L)	0.0056	.5756E-05	0.0024	42.7268	0.012	0.002	0.010	13
212	NITROGEN, TOTAL ORGANIC (MG/L)	0.63	.1387E+00	0.37	58.80	1.1	0.2	0.9	9
213	PHOSPHORUS, ORTHO (MG/L)	0.0090	.5433E-04	0.0074	81.9713	0.027	0.002	0.025	13
214	PHOSPHORUS, TOTAL (MG/L)	0.0714	.7246E-02	0.0851	119.1699	0.334	0.020	0.314	14
215	SULFATE (MG/L)	110.3	.2148E+04	46.3	42.0	178.	41.	137.	13
216	TOTAL DISSOLVED SOLIDS (MG/L)	236.7	.3827E+04	61.9	26.1	316.	122.	194.	13

Table D-2. Statistical analysis of water quality data for the San Miguel River at Placerville.

SAN MIGUEL PROJECT

STATION 24: SAN MIGUEL NEAR PLACERVILLE

CODE	CONSTITUENT	MEAN	VARIANCE	S.D.	C OF V	MAX	MIN	RANGE	N
	***** GROUP A: METALLIC CONSTITUENTS *****								
101	ALUMINIUM, DISSOLVED (UG/L)	314.2	.3755E+05	193.8	61.7	784.	65.	699.	14
102	ALUMINIUM, TOTAL (UG/L)	1998.1	.1023E+08	3197.7	160.0	12100.	121.	11979.	15
103	BARIUM, DISSOLVED (UG/L)	119.0	0.	0.0	0.0	119.	119.	0.	1
104	BARIUM, TOTAL (UG/L)	576.0	.7096E+06	842.4	146.2	2070.	112.	1958.	5
105	CADMIUM, DISSOLVED (UG/L)	4.0	0.	0.0	0.0	4.	4.	0.	1
106	CADMIUM, TOTAL (UG/L)	9.9	.4277E+02	6.5	66.1	23.	3.	20.	10
107	CALCIUM (MG/L)	62.4	.2887E+03	17.0	27.2	88.	31.	56.	15
108	CHROMIUM, HEXAVALENT (UG/L)	3.3	.2018E+01	1.4	43.4	5.	2.	4.	11
109	CHROMIUM, TOTAL (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
110	COPPER, DISSOLVED (UG/L)	15.0	0.	0.0	0.0	15.	15.	0.	1
111	COPPER, TOTAL (UG/L)	40.1	.3339E+03	18.3	45.6	67.	16.	51.	9
112	HARDNESS, TOTAL AS CACO3 (MG/L)	174.8	.2276E+04	47.7	27.3	260.	85.	175.	15
113	IRON, DISSOLVED (UG/L)	90.4	.8024E+04	89.6	99.1	284.	23.	261.	7
114	IRON, TOTAL (UG/L)	1850.1	.9142E+07	3023.5	163.4	11331.	89.	11242.	15
115	LEAD, DISSOLVED (UG/L)	5.0	.8000E+01	2.8	56.6	7.	3.	4.	2
116	LEAD, TOTAL (UG/L)	24.0	.4005E+03	20.0	83.4	44.	2.	42.	5
117	MAGNESIUM (MG/L)	4.9	.1346E+02	3.7	74.4	12.	1.	11.	14
118	MANGANESE, DISSOLVED (UG/L)	38.7	.8786E+03	29.6	76.5	115.	9.	106.	15
119	MANGANESE, TOTAL (UG/L)	130.5	.2643E+05	162.6	124.6	582.	21.	561.	15
120	MERCURY, DISSOLVED (UG/L)	0.65	.3006E+00	0.55	84.34	1.9	0.2	1.7	10
