Technical Appendix 3

Water Quality Analysis

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Water Quality

INTRODUCTION

The purposes of this Water Quality Appendix are to examine the historic water quality of the San Juan River Basin and quantify any changes to water quality that may occur as a result of the Animas LaPlata (ALP) project. Of particular concern are changes that would result in hazards to the environment or violation of state water quality standards. This Appendix is an extension of Appendix B to the 1996 FEIS, including data collected since the completion of that document and impacts associated with the changes in Project definition since that time.

Detailed analyses were completed only for Refined Alternative 4 relative to historical conditions. No detailed analysis was completed for Refined Alternative 6. Any conclusions concerning water quality impact of Refined Alternative 6 are based on interpretation of the results presented here for Refined Alternative 4, judging the difference in effect between the two alternatives.

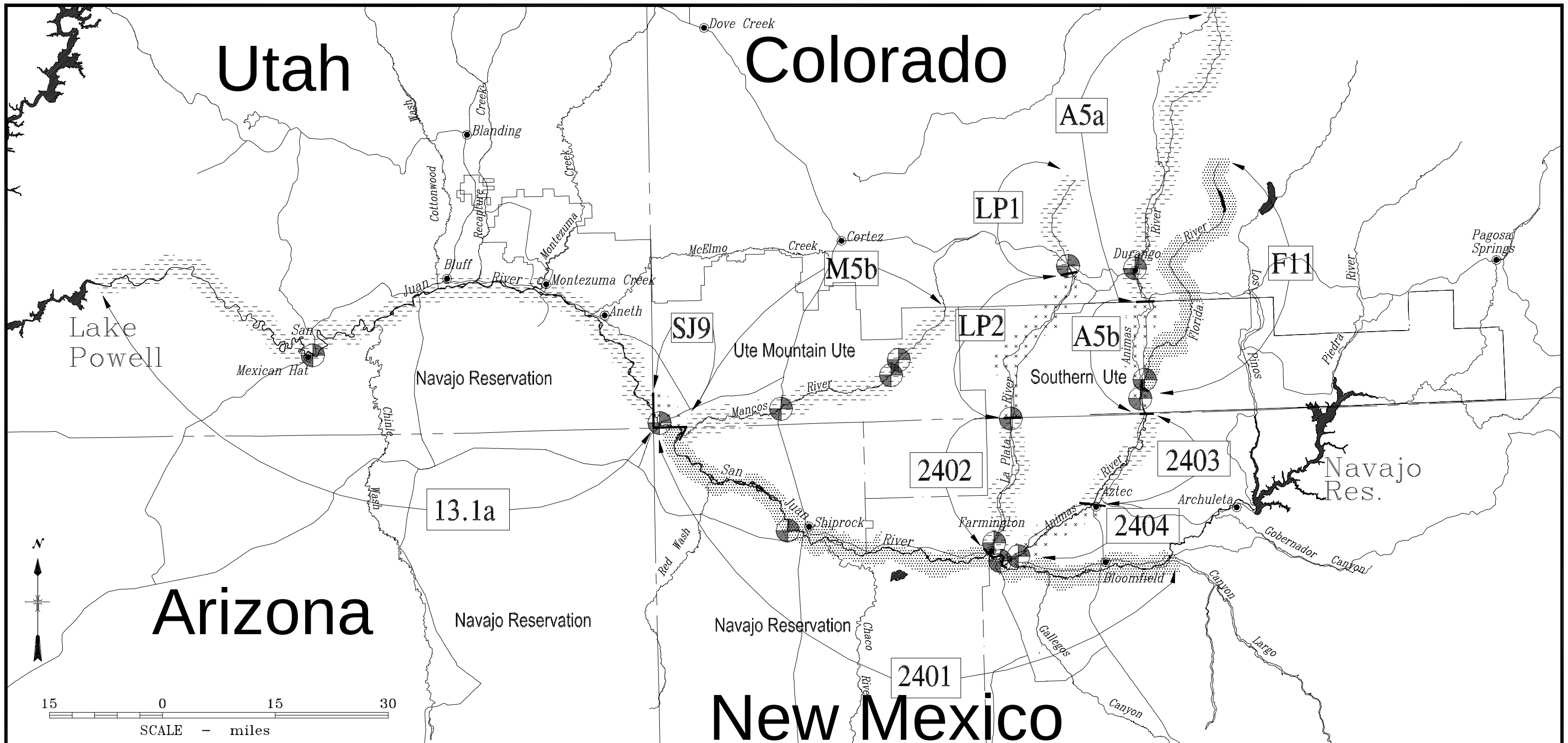
EXISTING WATER QUALITY

Water Quality Standards

The San Juan River Basin lies within three different states. Each state regulates those river reaches lying within their jurisdiction using different parameters and standards. The numeric water quality standards in Colorado (Colorado Public Health, 1998), New Mexico (New Mexico Water Quality Control Commission, 1995), and Utah (Utah Division of Water Quality, 1997) are listed in Attachments 1, 2 and 3. Each state agency in Colorado, New Mexico, and Utah have designated the surface water in the river segments into various use classes. Each classification carries a set of water quality standards. The number of segments along each river, depicted in Figure 3- 1, were:

- ❑ five segments on the Animas River - three in Colorado and two in New Mexico
- ❑ three segments on the LaPlata River - two in Colorado and one in New Mexico
- ❑ one segment on the Mancos River in Colorado
- ❑ three segments on the San Juan River - one each in New Mexico, Colorado and Utah

These attachments include information about the stream classifications and the numeric water quality standards for the various rivers segments in their respective states. The numeric tables also include the definitions and equations needed to calculate exceedences for the trace metals dependent upon water hardness. An accumulated list of the parameters regulated by the three states is compiled in Table 3-1.



