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Pre-Impoundment Water Quality Study for the Mc Elmo Project

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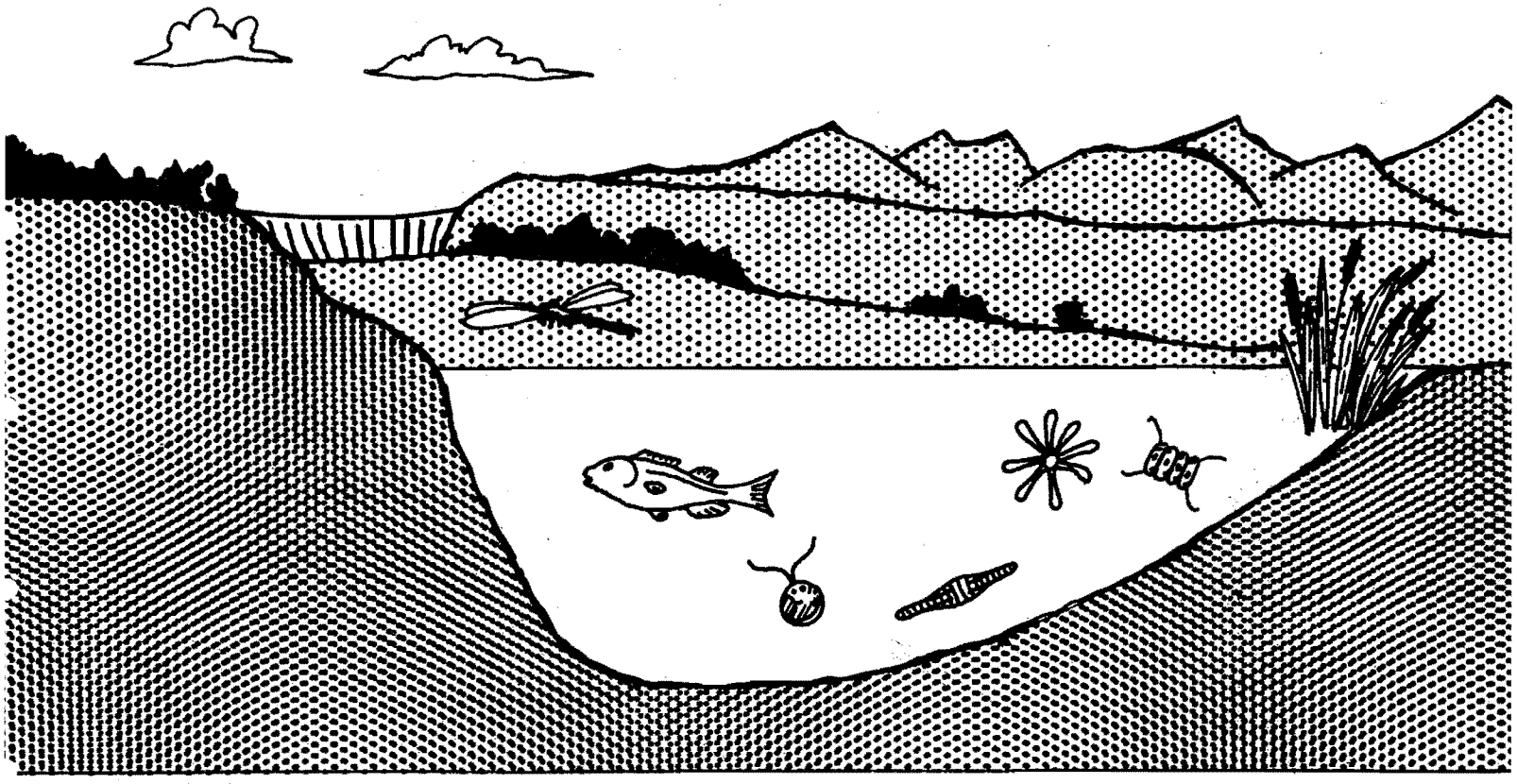

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Introduction

The U.S. Bureau of Reclamation is currently in the process of evaluating a number of water development projects in Southwest Colorado. As a part of the planning process the Bureau has conducted a water quality investigation, in cooperation with the UWRL, of the stream segments that will be affected by each project. The data collected in this study were used to evaluate the water quality of each stream segment with respect to various beneficial uses of water (agriculture, raw municipal water supply, protection of the aquatic biota) and will provide a baseline by which to assess the impact of each project. In addition, these data will be used in the process of site location, design and operation planning for reservoirs and other project features.