121	MERCURY, TOTAL (UG/L)	0.88	.8164E+00	0.90	102.14	3.2	0.2	3.0	13
122	MOLYBDENUM, DISSOLVED (UG/L)	7.8	.1137E+02	3.4	43.0	13.	5.	8.	6
123	MOLYBDENUM, TOTAL (UG/L)	11.7	.1065E+03	10.3	88.5	38.	5.	33.	9
124	NICKEL, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
125	NICKEL, TOTAL (UG/L)	49.0	.1997E+04	44.7	91.2	134.	7.	127.	8
126	POTASSIUM (MG/L)	1.7	.9250E+00	1.0	56.4	4.	1.	3.	15
127	SELENIUM, DISSOLVED (UG/L)	8.0	.3200E+02	5.7	70.7	12.	4.	8.	2
128	SELENIUM, TOTAL (UG/L)	4.6	.2330E+02	4.8	104.9	12.	1.	11.	5
129	SILVER, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
130	SILVER, TOTAL (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
131	SODIUM (MG/L)	7.5	.3098E+02	5.6	74.5	26.	3.	23.	15
132	ZINC, DISSOLVED (UG/L)	78.3	.1921E+04	43.8	56.0	166.	56.	110.	13
133	ZINC, TOTAL (UG/L)	279.8	.3740E+05	193.5	69.2	620.	36.	584.	14
	***** GROUP B: NON-METALLIC CONSTITUENTS *****								
201	ALKALINITY, TOTAL AS CACO3 (MG/L)	82.5	.4918E+03	22.2	26.9	138.	48.	90.	15
202	ARSENIC, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
203	ARSENIC, TOTAL (UG/L)	7.0	.3200E+02	5.7	80.8	11.	3.	8.	2
204	BICARBONATE HARDNESS AS CACO3 (MG/L)	82.7	.5085E+03	22.6	27.3	138.	48.	90.	15
205	BORON (MG/L)	0.477	.1813E+00	0.426	89.327	1.36	0.05	1.31	9
206	CARBONATE AS CACO3 (MG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
207	CHLORIDE (MG/L)	2.3	.1418E+01	1.2	52.4	5.	1.	4.	11
208	CYANIDE (MG/L)	0.039	.2410E-02	0.049	125.876	0.14	0.01	0.13	10
209	FLUORIDE (MG/L)	0.098	.2373E-02	0.049	49.711	0.17	0.01	0.16	16
210	NITROGEN, NITRATE (MG/L)	0.262	.9589E-02	0.098	37.375	0.48	0.12	0.36	15
211	NITROGEN, NITRITE (MG/L)	0.0057	.7667E-05	0.0028	48.8625	0.013	0.003	0.010	15
212	NITROGEN, TOTAL ORGANIC (MG/L)	0.59	.3541E+00	0.60	100.47	2.5	0.1	2.2	13
213	PHOSPHORUS, ORTHO (MG/L)	0.0056	.1180E-04	0.0034	61.6615	0.012	0.001	0.011	14
214	PHOSPHORUS, TOTAL (MG/L)	0.0538	.7379E-02	0.0859	159.6724	0.360	0.003	0.357	15
215	SULFATE (MG/L)	87.2	.1173E+04	34.2	39.3	163.	44.	119.	15
216	TOTAL DISSOLVED SOLIDS (MG/L)	221.9	.4108E+04	64.1	28.9	343.	128.	215.	15