State Defined River Reaches

5a - River Reach

River	Reach	Description
Colorado		
Animas	A5a	Source to S.Ute boundary
Animas	A5b	S.Ute boundary to St-line
Florida	F11	Source to Animas Confl.
La Plata	LP1	Source to Hay Gulch Div.
La Plata	LP2	Hay Gulch Div. to Stateline
San Juan	SJ9	Main stem in Montezuma County
Mancos	M5b	Ute Mtn Ute bound to San Juan Conf
New Mexico		
San Juan	2401	Blanco,NM to Stateline
La Plata	2402	Stateline to San Juan Conf
Animas	2403	Stateline to Aztec,NM
Animas	2404	Aztec,NM to San Juan Conf
Utah		
San Juan	13.1a	Stateline to Lake Powell

USGS Gaging Stations

Figure 3-1 State Water Quality Regulatory Stream Reaches

Table 3-1
The Chemical Parameters Regulated along River Reaches Potentially Affected by the Project

Aluminum Dissolved (μg/l as Al) [NM, UT]	Lead Total (μg/l as Pb)
Ammonia Unionized (Calc Fr Temp-pH-NH4) (mg/l) [CO, NM, UT]	Lead Total Recoverable in Water as Pb (μg/l)
Ammonia Unionized (mg/l as N) [CO, NM, UT]	Magnesium Dissolved (mg/l as Mg)
Arsenic Dissolved (μg/l as As) [CO, UT]	Manganese Dissolved (μg/l as Mn) [CO]
Arsenic Total (μg/l as As)	Manganese Total (μg/l as Mn)
Arsenic Total Recoverable in Water as As (μg/l) [CO]	Manganese Total Recoverable in Water as Mn (μg/l) [CO]
Beryllium Dissolved (μg/l as Be)[NM]	Mercury Dissolved (μg/l as Hg) [CO, UT]
Beta Total (piC/l) [UT]	Mercury Total (μg/l as Hg) [CO, NM]
BOD 5 Day 20° C (mg/l) [UT]	Mercury Total Recoverable in Water as Hg (μg/l)
Boron Dissolved (μg/l as B) [CO]	Nickel Dissolved (μg/l as Ni) [CO, NM, UT]
Cadmium Dissolved (μg/l as Cd) [CO, NM, UT]	Nickel Total (μg/l as Ni)
Cadmium Total (μg/l as Cd)	Nickel Total Recoverable in Water as Ni (μg/l)
Cadmium Total Recoverable in Water as Cd (μg/l)	Nitrate Nitrogen Dissolved (mg/l as N) [CO, UT]
Calcium Dissolved (mg/l as Ca)	Nitrate Nitrogen Total (mg/l as NO3) [CO, UT]
Chlordane(tech mix & metabolites) Whole Water (μg/l) [NM]	Nitrite Nitrogen Dissolved (mg/l as N) [CO]
Chloride Dissolved in Water (mg/l) [CO]	Nitrite Nitrogen Dissolved (mg/l as NO2) [CO]
Chlorine Total Residual (mg/l) [CO, NM]	Oxygen Dissolved (mg/l) [CO, NM, UT]
Chromium Dissolved (μg/l as Cr) [CO, NM, UT]	pH (Standard Units) [CO, NM, UT]
Chromium Hexavalent (μg/l as Cr) [CO, NM, UT]	pH Field (Standard Units) [CO, NM, UT]
Chromium Total (μg/l as Cr)	Phosphorus Total (mg/l as P) [UT]
Chromium Total Recoverable in Water as Cr (μg/l) [CO]	Selenium Dissolved (μg/l as Se) [CO, UT]
Copper Dissolved (μg/l as Cu) [CO, NM, UT]	Selenium Total (μg/l as Se)
Copper Total (μg/l as Cu)	Selenium Total Recoverable in Water as Se (μg/l)[CO, NM]
Copper Total Recoverable in Water as Cu (μg/l)	Silver Dissolved (μg/l as Ag) [CO, NM, UT]
Cyanide Total (mg/l as CN) [CO, NM, UT]	Silver Total (μg/l as Ag)
Fecal Coliforms Membr Filter M-fc Broth 44.5º C [CO, NM]	Silver Total Recoverable in Water as Ag (μg/l) [CO]
Fecal Coliforms Membr Filter M-fc 0.7 μm [CO, NM]	Solids Susp.-residue on Evap. At 180ºC (mg/l) [UT]
Hardness Ca Mg Calculated (mg/l as CaCO3)[CO, NM, UT]	Sulfate Dissolved (mg/l as SO4) [CO]
Hardness Total (mg/l as CaCO3) [CO, NM, UT]	Sulfide Dissolved (mg/l as S) [CO, UT]
Iron Dissolved (μg/l as Fe) [CO, UT]	Temperature Water (ºC) [CO, NM, UT]
Iron Total (μg/l as Fe)	Zinc Dissolved (μg/l as Zn) [CO, NM, UT]
Iron Total Recoverable in Water as Fe (μg/l) [CO]	Zinc Total (μg/l as Zn)
Lead Dissolved (μg/l as Pb) [CO, NM, UT]	Zinc Total Recoverable in Water as Zn (μg/l)

States for which parameter is regulated are shown in brackets

Most standards for the trace metals depend on water hardness. As water hardness increases, the biological impacts of the metals decrease. Although hardness is not regulated, water hardness (or calcium and magnesium concentrations for calculating missing hardness values) is included in this list for the purpose of calculating the trace metal standards.