This report includes only the results of the water quality study of McElmo Creek, associated with the McElmo Project[1]. Water quality data were collected during the period from May, 1977 through June, 1978. One sample was collected and analyzed during each month of the study except during June, 1977, in which two samples were collected from some sites. The concentration of 49 water quality constituents was determined for each sample received at the UWRL.

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[1]Other projects included in this study are: the Delores Project, the Animas La Plata Project, the Mancos Project, the West Divide Project, the Dominguez Project and the San Miguel Project. The results of the water quality study for each project are contained in individual reports.

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 of 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/l	Several months (refrigerated)
TKN	0.8 ml conc. H_2SO_4/l	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 obtained in this study are presented in Appendix B. Statistical analyses of these data, including the mean, standard deviation and coefficient of variance for each water quality constituent are presented in Appendix C.

The sampling period for this study lasted 16 months. If samples had been collected during each sampling period and if no analyses had been omitted, 744 parameter values would have been obtained. During this study samples were not collected from McElmo Creek during two sampling periods and resulted in the omission of 88 analyses (11.8% of the total analyses). In addition, sample bottles broke or leaked in transit during two sampling periods, resulting in a failure to determine 26 parameter values (3.5% of the total possible analyses), and on nine occasions the individual analysis were omitted (1.2% of the total).

In order to check the reliability of these analyses, ion balances were computed for each sampling period. The error in each ion balance was computed 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 McElmo Creek are presented in Table 4. A frequency distribution of errors in the ion balances is presented in Table 5 and Figure 1. These calculations indicate that the error in the ion balances were less than ten percent during 82% of the sampling periods.

Table 3. McElmo water quality survey - missing parameter values[a]

Sampling Round	Sample Station	Analyses not Performed	Reason for Omission
1	17	Cyanide: TDS	Omitted
2	17	Sodium	Omitted
3	17	All	No samples received
4	17	All	No samples received
5	17	All	No samples received
9	17	All non-metallic constituents (except total and ortho phosphorus), and calcium	Samples leaked in transit
10	17	Fluoride	Omitted
13	17	All non-metallic constituents and calcium	Samples leaked in transit
14	17	Selenium (total; dissolved); Arsenic (total; dissolved)	Omitted
17	17	Nitrite	Omitted

[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 4. Ion balance calculations for the McElmo water quality survey.

MC ELMO PROJECT

STATION 171 MC ELMO 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	324.0	382.0	0.0	0.0	0.0	307.0	423.0	460.0	0.0	259.0	385.0	410.0	0.0	406.0	300.0	282.0	440.0
MG	192.0	303.0	0.0	0.0	0.0	250.0	196.0	183.0	0.0	177.0	277.0	128.0	0.0	118.0	85.0	110.0	223.0
NA	372.0	0.0	0.0	0.0	0.0	276.0	288.0	316.0	427.0	449.0	451.0	245.0	270.0	180.0	120.0	153.0	279.0
K	9.0	12.0	0.0	0.0	0.0	13.0	10.5	4.1	8.8	4.7	7.5	4.4	3.6	5.0	6.0	7.0	9.0
HCO3	286.0	322.0	0.0	0.0	0.0	169.0	243.0	308.0	0.0	290.0	324.0	2076.0	0.0	258.0	232.0	312.0	342.0
CO3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL	72.0	77.0	0.0	0.0	0.0	67.0	50.0	57.0	0.0	48.0	50.0	57.0	0.0	45.0	30.0	38.0	60.0
SO4	1990.0	3230.0	0.0	0.0	0.0	1996.0	2191.0	2364.0	0.0	1441.0	2313.0	1746.0	0.0	1487.0	1300.0	988.0	2132.0
STDS	3245.0	4326.0	0.0	0.0	0.0	3078.0	3401.5	3700.1	435.8	2668.7	3807.5	4666.4	273.6	2499.0	2075.0	1890.0	3485.0
MTDS	0.0	4402.0	0.0	0.0	0.0	3414.0	3422.0	3369.0	0.0	2637.0	3529.0	2689.0	0.0	2739.0	1787.0	1969.0	3575.0
SC	48.374	44.293	0.000	0.000	0.000	48.223	50.027	51.858	18.800	47.136	61.808	41.758	11.837	37.924	27.387	29.955	52.667
SA	49.183	75.861	0.000	0.000	0.000	46.827	51.887	57.146	0.000	37.156	56.047	79.480	0.000	37.389	32.552	27.882	52.921
ADIFF	0.809	31.567	0.000	0.000	0.000	1.396	1.860	5.288	18.800	9.980	5.761	37.721	11.837	0.535	5.166	2.073	0.254
ERR(%)	0.830	26.272	0.000	0.000	0.000	1.469	1.825	4.851	100.000	11.840	4.888	31.114	100.000	0.711	8.618	3.584	0.241