Table D-3. Statistical analysis of water quality data for the San Miguel River at Naturita.

SAN MIGUEL PROJECT

STATION 25: SAN MIGUEL AT NATURITA

CODE	CONSTITUENT	MEAN	VARIANCE	S.D.	C OF V	MAX	MIN	RANGE	N
	***** GROUP A: METALLIC CONSTITUENTS *****								
101	ALUMINIUM, DISSOLVED (UG/L)	350.7	.7902E+05	281.1	80.2	1090.	56.	1034.	14
102	ALUMINIUM, TOTAL (UG/L)	3068.2	.2365E+08	4863.5	158.5	19000.	243.	18757.	15
103	BARIUM, DISSOLVED (UG/L)	142.0	0.	0.0	0.0	142.	142.	0.	1
104	BARIUM, TOTAL (UG/L)	446.8	.3574E+05	189.1	42.3	651.	194.	457.	4
105	CADMIUM, DISSOLVED (UG/L)	3.0	0.	0.0	0.0	3.	3.	0.	1
106	CADMIUM, TOTAL (UG/L)	12.3	.8375E+02	9.2	74.2	33.	4.	29.	9
107	CALCIUM (MG/L)	99.7	.3012E+04	54.9	55.0	228.	37.	191.	14
108	CHROMIUM, HEXAVALENT (UG/L)	3.0	.4000E+01	2.0	66.7	7.	1.	6.	8
109	CHROMIUM, TOTAL (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
110	COPPER, DISSOLVED (UG/L)	13.5	.1250E+02	3.5	26.2	16.	11.	5.	2
111	COPPER, TOTAL (UG/L)	54.5	.1055E+04	32.5	59.6	127.	26.	101.	8
112	HARDNESS, TOTAL AS CaCO3 (MG/L)	382.2	.6564E+05	256.2	67.0	908.	102.	806.	15
113	IRON, DISSOLVED (UG/L)	59.0	.8557E+03	29.3	49.6	122.	22.	100.	8
114	IRON, TOTAL (UG/L)	2311.5	.2396E+08	4895.2	211.8	18430.	122.	18308.	15
115	LEAD, DISSOLVED (UG/L)	1.5	.5000E+00	0.7	47.1	2.	1.	1.	2
116	LEAD, TOTAL (UG/L)	32.8	.6352E+03	25.2	76.8	57.	2.	55.	5
117	MAGNESIUM (MG/L)	21.9	.3663E+03	19.1	87.3	56.	2.	54.	12
118	MANGANESE, DISSOLVED (UG/L)	46.4	.1132E+04	33.6	72.5	154.	17.	137.	14
119	MANGANESE, TOTAL (UG/L)	137.1	.3423E+05	185.0	135.0	582.	21.	561.	14
120	MERCURY, DISSOLVED (UG/L)	0.55	.1847E+00	0.43	77.50	1.3	0.2	1.1	11
121	MERCURY, TOTAL (UG/L)	0.72	.2670E+00	0.52	72.10	1.8	0.2	1.6	12
122	MOLYBDENUM, DISSOLVED (UG/L)	11.0	.2714E+02	5.2	47.4	19.	5.	14.	8
123	MOLYBDENUM, TOTAL (UG/L)	14.0	.5889E+02	7.7	54.8	28.	6.	22.	10
124	NICKEL, DISSOLVED (UG/L)	16.8	.3316E+03	18.2	108.7	44.	6.	38.	4
125	NICKEL, TOTAL (UG/L)	48.7	.3339E+04	57.8	118.7	207.	9.	198.	10
126	POTASSIUM (MG/L)	2.7	.1638E+01	1.3	48.1	5.	1.	4.	15
127	SELENIUM, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
128	SELENIUM, TOTAL (UG/L)	1.7	.3333E+00	0.6	34.6	2.	1.	1.	3
129	SILVER, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
130	SILVER, TOTAL (UG/L)	16.0	.1267E+02	3.6	22.2	20.	13.	7.	4
131	SODIUM (MG/L)	24.0	.3600E+03	19.0	79.1	62.	4.	58.	15
132	ZINC, DISSOLVED (UG/L)	17.1	.1022E+03	10.1	59.2	42.	6.	36.	14
133	ZINC, TOTAL (UG/L)	372.2	.1590E+06	398.7	107.1	1514.	15.	1503.	13
	***** GROUP B: NON-METALLIC CONSTITUENTS *****								
201	ALKALINITY, TOTAL AS CACO3 (MG/L)	121.5	.2640E+04	51.4	42.3	219.	58.	161.	15
202	ARSENIC, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
203	ARSENIC, TOTAL (UG/L)	7.5	.8450E+02	9.2	122.6	14.	1.	13.	2
204	BICARBONATE HARDNESS AS CACO3 (MG/L)	119.4	.2298E+04	47.9	40.1	204.	58.	146.	15
205	BORON (MG/L)	0.511	.1254E+00	0.354	69.325	1.11	0.11	1.00	11
206	CARBONATE AS CACO3 (MG/L)	11.0	.2100E+02	4.6	41.7	15.	6.	9.	3
207	CHLORIDE (MG/L)	6.4	.1281E+02	3.6	55.8	14.	1.	13.	12
208	CYANIDE (MG/L)	0.038	.2294E-02	0.048	126.795	0.14	0.01	0.13	9
209	FLUORIDE (MG/L)	0.220	.2224E-01	0.149	67.794	0.41	0.01	0.40	10
210	NITROGEN, NITRATE (MG/L)	0.142	.8372E-02	0.091	64.371	0.30	0.04	0.26	14
211	NITROGEN, NITRITE (MG/L)	0.0045	.3269E-05	0.0018	40.5264	0.009	0.002	0.007	13
212	NITROGEN, TOTAL ORGANIC (MG/L)	0.71	.2477E+00	0.50	70.09	1.8	0.2	1.6	10
213	PHOSPHORUS, ORTHO (MG/L)	0.0044	.1380E-04	0.0037	83.4901	0.014	0.001	0.013	14
214	PHOSPHORUS, TOTAL (MG/L)	0.0651	.1678E-01	0.1296	199.1095	0.530	0.014	0.516	15
215	SULFATE (MG/L)	226.6	.4566E+05	213.7	94.3	711.	42.	669.	14
216	TOTAL DISSOLVED SOLIDS (MG/L)	513.4	.1566E+06	396.0	77.1	1074.	104.	1330.	14

Table D-4. Statistical analysis of water quality data for Leopard Creek.