Evaluation of Data Quality

The surface water quality data for the San Juan River basin and the upper Dolores River were compiled from the STORET database (STORET 1999), and data collected by Reclamation (Reclamation, 1999) and the BIA (BIA, 1999). The compiled data set contains approximately 275,000 observations collected mainly in the period of 1950-1998. A subset, 74,000 measurements of the parameters regulated by the states, was selected and formed the database for the water quality analysis. Other parameters were selected for biological studies as needed.

The Bureau of Reclamation began collecting water quality data in 1990 and found that a wide variation in the selenium concentrations in Animas River segments appeared when they changed laboratories in 1992. The problem persisted until a QC/QA study in late 1995 as described in the earlier FSFEIS (Appendix B, 1996). The variation in Reclamation dissolved selenium measurements can be seen in Figure 3-2 by comparing the BIA and USGS measurements in the same time period. Data before and after the 1992-1995 period agree reasonably well with USGS and BIA data, unlike the large difference during the period.

Reclamation data made up a sizable part of the data in the upper Animas and LaPlata Rivers, creating a large bias in the data. Since the Reclamation data did not agree with data from the other two agencies and there appear to be no hydrologic reasons for an increase in selenium concentrations for this time period, all the 1992-1995 Reclamation data for selenium were excluded from this study. Note also that the detection limit for selenium was higher in this time period. The exclusion affected only the dissolved and total selenium measurements in the Animas, LaPlata, and Mancos Rivers. No total recoverable selenium values were affected because their measurement did not begin until early 1996.

No other biases could be determined from this evaluation. Although the early data had higher detection limits, the concentrations were used as reported.

Historic Water Quality Conditions

The arithmetic means for parameters with no flow weighting were compiled for streams in the San Juan

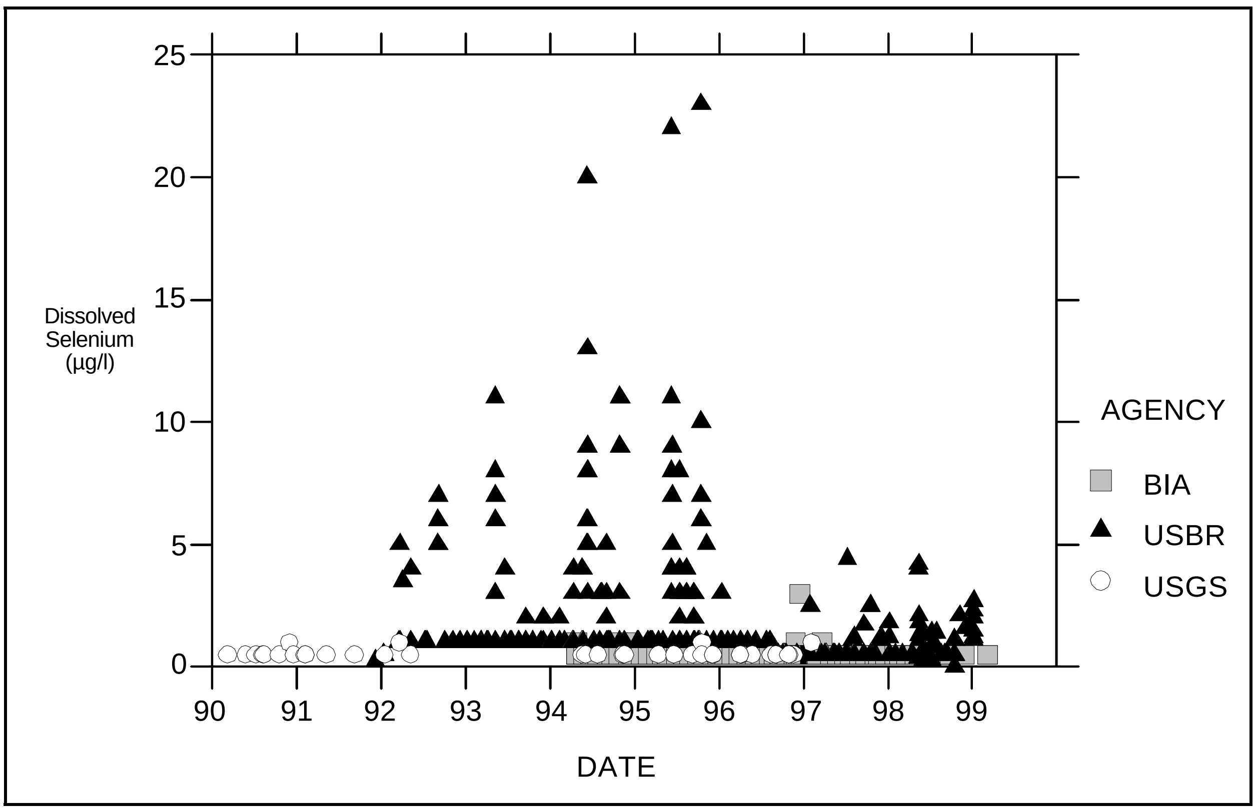


Figure 3-2 Comparison among Agencies of Dissolved Selenium Measurements

River Basin. Concurrent flow measurements were not taken at many sites which were located at some distance from a gage. In other cases, some gages had been discontinued. So a simple mean with no flow-weighting was calculated for the historic summary lists. The reported parameters were the more common water quality parameters, not necessarily limited to the state regulated lists. The means of the historically measured parameters are listed in this section for those streams or reservoirs considered in describing the alternatives and their impacts. In this discussion, the historic exceedence values, taken from tables in the impact analysis section, are also summarized to give insight into the historic water quality conditions.

Pine River

Streamflow in the Pine River is characteristic of western United States rivers that have watersheds receiving runoff primarily from melting snow pack. The water quality of the Pine River is considered excellent. The irrigation and M&I return flows in the lower river account for an increase in constituent concentration of about 28%, but the source water quality is so high that the resulting outflow quality is still very good. Table 3-2 summarizes the water quality measurements found in the combined STORET-Reclamation-BIA water quality database.