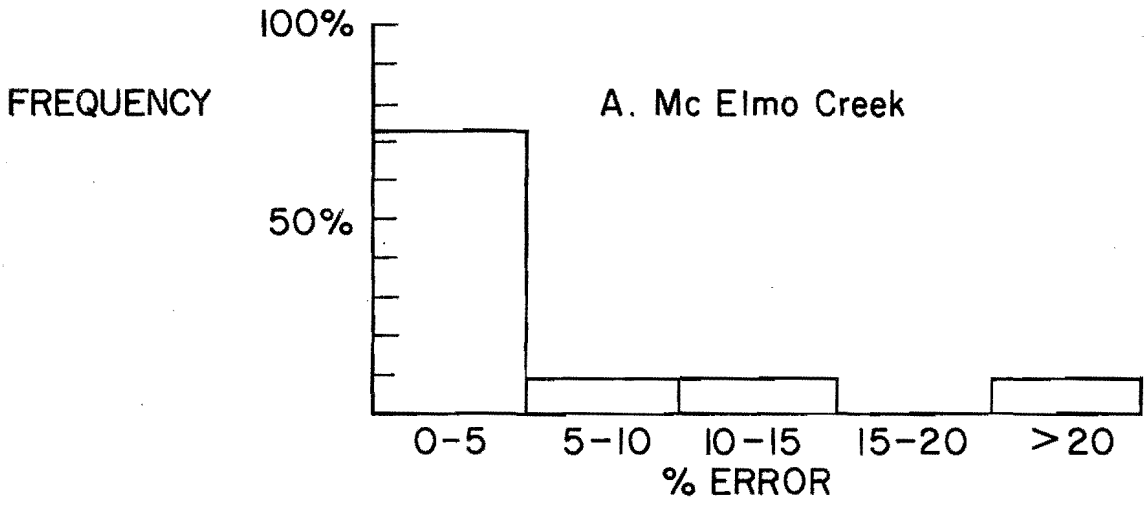
STDS = Sum of the constituents (mg/ℓ)
MTDS = Laboratory measured TDS (mg/ℓ)
SC = Sum of cations (meq/ℓ)
SA = Sum of anions (meq/ℓ)
ADIFF = Absolute difference between SC and SA (meq/ℓ)
ERR(%) = (ADIFF)/(SC + SA) x 100
* = Indicated date where one or more constituents have not been recorded.
– = Indicates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

Table 5. Frequency distribution of errors in ion balances for McElmo Creek.

Station 17: McElmo Creek

Err(%)	Number	% of total
0 - 5	8	72.7
5 - 10	1	9.1
10 - 15	1	9.1
15 - 20	0	0
>20	1	9.1
Missing Data	3	
Total	14	

Figure 1. Frequency distribution of errors in ion balance for the McElmo water quality study.