SAN MIGUEL PROJECT

STATION 24: LEOPARD CREEK

CODE	CONSTITUENT	MEAN	VARIANCE	S.D.	C OF V	MAX	MIN	RANGE	N
	***** GROUP A: METALLIC CONSTITUENTS *****								
101	ALUMINUM, DISSOLVED (UG/L)	351.7	.1466E+06	382.5	108.8	1466.	56.	1410.	14
102	ALUMINUM, TOTAL (UG/L)	1129.1	.2197E+07	1482.3	131.3	5011.	131.	4880.	14
103	BARIUM, DISSOLVED (UG/L)	104.5	.5000E+00	0.7	0.7	105.	104.	1.	2
104	BARIUM, TOTAL (UG/L)	234.3	.3732E+05	193.2	82.1	599.	109.	490.	7
105	CADMIUM, DISSOLVED (UG/L)	3.0	0.	0.0	0.0	3.	3.	0.	1
106	CADMIUM, TOTAL (UG/L)	9.4	.4295E+02	6.6	69.5	21.	3.	18.	7
107	CALCIUM (MG/L)	72.6	.1421E+03	11.9	16.4	96.	51.	45.	14
108	CHROMIUM, HEXAVALENT (UG/L)	4.0	.5333E+01	2.3	57.7	6.	2.	4.	4
109	CHROMIUM, TOTAL (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
110	COPPER, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
111	COPPER, TOTAL (UG/L)	30.9	.618AE+03	24.9	67.5	80.	11.	73.	7
112	HARDNESS, TOTAL AS CACO3 (MG/L)	215.1	.2022E+04	51.2	23.8	270.	99.	175.	14
113	IRON, DISSOLVED (UG/L)	81.4	.4665E+04	68.3	83.9	150.	22.	128.	7
114	IRON, TOTAL (UG/L)	829.2	.1348E+07	1161.0	140.1	4090.	127.	3963.	14
115	LEAD, DISSOLVED (UG/L)	2.0	0.	0.0	0.0	2.	2.	0.	1
116	LEAD, TOTAL (UG/L)	12.0	.7200E+02	8.5	70.7	18.	6.	12.	2
117	MAGNESIUM (MG/L)	11.7	.4152E+02	6.4	55.2	29.	3.	17.	12
118	MANGANESE, DISSOLVED (UG/L)	16.2	.5569E+02	7.5	46.1	33.	7.	26.	13
119	MANGANESE, TOTAL (UG/L)	49.7	.3515E+04	59.3	119.3	243.	9.	234.	14
120	MERCURY, DISSOLVED (UG/L)	0.68	.3229E+00	0.57	84.70	1.9	0.2	1.7	8
121	MERCURY, TOTAL (UG/L)	0.95	.1273E+01	1.13	119.32	3.4	0.2	3.2	11
122	MOLYBDENUM, DISSOLVED (UG/L)	15.0	.5000E+02	7.1	47.1	20.	10.	10.	2
123	MOLYBDENUM, TOTAL (UG/L)	129.8	.8561E+05	292.6	225.4	727.	6.	721.	6
124	NICKEL, DISSOLVED (UG/L)	13.0	.7200E+02	8.5	65.3	19.	7.	12.	2
125	NICKEL, TOTAL (UG/L)	30.0	.9240E+03	30.4	99.4	96.	11.	87.	7
126	POTASSIUM (MG/L)	2.3	.8664E+00	0.9	40.1	5.	1.	4.	14
127	SELENIUM, DISSOLVED (UG/L)	0.0	0.	0.0	0.	0.	0.	0.	0
128	SELENIUM, TOTAL (UG/L)	1.5	.5000E+00	0.7	47.1	2.	1.	1.	2
129	SILVER, DISSOLVED (UG/L)	0.0	0.	0.0	0.	0.	0.	0.	0
130	SILVER, TOTAL (UG/L)	9.0	0.	0.0	0.	9.	9.	0.	1
131	SODIUM (MG/L)	13.5	.9412E+02	9.7	71.9	40.	6.	34.	14
132	ZINC, DISSOLVED (UG/L)	11.8	.2320E+02	4.8	40.6	18.	5.	13.	5
133	ZINC, TOTAL (UG/L)	222.9	.2101E+05	145.0	65.0	436.	15.	421.	8
	***** GROUP B: NON-METALLIC CONSTITUENTS *****								
201	ALKALINITY, TOTAL AS CACO3 (MG/L)	164.6	.1464E+04	38.3	23.2	210.	79.	131.	14
202	ARSENIC, DISSOLVED (UG/L)	0.0	0.	0.0	0.	0.	0.	0.	0
203	ARSENIC, TOTAL (UG/L)	3.0	.8000E+01	2.8	94.3	9.	1.	8.	2
204	BICARBONATE HARDNESS AS CACO3 (MG/L)	163.0	.1392E+04	37.3	22.8	205.	79.	126.	14
205	BORON (MG/L)	0.608	.1857E+00	0.431	71.349	1.28	0.12	1.16	10
206	CARBONATE AS CACO3 (MG/L)	4.0	.4667E+01	2.2	54.0	7.	2.	5.	4
207	CHLORIDE (MG/L)	3.6	.3720E+01	1.9	53.4	6.	2.	7.	12
208	CYANIDE (MG/L)	0.044	.3112E-02	0.056	127.520	0.16	0.01	0.15	8
209	FLUORIDE (MG/L)	0.083	.2501E-02	0.053	63.706	0.16	0.01	0.15	10
210	NITROGEN, NITRATE (MG/L)	0.612	.3000E+01	1.497	309.973	7.20	0.01	7.19	14
211	NITROGEN, NITRITE (MG/L)	0.0042	.4167E-05	0.0021	50.2703	0.009	0.001	0.008	14
212	NITROGEN, TOTAL ORGANIC (MG/L)	0.59	.1851E+00	0.43	73.25	1.2	0.1	1.1	9
213	PHOSPHORUS, ORTHO (MG/L)	0.0094	.2353E-04	0.0047	165.0655	0.026	0.001	0.025	13
214	PHOSPHORUS, TOTAL (MG/L)	0.0595	.1381E-02	0.0372	94.0832	0.128	0.004	0.124	14
215	SULFATE (MG/L)	55.3	.1742E+03	13.2	23.9	75.	32.	43.	14
216	TOTAL DISSOLVED SOLIDS (MG/L)	252.3	.3803E+04	62.2	24.6	351.	83.	275.	14

APPENDIX E

Comparison of Water Quality Data with the Proposed Colorado Water Quality Standards

Table E-1. Computer comparison of water quality data with proposed Colorado Water Quality Standards for the San Miguel River at Sawpit, Col.