Navajo Reservoir

Water quality in the Navajo Reservoir is determined by the various streams flowing into it. The major stream flow contribution is from the San Juan River. There are few impacts to this river so high in the basin. Other contributing streams such as the Pine and the Piedra Rivers have more irrigation and municipal and industrial (M&I) returns flows than the San Juan River, but these streams are still of excellent quality. There have not been many measurements in Navajo reservoir, but Table 3-3 summarizes the results in the STORET-Reclamation-BIA water quality database.

Animas River

Water quality in the Animas River is generally affected by toxic metals from historical mining activities in the headwaters, by naturally occurring minerals in various reaches, and by depletions for municipal, industrial and irrigation uses in the lower sections. For this river, the trace metal content tends to diminish as the water flows downstream as the metals partition to bed sediments (Church, 1997). Table 3-4 summarizes the water quality measurements found in the combined STORET-Reclamation-BIA water quality database.

For mercury, there are 100 historic exceedences in Colorado and 31 in New Mexico. For selenium there are 43 exceedences in New Mexico. The trace metals - arsenic, cadmium, copper, iron, manganese, silver and zinc - show occasional exceedences in Colorado. In New Mexico cadmium, copper, lead, and aluminum have shown occasional historic exceedences.

Table 3-2
Historic Water Quality Measurements on the Pine River

Parameter	n	mean
Alkalinity Total (mg/l as $CaCO_3$)	1	117
Aluminum Dissolved (µg/l as Al)		
Aluminum Total (µg/l as Al)	9	1560
Arsenic Dissolved (µg/l as As)	8	14.3
Arsenic Total (µg/l as As)	11	0.6
Boron Dissolved (µg/l as B)	14	9.3
Cadmium Dissolved (µg/l as Cd)	6	1.5
Cadmium Total (µg/l as Cd)	11	0.6
Calcium Dissolved (mg/l as Ca)	14	29.1
Calcium Total (mg/l as Ca)		
Chloride Total in Water (mg/l)	14	2.1
Chromium Dissolved (µg/l as Cr)	4	5.3
Chromium Total (µg/l as Cr)	11	1.9
Cobalt Dissolved (µg/l as Co)		
Cobalt Total (µg/l as Co)	9	1.4
Copper Dissolved (µg/l as Cu)	7	3.4
Copper Total (µg/l as Cu)	11	9.9
Hardness Calc. (mg/l as $CaCO_3$)	14	93
Hardness Total (mg/l as $CaCO_3$)	1	110
Iron Dissolved (µg/l as Fe)	14	75.6
Iron Total (µg/l as Fe)	11	1443
Lead Dissolved (µg/l as Pb)	6	13.8
Lead Total (µg/l as Pb)	10	2.8
Magnesium Dissolved (mg/l as Mg)	14	4.9
Magnesium Total (mg/l as Mg)		
Manganese Dissolved (µg/l as Mn)	8	19.3
Manganese Total (µg/l as Mn)	11	113
Mercury Dissolved (µg/l as Hg)	3	0.05
Mercury Total (µg/l as Hg)	10	0.05
Nickel Dissolved (µg/l as Ni)	3	16.7
Nickel Total (µg/l as Ni)	9	4.7
Nitrite + Nitrate Total (mg/l as N)	11	0.06
Oxygen Dissolved mg/l	14	9.1
pH Lab (Standard Units)	14	8.48
pH Field (Standard Units)		
Phosphorus Total (mg/l as P)	11	0.08
Residue Total Filtrable (Dried at 180ºC) mg/l	12	136
Selenium Dissolved (µg/l as Se)	4	1.3
Selenium Total (µg/l as Se)	11	0.5
Selenium Total Recoverable in Water as Se µg/l		
Silver Dissolved (µg/l as Ag)		
Silver Total (µg/l as Ag)		
Sodium Dissolved (mg/l as Na)	14	12.7
Sodium Total (mg/l as Na)		
Solids Susp.-residue on Evap. At 180ºC (mg/l)		
Specific Conductance (µmhos/cm @ 25ºC)	129	229
Sulfate Total (mg/l as SO_4)	14	16
Temperature Water (ºC)	14	11.0
Zinc Dissolved (µg/l as Zn)	7	7.8
Zinc Total (µg/l as Zn)	11	12.7