Discussion

The water from McElmo Creek has a very high concentration of total dissolved solids for inland waters, ranging from 1,700 to 4,500 mg/l (mean = 3,040 mg/l) and can be considered to be "slightly saline" to "moderately saline" (Hem, 1972). Although the proposed Colorado Water Quality Standards do not include agricultural standards for the salinity of irrigation water, NAS (1972) classifies water containing 2,000-5,000 mg/l TDS as being suitable only for tolerant plants on permeable soil, using careful management practices. In addition to the general osmotic effect of high salinity, high concentrations of specific ions, especially sodium, is undesirable in irrigation water. In addition to the high salinity, the level of manganese in McElmo Creek exceeded the proposed Colorado Water Quality Standard for agricultural use during 8 out of the 14 sampling periods in which total manganese was determined and total cadmium exceeded the proposed agricultural standard during 6 out of 14 sampling periods (Table 6).

Associated with the high salinity were high concentrations of sulfate. The sulfate concentration in McElmo Creek ranged from 988 to 2,242 mg/l (mean = 1,932 mg/l) and exceeded the proposed drinking water standard during each sampling period in which sulfate was measured. Moore (1952, cited in EPA, 1976) found that 62% of the people responding to a questionnaire indicated that water containing 1,500 to 2,000 mg/l sulfate had a laxative effect. The proposed water supply standard for manganese was also exceeded frequently (79% of the samples). The levels of dissolved manganese found in McElmo Creek are sufficiently high (up to 356 µg/l) to cause a taste and staining problem in domestic water supplies.

Concentrations of magnesium exceeded the proposed water supply standard during 9 out of 14 samples. High magnesium concentrations also have a laxative effect on some people. Several toxic metals exceeded the proposed water supply standards, including cadmium (during 6 out of 14 sampling periods), barium, and chromium (once each).

The concentrations of several metals exceeded the proposed Colorado Water Quality Standards for the protection of the aquatic biota, including total mercury (10 out of 14 samples), total silver (5 out of 14 samples), total copper (3 out of 14 samples), total iron (9 out of 14 samples), dissolved aluminum (14 out of 14 samples), total cadmium (2 out of 14 samples), total manganese (once), total nickel (once), and total zinc (once). In addition, the concentration of total cyanide exceeded the proposed standard for the protection of aquatic biota during 8 out of 11 sampling periods and the nitrite concentration exceeded the proposed standard twice.

Table 6. Constituents that exceeded the proposed Colorado River Quality Standards at McElmo Creek.[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)	-	-	-	-	14/14	100
Barium	1/10	10	-	-	-	-
Cadmium[3]	6/14	43	6/14	43	(2/14)	(14)
Chromium	1/10	10	0/10	0	0/10	0
Copper[3]	0/14	0	0/14	0	(3/14)	(21)
Iron (total)	-	-	-	-	9/14	53
Lead	0/10	0	0/10	0	0/10	0
Magnesium	9/14	53	-	-	-	-
Manganese (dissolved)	11/14	79	-	-	-	-
Manganese (total)	-	-	8/14	57	1/14	7
Mercury[3]	0/14	0	-	-	(10/14)	(71)
Nickel	-	-	1/14	7	1/14	7
Silver[3]	0/14	0	-	-	(5/14)	(36)
Zinc[3]	0/14	0	0/14	0	(1/14)	(7)
Total Cyanide	0/11	0	0/11	0	8/11	73
Nitrogen (nitrite)	0/12	0	0/12	0	2/12	17
Sulfate	12/12	100	-	-	-	-

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

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

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

APPENDIX A

Proposed Colorado Water Quality Standards

Table A-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 A-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 A-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 A-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 A-3 for aquatic life limitations.

Table A-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 A-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 S (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 A-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 A-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 A-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 B

Raw Water Quality Data

Table B-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 B-2. Water quality data for the McElmo Project.