SAN MIGUEL PROJECT

STATION 291 SAN MIGUEL AT SAWPIT

CODE	CONSTITUENT	STANDARD	SOURCE	NUMBER EXCEEDING	NUMBER OF SAMPLES	PERCENT EXCEEDING
101	ALUMINUM, DISSOLVED (UG/L)	100.000	AB	13	14	92.86
104	BARIUM, TOTAL (UG/L)	1000.000	WS	1	3	33.33
106	CADMIUM, TOTAL (UG/L)	10.000	AG	4	9	44.44
		10.000	WS	4	9	44.44
		0.400	ABL1	0	9	0.00
		1.000	AB12	5	9	55.56
		5.000	AB23	4	9	44.44
		10.000	AB34	0	9	0.00
		15.000	ABG4	0	9	0.00
109	CHROMIUM, TOTAL (UG/L)	100.000	AG	0	0	0.00
		50.000	WS	0	0	0.00
		100.000	AB	0	0	0.00
111	COPPER, TOTAL (UG/L)	200.000	AG	0	7	0.00
		1000.000	WS	0	7	0.00
		10.000	ABL1	2	7	28.57
		10.000	AB12	4	7	57.14
		10.000	AB23	1	7	14.29
		20.000	AB34	0	7	0.00
		40.000	ABG4	0	7	0.00
113	IRON, DISSOLVED (UG/L)	300.000	WS	0	9	0.00
114	IRON, TOTAL (UG/L)	1000.000	AB	5	14	35.71
116	LEAD, TOTAL (UG/L)	100.000	AG	0	5	0.00
		50.000	WS	0	5	0.00
		4.000	ABL1	2	5	40.00
		25.000	AB12	1	5	20.00
		50.000	AB23	0	5	0.00
		100.000	AB34	0	5	0.00
		150.000	ABG4	0	5	0.00
117	MAGNESIUM (MG/L)	125.000	WS	0	11	0.00
118	MANGANESE, DISSOLVED (UG/L)	50.000	WS	5	14	35.71
119	MANGANESE, TOTAL (UG/L)	200.000	AG	1	14	7.14
		1000.000	AB	0	14	0.00
121	MERCURY, TOTAL (UG/L)	2.000	WS	2	11	18.18
		0.050	AB	11	11	100.00
125	NICKEL, TOTAL (UG/L)	200.000	AG	0	5	0.00
		50.000	ABL1	0	5	0.00
		100.000	AB12	0	5	0.00
		200.000	AB23	0	5	0.00
		300.000	AB34	0	5	0.00
		400.000	ABG4	0	5	0.00
128	SELENIUM, TOTAL (UG/L)	20.000	AG	0	3	0.00
		10.000	WS	0	3	0.00
		50.000	AB	0	3	0.00
130	SILVER, TOTAL (UG/L)	50.000	WS	0	1	0.00
		0.100	ABL1	0	1	0.00
		0.100	AB12	0	1	0.00
		0.150	AB23	1	1	100.00
		0.200	AB34	0	1	0.00
		0.250	ABG4	0	1	0.00
133	ZINC, TOTAL (UG/L)	2000.000	AG	0	14	0.00
		5000.000	WS	0	14	0.00
		50.000	ABL1	2	14	14.29
		50.000	AB12	5	14	35.71
		100.000	AB23	5	14	35.71
		300.000	AB34	0	14	0.00
		600.000	ABG4	0	14	0.00
202	ARSENIC, DISSOLVED (UG/L)	100.000	AG	0	0	0.00
		50.000	WS	0	0	0.00
		50.000	AB	0	0	0.00
205	BORON (MG/L)	750.000	AG	0	8	0.00
207	CHLORIDE (MG/L)	250.000	WS	0	11	0.00
208	CYANIDE (MG/L)	0.200	AG	0	8	0.00
		0.200	WS	0	8	0.00
		0.005	AB	8	8	100.00
209	FLUORIDE (MG/L)	2.400	WS	0	9	0.00
210	NITROGEN, NITRATE (MG/L)	100.000	AG	0	13	0.00
		10.000	WS	0	13	0.00
211	NITROGEN, NITRITE (MG/L)	10.000	AG	0	13	0.00
		1.000	WS	0	13	0.00
		0.150	REC	0	13	0.00
		0.500	AB	0	13	0.00
215	SULFATE (MG/L)	250.000	WS	0	13	0.00

SOURCE CODES: AB = AQUATIC BIOTA
AQC = AQUATIC BIOTA (COLD)
ABW = AQUATIC BIOTA (WARM)
ABL1 = AQUATIC BIOTA (TOTAL HARDNESS) LESS THAN 100)
AB12 = AQUATIC BIOTA (TOTAL HARDNESS) 100-200)
AB23 = AQUATIC BIOTA (TOTAL HARDNESS) 200-300)
AB34 = AQUATIC BIOTA (TOTAL HARDNESS) 300-400)
ABG4 = AQUATIC BIOTA (TOTAL HARDNESS) GREATER THAN 400)
AG = AGRICULTURE
WS = CLASS 2 WARM WATER SUPPLY

Table E-2. Computer comparison of water quality data with proposed Colorado Water Quality Standards for the San Miguel River at Placerville, Col.