Table 3-3
Historic Water Quality Measurements in the Navajo Reservoir

Parameter	n	mean
Alkalinity Total (mg/l as CaCO3)	26	81.1
Aluminum Dissolved (μg/l as Al)	25	18.4
Aluminum Total (μg/l as Al)	25	221.6
Arsenic Dissolved (μg/l as As)	71	1.8
Arsenic Total (μg/l as As)	71	2.1
Boron Dissolved (μg/l as B)		
Cadmium Dissolved (μg/l as Cd)		
Cadmium Total (μg/l as Cd)		
Calcium Dissolved (mg/l as Ca)	26	38.6
Calcium Total (mg/l as Ca)	1	31.9
Chloride Total in Water (mg/l)	1	1.0
Chromium Dissolved (μg/l as Cr)		
Chromium Total (μg/l as Cr)		
Cobalt Dissolved (μg/l as Co)		
Cobalt Total (μg/l as Co)		
Copper Dissolved (μg/l as Cu)	26	2.7
Copper Total (μg/l as Cu)	26	4.4
Hardness Calc. (mg/l as CaCO3)	26	124
Hardness Total (mg/l as CaCO3)		
Iron Dissolved (μg/l as Fe)		
Iron Total (μg/l as Fe)		
Lead Dissolved (μg/l as Pb)	71	0.4
Lead Total (μg/l as Pb)	71	1.2
Magnesium Dissolved (mg/l as Mg)	26	6.7
Magnesium Total (mg/l as Mg)	1	7.4
Manganese Dissolved (μg/l as Mn)	1	2.5
Manganese Total (μg/l as Mn)	1	48
Mercury Dissolved (μg/l as Hg)	71	0.11
Mercury Total (μg/l as Hg)	71	0.10
Nickel Dissolved (μg/l as Ni)	25	5.2
Nickel Total (μg/l as Ni)	25	6.8
Nitrite + Nitrate Total (mg/l as N)	1	0.01
Oxygen Dissolved mg/l	69	9.1
pH Lab (Standard Units)		
pH Field (Standard Units)	71	7.76
Phosphorus Total (mg/l as P)		
Residue Total Filtrable (Dried at 180ºC) mg/l	25	251
Selenium Dissolved (μg/l as Se)	71	0.5
Selenium Total (μg/l as Se)	71	0.6
Selenium Total Recoverable in Water as Se μg/l	9	0.5
Silver Dissolved (μg/l as Ag)		
Silver Total (μg/l as Ag)		
Sodium Dissolved (mg/l as Na)	2	15.5
Sodium Total (mg/l as Na)	1	14.5
Solids Susp.-residue on Evap. At 180ºC (mg/l)	69	10
Specific Conductance (μmhos/cm @ 25ºC)		
Sulfate Total (mg/l as SO4)		
Temperature Water (ºC)	71	8.7
Zinc Dissolved (μg/l as Zn)	71	6.8
Zinc Total (μg/l as Zn)	71	15.1

Table 3-4
Historic Water Quality Measurements on the Animas River

	within Colorado		within New Mexico	
Parameter	**n**	**mean**	**n**	**mean**
Alkalinity Total (mg/l as CaCO3)	468	106	304	130
Aluminum Dissolved (µg/l as Al)			113	65.1
Aluminum Total (µg/l as Al)	2	0	56	2806
Arsenic Dissolved (µg/l as As)	493	6.7	356	3.5
Arsenic Total (µg/l as As)	243	21.1	304	8.8
Boron Dissolved (µg/l as B)	7	71.4	197	86.4
Cadmium Dissolved (µg/l as Cd)	255	0.2	74	1.3
Cadmium Total (µg/l as Cd)	345	0.7	21	3.9
Calcium Dissolved (mg/l as Ca)	857	64.0	822	74.1
Calcium Total (mg/l as Ca)	244	56.6	122	56.9
Chloride Total in Water (mg/l)	248	14.4	410	17.0
Chromium Dissolved (µg/l as Cr)	253	2.8	58	3.8
Chromium Total (µg/l as Cr)	1	4.0	22	13.3
Cobalt Dissolved (µg/l as Co)			65	1.3
Cobalt Total (µg/l as Co)	2	1.5	19	21.1
Copper Dissolved (µg/l as Cu)	492	4.1	252	3.4
Copper Total (µg/l as Cu)	585	15.6	205	15.6
Hardness Calc. (mg/l as CaCO3)	4	125	684	238
Hardness Total (mg/l as CaCO3)	4	125	561	242
Iron Dissolved (µg/l as Fe)	258	42.1	226	32.7
Iron Total (µg/l as Fe)	344	501	26	3650
Lead Dissolved (µg/l as Pb)	243	2.6	231	1.7
Lead Total (µg/l as Pb)	338	13.5	198	29.4
Magnesium Dissolved (mg/l as Mg)	857	10.1	820	11.0
Magnesium Total (mg/l as Mg)	244	9.8	122	10.1
Manganese Dissolved (µg/l as Mn)	757	87.9	211	48.3
Manganese Total (µg/l as Mn)	244	416	148	231
Mercury Dissolved (µg/l as Hg)	485	0.10	324	0.11
Mercury Total (µg/l as Hg)	581	0.15	314	0.14
Nickel Dissolved (µg/l as Ni)	248	2.7	120	4.6
Nickel Total (µg/l as Ni)	263	5.7	67	6.4
Nitrite + Nitrate Total (mg/l as N)	575	1.01	107	0.20
Oxygen Dissolved mg/l	31	7.7	343	9.7
pH Lab (Standard Units)	34	8.00	680	7.89
pH Field (Standard Units)	905	7.49	373	7.97
Phosphorus Total (mg/l as P)			178	0.14
Residue Total Filtrable (Dried at 180ºC) mg/l			565	397
Selenium Dissolved (µg/l as Se)	216	0.9	309	0.9
Selenium Total (µg/l as Se)	255	1.1	245	1.0
Selenium Total Recoverable in Water as Se µg/l	336	1.0	129	1.4
Silver Dissolved (µg/l as Ag)	487	0.10	167	0.25
Silver Total (µg/l as Ag)	512	0.26	126	0.66
Sodium Dissolved (mg/l as Na)	855	16.0	737	29.8
Sodium Total (mg/l as Na)	244	13.4	122	18.3
Solids Susp.-residue on Evap. At 180ºC (mg/l)			155	108
Specific Conductance (µmhos/cm @ 25ºC)	1498	455	952	549
Sulfate Total (mg/l as SO4)	4	67	291	154
Temperature Water (ºC)	557	10.3	189	10.9
Zinc Dissolved (µg/l as Zn)	489	31.3	361	13.0
Zinc Total (µg/l as Zn)	587	121.6	307	97.9

Florida River

Streamflow in the Florida River is similar in nature to the Pine except the drainage area is smaller and the mean elevation somewhat lower, resulting in much less inflow. No water quality measurements could be located for Lemon Reservoir. The water quality is assumed to be excellent above Lemon Reservoir. Few water quality measurements were compiled for the Florida River lower in the system. Yahnke (Yahnke, 1999) reported that the specific conductance averaged 437 μmho/cm in 91 samples collected by the USGS at the former gage near Bondad. Irrigation return flows usually are greater than 1,500 μmho/cm; the maximum of the USGS samples was 1,200 μmho/cm. The water quality in the Florida River appears to be good in spite of irrigation depletions.