MC ELMO PROJECT

STATION 17: MC ELMO CREEK

CODE	5/25/77	6/16	6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/10/78	2/15	3/21	4/18	5/18	6/15	7/19	8/24
101	924.	1180.				750.	631.	584.	813.	139.	790.	656.	482.	462.	2910.	764.	1042.
102	1356.	1180.				750.	631.	1356.	1634.	814.	8372.	87514.	12150.	4800.	15540.	13066.	1042.
103								-100.	142.	170.	225.	257.	-100.	-100.	103.	115.	-100.
104								-100.	200.	406.	330.	1671.	280.	555.	637.	675.	361.
105	-3.	-3.				10.	11.	8.	7.	-3.	-3.	-3.	5.	5.	-3.	6.	13.
106	98.	101.				12.	14.	12.	9.	0.	-3.	9.	13.	7.	5.	7.	11.
107	324.	382.				307.	423.	460.		252.	385.	810.		406.	300.	282.	880.
108		1.				-1.	-1.	3.		3.	3.	2.		2.	4.	-1.	3.
109										-20.	-20.	86.	-20.	-20.	-20.	29.	30.
110	-10.	17.				-10.	11.	14.	-10.	12.	17.	-10.	-10.	-10.	-10.	13.	18.
111	15.	39.				32.	20.	23.	37.	34.	35.	140.	-10.	35.	85.	60.	23.
112	1610.	2216.				1808.	1872.	1909.		1020.	2113.	1557.		1507.	1100.	1155.	2028.
113	-21.	33.				41.	26.	20.	50.	27.	29.	93.	36.	40.	41.	107.	66.
114	586.	102.				255.	161.	1911.	1109.	5600.	4531.	6151.	2393.	4312.	12600.	10457.	145.
115								-1.	-1.	-1.	-1.	12.	-1.	-1.	-1.	3.	-1.
116								3.	4.	-1.	-1.	55.	-1.	-1.	-1.	-1.	-1.
117	192.	303.				250.	196.	183.		177.	277.	125.		118.	95.	110.	223.
118	556.	9.				62.	106.	168.	139.	88.	108.	51.	61.	74.	13.	27.	115.
119	364.	9.				97.	110.	260.	170.	307.	253.	1190.	151.	538.	350.	314.	171.
120	0.4	-0.2				-0.2	0.2	0.3	-0.2	0.2	0.3	1.3	0.6	-0.2	-0.2	1.3	1.7
121	1.3	-0.2				0.2	1.2	0.4	-1.2	0.2	0.4	1.3	0.8	-0.2	-0.2	1.6	1.6
122	-5.	33.				28.	28.	21.	11.	12.	52.	13.	51.	-0.	-5.	29.	11.
123	13.	41.				28.	28.	21.	11.	12.	53.	32.	873.	9.	5.	30.	35.
124	-6.	-6.				-6.	21.	128.	135.	-6.	-6.	-6.	-6.	-6.	35.	8.	-6.
125	22.	57.				-6.	50.	130.	160.	-6.	10.	458.	91.	-6.	48.	25.	-6.
126	9.0	12.0				13.0	10.5	4.1	8.8	4.7	7.5	8.4	5.6	5.0	8.0	7.1	9.0
127	-1.	-1.				2.	-1.	-1.	-1.	2.	-1.	-1.	-1.		-1.	-1.	-1.
128	-1.	-1.				2.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	2.	-1.
129	-9.	-9.				-9.	-9.	-9.	-9.	-9.	-9.	16.	-9.	-9.	-9.	-9.	12.
130	-9.	-9.				-9.	-9.	-9.	-9.	13.	9.	20.	-1.	-9.	15.	-9.	15.
131	372.					276.	288.	316.	427.	888.	851.	245.	270.	188.	120.	153.	279.
132	-5.	-5.				16.	18.	19.	-5.	-5.	-5.	21.	19.	10.	6.	30.	24.
133	98.	200.				200.	358.	164.	328.	345.	156.	680.	377.	208.	251.	529.	178.
201	286.	322.				169.	243.	316.		230.	320.	2076.		258.	232.	312.	382.
202	-1.	-1.				-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	-1.
203	-1.	-1.				-1.	-1.	-1.	-1.	-1.	1.	82.	-1.		5.	5.	-1.
204	286.	322.				169.	243.	308.		200.	320.	2076.		258.	232.	312.	382.
205	1.91	0.42				0.68	0.11	0.12	-0.05	0.09	-0.05	1.40	0.69	0.71	0.55	-0.05	0.09
206	0	0				0	0	8.		0	0	0		0	0	0	0
207	72.	77.				67.	50.	57.		48.	50.	57.		45.	30.	38.	60.
208		0.01				-0.01	0.03	0.10		0.02	-0.01	0.01		-0.01	0.01	0.02	0.08
209	0.23	0.25				0.29	0.26	0.26			0.33	0.32		1.02	0.02	0.05	0.05
210	0.15	0.04				0.04	0.70	4.75		2.00	0.80	1.00		1.37	0.37	0.50	0.23
211	0.007	0.001				0.005	0.029	0.049		0.100	0.033	0.020		1.007	0.008	0.013	
212	0.7	1.0				-0.1	0.6	0.9		2.0	1.4	5.7		0.9	2.0	0.7	0.7
213	-0.001	0.005				0.002	0.002	0.123	0.259	0.170	0.138	0.041		0.051	0.034	0.023	0.002
214	0.007	0.006				0.056	0.070	0.290	0.292	0.563	0.586	0.007		1.200	0.007	0.031	0.050
215	1990.	3230.				1996.	2191.	2364.		1001.	2313.	1745.		1487.	1300.	948.	2152.
216		4402.				3414.	3422.	3369.		2437.	3529.	2689.		2230.	1787.	1969.	3575.