SAN MIGUEL PROJECT

STATION 241 SAN MIGUEL NEAR PLACERVILLE

CODE	CONSTITUENT	STANDARD	SOURCE	NUMBER EXCEEDING	NUMBER OF SAMPLES	PERCENT EXCEEDING
101	ALUMINIUM, DISSOLVED (UG/L)	100.000	AB	13	14	92.86
104	BARIUM, TOTAL (UG/L)	1000.000	WS	1	5	20.00
106	CADMIUM, TOTAL (UG/L)	10.000	AG	4	10	40.00
		10.000	WS	4	10	40.00
		0.400	ABL1	1	10	10.00
		1.000	AB12	5	10	50.00
		5.000	AB23	4	10	40.00
		10.000	AB34	0	10	0.00
		15.000	ABG4	0	10	0.00
109	CHROMIUM, TOTAL (UG/L)	100.000	AG	0	0	0.00
		50.000	WS	0	0	0.00
		100.000	AB	0	0	0.00
111	COPPER, TOTAL (UG/L)	200.000	AG	0	9	0.00
		1000.000	WS	0	9	0.00
		10.000	ABL1	2	9	22.22
		10.000	AB12	5	9	55.56
		10.000	AB23	2	9	22.22
		20.000	AB34	0	9	0.00
		40.000	ABG4	0	9	0.00
113	IRON, DISSOLVED (UG/L)	300.000	WS	0	7	0.00
114	IRON, TOTAL (UG/L)	1000.000	AB	6	15	40.00
116	LEAD, TOTAL (UG/L)	100.000	AG	0	5	0.00
		50.000	WS	0	5	0.00
		4.000	ABL1	2	5	40.00
		25.000	AB12	1	5	20.00
		50.000	AB23	0	5	0.00
		100.000	AB34	0	5	0.00
		150.000	ABG4	0	5	0.00
117	MAGNESIUM (MG/L)	125.000	WS	0	14	0.00
118	MANGANESE, DISSOLVED (UG/L)	50.000	WS	4	15	26.67
119	MANGANESE, TOTAL (UG/L)	200.000	AG	3	15	20.00
		1000.000	AB	0	15	0.00
121	MERCURY, TOTAL (UG/L)	2.000	WS	2	13	15.38
		0.050	AB	13	13	100.00
125	NICKEL, TOTAL (UG/L)	200.000	AG	0	8	0.00
		50.000	ABL1	0	8	0.00
		100.000	AB12	2	8	25.00
		200.000	AB23	0	8	0.00
		300.000	AB34	0	8	0.00
		400.000	ABG4	0	8	0.00
128	SELENIUM, TOTAL (UG/L)	20.000	AG	0	5	0.00
		10.000	WS	1	5	20.00
		50.000	AB	0	5	0.00
130	SILVER, TOTAL (UG/L)	50.000	WS	0	0	0.00
		0.100	ABL1	0	0	0.00
		0.100	AB12	0	0	0.00
		0.150	AB23	0	0	0.00
		0.200	AB34	0	0	0.00
		0.250	ABG4	0	0	0.00
133	ZINC, TOTAL (UG/L)	2000.000	AG	0	14	0.00
		5000.000	WS	0	14	0.00
		50.000	ABL1	2	14	14.29
		50.000	AB12	6	14	42.86
		100.000	AB23	3	14	21.43
		300.000	AB34	0	14	0.00
		600.000	ABG4	0	14	0.00
202	ARSENIC, DISSOLVED (UG/L)	100.000	AG	0	0	0.00
		50.000	WS	0	0	0.00
		50.000	AB	0	0	0.00
205	BORON (MG/L)	750.000	AG	0	9	0.00
207	CHLORIDE (MG/L)	250.000	WS	0	11	0.00
208	CYANIDE (MG/L)	0.200	AG	0	10	0.00
		0.200	WS	0	10	0.00
		0.005	AB	10	10	100.00
209	FLUORIDE (MG/L)	2.400	WS	0	10	0.00
210	NITROGEN, NITRATE (MG/L)	100.000	AG	0	15	0.00
		10.000	WS	0	15	0.00
211	NITROGEN, NITRITE (MG/L)	10.000	AG	0	15	0.00
		1.000	WS	0	15	0.00
		0.050	ABC	0	15	0.00
		0.500	ABW	0	15	0.00
215	SULFATE (MG/L)	250.000	WS	0	15	0.00

SOURCE CODES: AB = AQUATIC BIOTA
ABC = AQUATIC BIOTA (COLD)
ABW = AQUATIC BIOTA (WARM)
ABL1 = AQUATIC BIOTA (TOTAL HARDNESS) LESS THAN 100)
AB12 = AQUATIC BIOTA (TOTAL HARDNESS) 100-200)
AB23 = AQUATIC BIOTA (TOTAL HARDNESS) 200-300)
AB34 = AQUATIC BIOTA (TOTAL HARDNESS) 300-400)
ABG4 = AQUATIC BIOTA (TOTAL HARDNESS) GREATER THAN 400)
AG = AGRICULTURE
WS = CLASS 2 WATER SUPPLY

Table E-3. Computer comparison of water quality data with proposed Colorado Water Quality Standards for the San Miguel River at Naturita, Col.