LaPlata River

The LaPlata River has been heavily impacted by historic mining activities and agricultural development. At several reaches along the river, such as above the confluence with Cherry Creek and in New Mexico, the river goes completely dry for some period during many years. Flows are reduced from spring through fall for irrigation diversion. Hence, the water quality fluctuates depending on the amounts of diversions and return flow occurring during the seasons.

In the Colorado portion of the river there are historic exceedences for copper, mercury, manganese, silver, and zinc. In the New Mexico segment of the LaPlata River, the number of exceedences for mercury increases. For the other metals the exceedences decrease to just an occasional or no exceedences. Selenium concentrations are exceeded about 25 percent of the time per New Mexico standards which are stricter than Colorado's regulations. Table 3-5 summarizes the water quality measurements found in the combined STORET-Reclamation-BIA water quality database.

Mancos River

Water quality in the Mancos River is poor, with elevated levels of trace metals from mining in the headwaters, leaching from the Mancos shale that underlies the River basin and irrigation return flows. Some reaches of the river from Mancos, Colorado to the confluence with the San Juan River are dry during the irrigation season due to diversions. Table 3-6 summarizes the water quality measurements found in the combined STORET-Reclamation-BIA water quality database.

The Colorado regulations are not as strict for this portion of the Mancos River as for other rivers, so there are only a few exceedences in dissolved oxygen, pH, and selenium. Mercury concentrations are exceeded in all measurements.

San Juan River

These historic values could be slightly affected by the operation of Navajo Dam for endangered fish. The timing of releases to produce reduced base flow and increased spring runoff will result in the winter flows containing a higher percentage of return flows in the lower reaches. Higher summer base flows reduce the portion of return flows for a potential improvement in water quality in these post-runoff months. However, measurements over the last seven years of modified flows have not detected a measurable change in water quality due to this change in flow regime. There are return flow points from municipal, industrial and irrigation uses along most of the length of the River. However, most of the return flow points occur

Table 3-5
Historic Water Quality Measurements on the LaPlata River

	within Colorado		within New Mexico	
Parameter	**n**	**mean**	**n**	**mean**
Alkalinity Total (mg/l as CaCO3)	138	161.7	93	188
Aluminum Dissolved (μg/l as Al)			83	18.9
Aluminum Total (μg/l as Al)			65	2612
Arsenic Dissolved (μg/l as As)	129	5.9	324	5.4
Arsenic Total (μg/l as As)	135	15.4	330	19.9
Boron Dissolved (μg/l as B)			67	99.4
Cadmium Dissolved (μg/l as Cd)			14	1.1
Cadmium Total (μg/l as Cd)			8	1.8
Calcium Dissolved (mg/l as Ca)	138	70.0	324	140.9
Calcium Total (mg/l as Ca)			1	48.0
Chloride Total in Water (mg/l)	136	10.6	99	82.3
Chromium Dissolved (μg/l as Cr)			6	10.0
Chromium Total (μg/l as Cr)			12	79.6
Cobalt Dissolved (μg/l as Co)			8	1.6
Cobalt Total (μg/l as Co)			8	23.4
Copper Dissolved (μg/l as Cu)	132	3.4	237	4.0
Copper Total (μg/l as Cu)	137	9.7	240	33.0
Hardness Calc. (mg/l as CaCO3)			162	588
Hardness Total (mg/l as CaCO3)			93	766
Iron Dissolved (μg/l as Fe)			69	142.8
Iron Total (μg/l as Fe)			23	208135
Lead Dissolved (μg/l as Pb)			162	0.8
Lead Total (μg/l as Pb)			165	18.7
Magnesium Dissolved (mg/l as Mg)	138	34.4	323	61.2
Magnesium Total (mg/l as Mg)			1	11.0
Manganese Dissolved (μg/l as Mn)	133	36.2	185	164.1
Manganese Total (μg/l as Mn)	136	107	196	2118
Mercury Dissolved (μg/l as Hg)	128	0.11	316	0.11
Mercury Total (μg/l as Hg)	131	0.13	325	0.15
Nickel Dissolved (μg/l as Ni)			74	5.3
Nickel Total (μg/l as Ni)			79	24.8
Nitrite + Nitrate Total (mg/l as N)			49	0.38
Oxygen Dissolved mg/l			206	8.8
pH Lab (Standard Units)	138	7.95	98	8.00
pH Field (Standard Units)	121	7.57	297	7.89
Phosphorus Total (mg/l as P)			52	0.63
Residue Total Filtrable (Dried at 180ºC) mg/l			74	1437
Selenium Dissolved (μg/l as Se)	38	0.8	231	1.7
Selenium Total (μg/l as Se)	32	0.8	218	1.3
Selenium Total Recoverable in Water as Se μg/l	36	0.9	111	1.9
Silver Dissolved (μg/l as Ag)	129	0.12	153	0.10
Silver Total (μg/l as Ag)	137	0.13	163	0.71
Sodium Dissolved (mg/l as Na)	138	19.8	237	120.5
Sodium Total (mg/l as Na)			1	8.0
Solids Susp.-residue on Evap. At 180ºC (mg/l)			150	706
Specific Conductance (μmhos/cm @ 25ºC)	138	603	328	1674
Sulfate Total (mg/l as SO4)	137	218	103	889
Temperature Water (ºC)			152	10.7
Zinc Dissolved (μg/l as Zn)	133	6.3	324	7.2
Zinc Total (μg/l as Zn)	132	7.7	325	206.4