APPENDIX C

Statistical Analyses of Water Quality Data

Table C-1. Statistical analysis of the water quality data for the McElmo Project.

MC ELMO PROJECT

STATION 17: MC ELMO CREEK

CODE	CONSTITUENT	MEAN	VARIANCE	S.D.	C OF V	MAX	MIN	RANGE	N
	***** GROUP A: METALLIC CONSTITUENTS *****								
101	ALUMINIUM, DISSOLVED (UG/L)	830.5	.3959E+06	629.2	75.8	2410.	139.	2671.	14
102	ALUMINIUM, TOTAL (UG/L)	10415.7	.5194E+09	22790.1	218.8	87910.	810.	87100.	12
103	BARIUM, DISSOLVED (UG/L)	168.7	.3776E+04	61.5	36.4	257.	103.	154.	6
104	BARIUM, TOTAL (UG/L)	568.3	.1980E+06	445.0	78.3	1671.	209.	1462.	9
105	CADMIUM, DISSOLVED (UG/L)	8.1	.8696E+01	2.9	36.3	13.	5.	8.	8
106	CADMIUM, TOTAL (UG/L)	23.5	.1104E+04	33.8	144.7	101.	5.	96.	13
107	CALCIUM (MG/L)	364.8	.4528E+04	67.3	18.4	481.	259.	201.	12
108	CHROMIUM, HEXAVALENT (UG/L)	2.6	.8393E+00	0.9	36.9	3.	1.	3.	5
109	CHROMIUM, TOTAL (UG/L)	48.3	.1064E+04	32.6	67.5	86.	29.	57.	5
110	COPPER, DISSOLVED (UG/L)	14.6	.7619E+01	2.8	19.9	18.	11.	7.	7
111	COPPER, TOTAL (UG/L)	46.0	.1510E+04	38.9	84.5	190.	15.	175.	13
112	HARDNESS, TOTAL AS CACO3 (MG/L)	1692.4	.1288E+06	358.9	21.2	2216.	1100.	1116.	12
113	IRON, DISSOLVED (UG/L)	49.5	.1214E+04	34.8	70.5	147.	26.	121.	13
114	IRON, TOTAL (UG/L)	3603.1	.1586E+08	3980.4	110.5	12600.	142.	12458.	14
115	LEAD, DISSOLVED (UG/L)	6.5	.6050E+02	7.8	119.7	12.	1.	11.	2
116	LEAD, TOTAL (UG/L)	20.7	.8843E+03	29.7	143.9	55.	3.	52.	3
117	MAGNESIUM (MG/L)	186.8	.4693E+04	68.5	36.7	303.	85.	218.	12
118	MANGANESE, DISSOLVED (UG/L)	98.4	.7641E+04	87.4	88.9	354.	9.	347.	14
119	MANGANESE, TOTAL (UG/L)	306.5	.8265E+05	287.5	93.8	1190.	9.	1181.	14
120	MERCURY, DISSOLVED (UG/L)	0.70	.3300E+00	0.57	82.07	1.7	0.2	1.5	9
121	MERCURY, TOTAL (UG/L)	0.90	.3200E+00	0.57	62.85	1.8	0.2	1.6	10
122	MOLYBDENUM, DISSOLVED (UG/L)	24.4	.2237E+03	15.0	61.3	56.	9.	43.	12
123	MOLYBDENUM, TOTAL (UG/L)	56.9	.1453E+05	120.6	212.0	473.	6.	467.	14
124	NICKEL, DISSOLVED (UG/L)	65.4	.3738E+04	61.1	93.5	135.	8.	127.	5