SAN MIGUEL PROJECT

STATION 251 SAN MIGUEL AT NATURITA

CODE	CONSTITUENT	STANDARD	SOURCE	NUMBER EXCEEDING	NUMBER OF SAMPLES	PERCENT EXCEEDING
101	ALUMINUM, DISSOLVED (UG/L)	100.000	AB	13	14	92.86
104	BARIUM, TOTAL (UG/L)	1000.000	WS	0	4	0.00
106	CADMIUM, TOTAL (UG/L)	10.000	AG	4	9	44.44
		10.000	WS	4	9	44.44
		0.400	ABL1	0	9	0.00
		1.000	AB12	3	9	33.33
		5.000	AB23	1	9	11.11
		10.000	AB34	0	9	0.00
		15.000	ABG4	2	9	22.22
109	CHROMIUM, TOTAL (UG/L)	100.000	AG	0	0	0.00
		50.000	WS	0	0	0.00
		100.000	AB	0	0	0.00
111	COPPER, TOTAL (UG/L)	200.000	AG	0	8	0.00
		1000.000	WS	0	8	0.00
		10.000	ABL1	0	8	0.00
		10.000	AB12	3	8	37.50
		10.000	AB23	1	8	12.50
		20.000	AB34	0	8	0.00
		40.000	ABG4	1	8	12.50
113	IRON, DISSOLVED (UG/L)	300.000	WS	0	8	0.00
114	IRON, TOTAL (UG/L)	1000.000	AB	4	15	26.67
116	LEAD, TOTAL (UG/L)	100.000	AG	0	5	0.00
		50.000	WS	2	5	40.00
		4.000	ABL1	0	5	0.00
		25.000	AB12	3	5	60.00
		50.000	AB23	0	5	0.00
		100.000	AB34	0	5	0.00
		150.000	ABG4	0	5	0.00
117	MAGNESIUM (MG/L)	125.000	WS	0	12	0.00
118	MANGANESE, DISSOLVED (UG/L)	50.000	WS	3	14	21.43
119	MANGANESE, TOTAL (UG/L)	200.000	AG	2	14	14.29
		1000.000	AB	0	14	0.00
121	MERCURY, TOTAL (UG/L)	2.000	WS	0	12	0.00
		0.050	AB	12	12	100.00
125	NICKEL, TOTAL (UG/L)	200.000	AG	1	10	10.00
		50.000	ABL1	0	10	0.00
		100.000	AB12	0	10	0.00
		200.000	AB23	0	10	0.00
		300.000	AB34	0	10	0.00
		400.000	ABG4	0	10	0.00
128	SELENIUM, TOTAL (UG/L)	20.000	AG	0	3	0.00
		10.000	WS	0	3	0.00
		50.000	AB	0	3	0.00
130	SILVER, TOTAL (UG/L)	50.000	WS	0	4	0.00
		0.100	ABL1	0	4	0.00
		0.100	AB12	0	4	0.00
		0.150	AB23	1	4	25.00
		0.200	AB34	2	4	50.00
		0.250	ABG4	1	4	25.00
133	ZINC, TOTAL (UG/L)	2000.000	AG	0	13	0.00
		5000.000	WS	0	13	0.00
		50.000	ABL1	0	13	0.00
		50.000	AB12	4	13	30.77
		100.000	AB23	1	13	7.69
		300.000	AB34	0	13	0.00
		600.000	ABG4	1	13	7.69
202	ARSENIC, DISSOLVED (UG/L)	100.000	AG	0	0	0.00
		50.000	WS	0	0	0.00
		50.000	AB	0	0	0.00
205	BORON (MG/L)	750.000	AG	0	11	0.00
207	CHLORIDE (MG/L)	250.000	WS	0	12	0.00
208	CYANIDE (MG/L)	0.200	AG	0	9	0.00
		0.200	WS	0	9	0.00
		0.005	AB	9	9	100.00
209	FLUORIDE (MG/L)	2.400	WS	0	10	0.00
210	NITROGEN, NITRATE (MG/L)	100.000	AG	0	14	0.00
		10.000	WS	0	14	0.00
211	NITROGEN, NITRITE (MG/L)	10.000	AG	0	13	0.00
		1.000	WS	0	13	0.00
		0.050	ABC	0	13	0.00
		0.500	ABW	0	13	0.00
215	SULFATE (MG/L)	250.000	WS	5	14	35.71

SOURCE CODES: AB = AQUATIC BIOTA
ABC = AQUATIC BIOTA (COLD)
ABW = AQUATIC BIOTA (WARM)
ABL1 = AQUATIC BIOTA (TOTAL HARDNESS) LESS THAN 100)
AB12 = AQUATIC BIOTA (TOTAL HARDNESS) 100-200)
AB23 = AQUATIC BIOTA (TOTAL HARDNESS) 200-300)
AB34 = AQUATIC BIOTA (TOTAL HARDNESS) 300-400)
ABG4 = AQUATIC BIOTA (TOTAL HARDNESS) GREATER THAN 400)
AG = AGRICULTURE
WS = CLASS 2 RAW WATER SUPPLY

Table E-4. Computer comparison of water quality data with proposed Colorado Water Quality Standards at Leopard Creek.