Table 3-6
Historic Water Quality Measurements on the Mancos River

Parameter	n	mean
Alkalinity Total (mg/l as CaCO3)	54	177
Aluminum Dissolved (µg/l as Al)	25	35.2
Aluminum Total (µg/l as Al)	24	12073
Arsenic Dissolved (µg/l as As)	164	6.1
Arsenic Total (µg/l as As)	158	19.9
Boron Dissolved (µg/l as B)	8	111.3
Cadmium Dissolved (µg/l as Cd)	6	0.8
Cadmium Total (µg/l as Cd)		
Calcium Dissolved (mg/l as Ca)	254	148.0
Calcium Total (mg/l as Ca)	1	167.0
Chloride Total in Water (mg/l)	130	14.9
Chromium Dissolved (µg/l as Cr)	6	1.0
Chromium Total (µg/l as Cr)		
Cobalt Dissolved (µg/l as Co)		
Cobalt Total (µg/l as Co)		
Copper Dissolved (µg/l as Cu)	139	6.4
Copper Total (µg/l as Cu)	135	29.1
Hardness Calc. (mg/l as CaCO3)	157	787
Hardness Total (mg/l as CaCO3)	80	915
Iron Dissolved (µg/l as Fe)	74	41.1
Iron Total (µg/l as Fe)		
Lead Dissolved (µg/l as Pb)	54	0.5
Lead Total (µg/l as Pb)	48	10.5
Magnesium Dissolved (mg/l as Mg)	254	78.2
Magnesium Total (mg/l as Mg)	1	49.0
Manganese Dissolved (µg/l as Mn)	183	51.3
Manganese Total (µg/l as Mn)	110	212
Mercury Dissolved (µg/l as Hg)	164	0.10
Mercury Total (µg/l as Hg)	157	0.14
Nickel Dissolved (µg/l as Ni)	24	5.8
Nickel Total (µg/l as Ni)	24	15.2
Nitrite + Nitrate Total (mg/l as N)		
Oxygen Dissolved mg/l	131	9.4
pH Lab (Standard Units)	131	7.87
pH Field (Standard Units)	131	8.18
Phosphorus Total (mg/l as P)		
Residue Total Filtrable (Dried at 180ºC) mg/l	12	1487
Selenium Dissolved (µg/l as Se)	91	4.9
Selenium Total (µg/l as Se)	77	5.4
Selenium Total Recoverable in Water as Se µg/l	51	2.5
Silver Dissolved (µg/l as Ag)	107	0.19
Silver Total (µg/l as Ag)	109	0.23
Sodium Dissolved (mg/l as Na)	234	90.1
Sodium Total (mg/l as Na)	1	22.0
Solids Susp.-residue on Evap. At 180ºC (mg/l)	48	609
Specific Conductance (µmhos/cm @ 25ºC)	417	1406
Sulfate Total (mg/l as SO4)	130	835
Temperature Water (ºC)	61	12.1
Zinc Dissolved (µg/l as Zn)	161	11.5
Zinc Total (µg/l as Zn)	157	49.0

between Bloomfield and Shiprock, New Mexico. The water quality of the San Juan River steadily decreases moving downstream. For example, the salt content continually increases going downstream from Navajo Reservoir to Mexican Hat. This happens as the San Juan River collects water from the Animas, LaPlata, and Mancos Rivers and from numerous smaller intermittent streams and washes, is depleted for irrigation and other uses and receives return flows. The water quality can also fluctuate quickly due to storm runoff from small streams and washes entering the river. Table 3-7 summarizes the water quality measurements found in the combined STORET-Reclamation-BIA water quality database.

Above Farmington, NM, there are a few historic exceedences in the San Juan River for aluminum, mercury, selenium, cadmium and lead. The number of exceedences increase between Farmington and Shiprock, NM including several for copper and zinc. At Four Corners, the number of exceedences decreases. Per Utah's regulations there were additional exceedences at Mexican Hat (near Bluff) in nutrients and total suspended solids.

Groundwater

Ground water quality data have been published in *Water Quality Appendix B* (Reclamation, 1996) and in site characterization of the pumping plant (Reclamation, 1990). After the site characterization report, Reclamation has continued to collect data in the DOE monitoring well network located around the propose pumping plant site. The groundwater data used in this study were taken from those reports. Groundwater data from seeps, drains, and springs were selected from Appendix B and were compiled shown in Table 3-8.

These data show that shallow groundwater within the LaPlata Basin contains relatively low concentrations of these trace metals. The variable conductances (E.C) values indicate that the return flow from irrigated lands can be salty in spite of many years of leaching. Under these conditions the selenium concentrations appear to be low. The measured concentrations of these trace metals would be reflected in those concentrations expected from shallow ground water return flows under the various alternatives.

The ground water quality around the Animas River pumping plant site was different from those in the LaPlata Basin. The monitoring wells showed that the shallow groundwater in the local area was very salty. The Durango Pumping Plant groundwater data described in the Appendix B (Reclamation, 1996) reflect the trace element concentrations generally. In the groundwater the total dissolved solids ranged from 2,000 to 20,000 mg/l, the sulfate from 200 to 10,000 mg/l. These high concentrations partly are explained by the site's groundwater contamination from settling ponds for uranium mill tailings. However the background wells also show the ground water is naturally salty with TDS ranging from 1,000 to 3,000 mg/l. Subsequent sampling by Reclamation only confirms the concentrations of most trace metals reported earlier except for selenium. Beginning in 1996 the selenium concentrations (Reclamation Database, 1999) appear to be lower than those reported in Appendix B (ranges nondetectable-370 µg/l). The measurable Se values range up to about 50 µg/l with most reported in the nondetectable-25 µg/l range. The reduced range appears connected to the improved precision in measuring Se in all samples experienced by Reclamation.