125	NICKEL, TOTAL (UG/L)	105.7	.1748E+05	132.2	125.0	454.	14.	440.	10
126	POTASSIUM (MG/L)	7.6	.8960E+01	3.0	39.4	13.	4.	9.	14
127	SELENIUM, DISSOLVED (UG/L)	2.0 0.		0.0	0.0	2.	2.	0.	2
128	SELENIUM, TOTAL (UG/L)	2.0 0.		0.0	0.0	2.	2.	0.	2
129	SILVER, DISSOLVED (UG/L)	14.0	.8000E+01	2.8	20.2	16.	12.	4.	2
130	SILVER, TOTAL (UG/L)	16.2	.5720E+02	7.6	46.7	29.	9.	20.	5
131	SODIUM (MG/L)	294.3	.1164E+05	107.9	36.7	451.	120.	331.	13
132	ZINC, DISSOLVED (UG/L)	18.6	.6719E+02	8.2	43.7	30.	6.	24.	9
133	ZINC, TOTAL (UG/L)	295.4	.2512E+05	158.5	53.7	461.	99.	362.	14
	***** GROUP B: NON-METALLIC CONSTITUENTS *****								
201	ALKALINITY, TOTAL AS CACO3 (MG/L)	430.8	.2708E+06	520.4	120.8	2074.	168.	1907.	12
202	ARSENIC, DISSOLVED (UG/L)	0.0 0.		0.0	0.0	0.	0.	0.	0
203	ARSENIC, TOTAL (UG/L)	12.8	.3829E+03	19.6	153.5	42.	1.	41.	8
204	BICARBONATE HARDNESS AS CACO3 (MG/L)	430.2	.2710E+06	520.6	121.0	2074.	168.	1907.	12
205	BORON (MG/L)	0.597	.3412E+00	0.584	97.882	1.91	0.09	1.82	11
206	CARBONATE AS CACO3 (MG/L)	8.0 0.		0.0	0.0	8.	8.	0.	1
207	CHLORIDE (MG/L)	54.3	.1869E+03	13.7	25.2	77.	34.	43.	12
208	CYANIDE (MG/L)	0.041	.2155E-02	0.046	112.547	0.11	0.01	0.10	5
209	FLUORIDE (MG/L)	0.160	.1666E-01	0.129	80.671	0.33	0.02	0.31	11
210	NITROGEN, NITRATE (MG/L)	1.347	.293?E+01	1.714	127.291	4.41	0.04	4.40	12
211	NITROGEN, NITRITE (MG/L)	0.0315	.1192E-02	0.0345	109.4313	0.104	0.001	0.099	11
212	NITROGEN, TOTAL ORGANIC (MG/L)	1.62	.2210E+01	1.49	91.84	5.7	0.6	5.1	11
213	PHOSPHORUS, ORTHO (MG/L)	0.0725	.6829E-02	0.0826	113.9482	0.259	0.002	0.257	12
214	PHOSPHORUS, TOTAL (MG/L)	0.2042	.4396E-01	0.2097	102.6683	0.586	0.006	0.580	13
215	SULFATE (MG/L)	1931.5	.3541E+06	595.1	30.8	3230.	986.	2242.	12
216	TOTAL DISSOLVED SOLIDS (MG/L)	3048.4	.5867E+06	766.0	25.1	4002.	1787.	2215.	11

APPENDIX D

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

Table D-1. Comparison of water quality data for the McElmo Project with the propresed Colorado Water Quality Standards