SAN MIGUEL PROJECT

STATION 28: LEOPARD CREEK

CODE	CONSTITUENT	STANDARD	SOURCE	NUMBER EXCEEDING	NUMBER OF SAMPLES	PERCENT EXCEEDING
101	ALUMINUM, DISSOLVED (UG/L)	100,000	AH	13	14	92.86
104	BARIUM, TOTAL (UG/L)	1000,000	WS	0	7	0.00
106	CADMIUM, TOTAL (UG/L)	10,000	AG	3	7	42.86
		10,000	WS	3	7	42.86
		0,400	ABL1	1	7	14.29
		1,000	AH12	2	7	28.57
		5,000	AB23	3	7	42.86
		10,000	AB34	0	7	0.00
		15,000	ABG4	0	7	0.00
109	CHROMIUM, TOTAL (UG/L)	100,000	AG	0	0	0.00
		50,000	WS	0	0	0.00
		100,000	AH	0	0	0.00
111	COPPER, TOTAL (UG/L)	200,000	AG	0	7	0.00
		1000,000	WS	0	7	0.00
		10,000	ABL1	0	7	0.00
		10,000	AH12	3	7	42.86
		10,000	AH23	4	7	57.14
		20,000	AH34	0	7	0.00
		40,000	AHG4	0	7	0.00
113	IRON, DISSOLVED (UG/L)	300,000	WS	0	7	0.00
114	IRON, TOTAL (UG/L)	1000,000	AH	3	14	21.43
116	LEAD, TOTAL (UG/L)	100,000	AG	0	2	0.00
		50,000	WS	0	2	0.00
		0,000	ABL1	0	2	0.00
		25,000	AH12	0	7	0.00
		50,000	AH23	0	2	0.00
		100,000	AB34	0	2	0.00
		150,000	ABG4	0	2	0.00
117	MAGNESIUM (MG/L)	125,000	WS	0	12	0.00
118	MANGANESE, DISSOLVED (UG/L)	50,000	WS	0	13	0.00
119	MANGANESE, TOTAL (UG/L)	200,000	AG	1	14	7.14
		1000,000	AB	0	14	0.00
121	MERCURY, TOTAL (UG/L)	2,000	WS	2	11	18.18
		0,050	AB	11	11	100.00
125	NICKEL, TOTAL (UG/L)	200,000	AG	0	7	0.00
		50,000	ABL1	0	7	0.00
		100,000	AH12	0	7	0.00
		200,000	AB23	0	7	0.00
		300,000	AB34	0	7	0.00
		400,000	ABG4	0	7	0.00
126	SELENIUM, TOTAL (UG/L)	20,000	AG	0	2	0.00
		10,000	WS	0	2	0.00
		50,000	AB	0	2	0.00
130	SILVER, TOTAL (UG/L)	50,000	WS	0	1	0.00
		0,100	ABL1	0	1	0.00
		0,100	AH12	0	1	0.00
		0,150	AB23	1	1	100.00
		0,200	AB34	0	1	0.00
		0,250	ABG4	0	1	0.00
133	ZINC, TOTAL (UG/L)	2000,000	AG	0	8	0.00
		5000,000	WS	0	8	0.00
		50,000	ABL1	0	8	0.00
		50,000	AH12	2	8	25.00
		100,000	AB23	4	8	50.00
		300,000	AB34	0	8	0.00
		600,000	ABG4	0	8	0.00
202	ARSENIC, DISSOLVED (UG/L)	100,000	AG	0	0	0.00
		50,000	WS	0	0	0.00
		50,000	AH	0	0	0.00
205	BORON (MG/L)	750,000	AG	0	10	0.00
207	CHLORIDE (MG/L)	250,000	WS	0	12	0.00
208	CYANIDE (MG/L)	0,200	AG	0	8	0.00
		0,200	WS	0	8	0.00
		0,005	AB	8	8	100.00
209	FLUORIDE (MG/L)	2,400	WS	0	10	0.00
210	NITROGEN, NITRATE (MG/L)	100,000	AG	0	14	0.00
		10,000	WS	0	14	0.00
211	NITROGEN, NITRITE (MG/L)	10,000	AG	0	14	0.00
		1,000	WS	0	14	0.00
		0,050	AHC	0	14	0.00
		0,500	AHW	0	14	0.00
215	SULFATE (MG/L)	250,000	WS	0	14	0.00

SOURCE CODES: AH = AQUATIC BIOTA
AHC = AQUATIC BIOTA (COLD)
AHW = AQUATIC BIOTA (WARM)
ABL1 = AQUATIC BIOTA (TOTAL HARDNESS: LESS THAN 100)
AH12 = AQUATIC BIOTA (TOTAL HARDNESS: 100-200)
AB23 = AQUATIC BIOTA (TOTAL HARDNESS: 200-300)
AB34 = AQUATIC BIOTA (TOTAL HARDNESS: 300-400)
ABG4 = AQUATIC BIOTA (TOTAL HARDNESS: GREATER THAN 400)
AG = AGRICULTURE
WS = CLASS 2 RAW WATER SUPPLY

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