MC ELMO PROJECT

STATION 171 MC ELMO CREEK

CODE	CONSTITUENT	STANDARD	SOURCE	NUMBER EXCEEDING	NUMBER OF SAMPLES	PERCENT EXCEEDING
101	ALUMINIUM, DISSOLVED (UG/L)	100.000	AB	14	14	100.00
104	BARIUM, TOTAL (UG/L)	1000.000	WS	1	9	11.11
106	CADMIUM, TOTAL (UG/L)	10.000	AG	6	13	46.15
		10.000	WS	6	13	46.15
		0.400	ABL1	0	13	0.00
		1.000	AB12	0	13	0.00
		5.000	AB23	0	13	0.00
		10.000	AB34	0	13	0.00
		15.000	ABG4	2	13	15.38
109	CHROMIUM, TOTAL (UG/L)	100.000	AG	0	3	0.00
		50.000	WS	1	3	33.33
		100.000	AB	0	3	0.00
111	COPPER, TOTAL (UG/L)	200.000	AG	0	13	0.00
		1000.000	WS	0	13	0.00
		10.000	ABL1	0	13	0.00
		10.000	AB12	0	13	0.00
		10.000	AB23	0	13	0.00
		20.000	AB34	0	13	0.00
		40.000	ABG4	3	13	23.08
113	IRON, DISSOLVED (UG/L)	300.000	WS	0	13	0.00
114	IRON, TOTAL (UG/L)	1000.000	AB	9	14	64.29
116	LEAD, TOTAL (UG/L)	100.000	AG	0	3	0.00
		50.000	WS	1	3	33.33
		4.000	ABL1	0	3	0.00
		25.000	AB12	0	3	0.00
		50.000	AB23	0	3	0.00
		100.000	AB34	0	3	0.00
		150.000	ABG4	0	3	0.00
117	MAGNESIUM (MG/L)	125.000	WS	9	12	75.00
118	MANGANESE, DISSOLVED (UG/L)	50.000	WS	11	14	78.57
119	MANGANESE, TOTAL (UG/L)	200.000	AG	8	14	57.14
		1000.000	AB	1	14	7.14
121	MERCURY, TOTAL (UG/L)	2.000	WS	0	10	0.00
		0.050	AB	10	10	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	1	10	10.00
128	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	5	0.00
		0.100	ABL1	0	5	0.00
		0.100	AB12	0	5	0.00
		0.150	AB23	0	5	0.00
		0.200	AB34	0	5	0.00
		0.250	ABG4	5	5	100.00
133	ZINC, TOTAL (UG/L)	2000.000	AG	0	14	0.00
		5000.000	WS	0	14	0.00
		50.000	ABL1	0	14	0.00
		50.000	AB12	0	14	0.00
		100.000	AB23	0	14	0.00
		300.000	AB34	0	14	0.00
		600.000	ABG4	1	14	7.14
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	8	0.00
		0.200	WS	0	8	0.00
		0.005	AB	6	8	100.00
209	FLUORIDE (MG/L)	2.400	WS	0	11	0.00
210	NITROGEN, NITRATE (MG/L)	100.000	AG	0	12	0.00
		10.000	WS	0	12	0.00
211	NITROGEN, NITRITE (MG/L)	10.000	AG	0	11	0.00
		1.000	WS	0	11	0.00
		0.050	ABC	2	11	18.18
		0.500	AB4	0	11	0.00
215	SULFATE (MG/L)	250.000	WS	12	12	100.00

SOURCE CODES: AB = AQUATIC BIOTA
ABC = AQUATIC BIOTA (COLD)
AB4 = 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

Bibliography

A.P.H.A. 1975. Standard methods for the examination of water and wastewater. 14th Edition. 1193 p.

Hem, John D. 1970. Study and interpretation of the chemical characteristics of natural water. 2nd Edition. U.S.G.S. Water Supply Paper No. 1473. 363 p.

National Academy of Sciences. 1972. Water quality criteria, 1972. Ecological Research Series EPA-R-3-73-003. 594 p.

Sawyer, Clair N., and Perry L. McCarty. 1978. Chemistry for sanitary engineers. 3rd Edition. McGraw-Hill Book Co., New York. 532 p.

U.S.E.P.A. 1971. Algal assay procedure: Bottle test. National Eutrophication Research Laboratory, Corvallis, OR. 81 p.

U.S.E.P.A. 1976a. Methods for chemical analysis of water and wastes. Technology Transfer Series EPA-625/6-74-003a. 298 p.

U.S.E.P.A. 1976b. Quality criteria for water. U.S.G.P.O. 0-222-904, Washington, D.C. 256 p.