Table 3-7 Historic Water Quality Measurements on the San Juan River								
	Farmington		Shiprock		Four Corners		Bluff	
Parameter	**n**	**mean**	**n**	**mean**	**n**	**mean**	**n**	**mean**
Alkalinity Total (mg/l as CaCO3)	607	114	646	119	59	121	2333	147
Aluminum Dissolved (μg/l as Al)	34	34.4	138	58.5	40	63.9	174	64.1
Aluminum Total (μg/l as Al)	30	5283	83	15636	30	11373	134	20500
Arsenic Dissolved (μg/l as As)	76	1.9	267	2.3	78	1.8	345	1.9
Arsenic Total (μg/l as As)	78	2.8	224	4.4	72	3.8	309	4.3
Boron Dissolved (μg/l as B)	315	49.5	678	103.9	45	126.0	1720	68.7
Cadmium Dissolved (μg/l as Cd)	11	0.8	71	0.9	15	1.2	56	1.0
Cadmium Total (μg/l as Cd)	12	5.7	29	3.6	7	3.7	15	3.7
Calcium Dissolved (mg/l as Ca)	859	61.6	1178	72.4	135	65.6	2627	93.8
Calcium Total (mg/l as Ca)	5	71.5	12	70.8	6	78.8	23	88.8
Chloride Total in Water (mg/l)	830	9.8	1084	16.9	104	13.5	2568	20.6
Chromium Dissolved (μg/l as Cr)	4	11.3	53	3.2	4	2.9	48	2.5
Chromium Total (μg/l as Cr)	9	51.8	25	22.5	5	17.0	17	52.1
Cobalt Dissolved (μg/l as Co)	9	1.5	67	1.4	10	1.6	53	1.5
Cobalt Total (μg/l as Co)	13	44.4	29	22.9	7	10.6	21	41.7
Copper Dissolved (μg/l as Cu)	45	3.8	165	4.2	48	5.0	203	4.9
Copper Total (μg/l as Cu)	45	29.5	121	35.5	42	20.8	163	35.8
Hardness Calc. (mg/l as CaCO3)	859	189	1154	237	123	222	2589	326
Hardness Total (mg/l as CaCO3)	824	189	969	245	45	224	2423	336
Iron Dissolved (μg/l as Fe)	164	47.2	251	31.2	42	22.0	69	30.5
Iron Total (μg/l as Fe)	15	25691	39	30449	13	13405	201	4809
Lead Dissolved (μg/l as Pb)	67	0.7	256	1.5	70	0.8	343	1.0
Lead Total (μg/l as Pb)	79	30.3	222	27.6	71	23.6	305	26.1
Magnesium Dissolved (mg/l as Mg)	859	8.4	1176	13.4	135	14.4	2628	25.0
Magnesium Total (mg/l as Mg)	5	11.9	12	14.0	6	17.4	23	27.1
Manganese Dissolved (μg/l as Mn)	26	22.3	110	45.0	30	6.3	86	6.1
Manganese Total (μg/l as Mn)	20	852	56	978	27	449	39	1109
Mercury Dissolved (μg/l as Hg)	70	0.12	254	0.13	75	0.10	338	0.11
Mercury Total (μg/l as Hg)	78	0.14	225	0.15	71	0.13	309	0.14
Nickel Dissolved (μg/l as Ni)	28	6.1	146	4.6	36	5.2	184	4.6
Nickel Total (μg/l as Ni)	28	6.8	105	12.1	39	9.7	144	15.5
Nitrite + Nitrate Total (mg/l as N)	47	0.27	98	0.39	27	0.74	55	0.78
Oxygen Dissolved mg/l	251	9.5	455	9.8	159	9.5	478	9.2
pH Lab (Standard Units)	879	7.81	1097	7.89	107	8.25	1357	7.78
pH Field (Standard Units)	60	8.13	190	8.26	60	8.25	285	8.20
Phosphorus Total (mg/l as P)	59	0.27	164	0.32	31	0.37	95	0.58

Table 3-7
Historic Water Quality Measurements on the San Juan River

	Farmington		Shiprock		Four Corners		Bluff	
Parameter	**n**	**mean**	**n**	**mean**	**n**	**mean**	**n**	**mean**
Residue Total Filtrable (Dried at 180ºC) mg/l	374	382	667	498	102	422	1313	656
Selenium Dissolved (µg/l as Se)	81	0.6	277	1.0	78	1.3	349	1.1
Selenium Total (µg/l as Se)	76	0.7	227	0.9	71	1.6	309	1.4
Selenium Total Recoverable in Water as Se µg/l	10	0.5	29	1.0	10	0.9	47	0.8
Silver Dissolved (µg/l as Ag)	2	0.75	51	0.56			45	0.56
Silver Total (µg/l as Ag)	2	0.75	10	1.10			9	2.06
Sodium Dissolved (mg/l as Na)	836	44.7	951	64.6	112	49.3	2047	79.2
Sodium Total (mg/l as Na)	5	37.7	12	38.5	6	43.8	23	58.2
Solids Susp.-residue on Evap. At 180ºC (mg/l)	59	242	191	956	60	663	283	934
Specific Conductance (µmhos/cm @ 25ºC)	905	550	1136	716	112	644	2020	931
Sulfate Total (mg/l as SO4)	827	154	1083	225	104	193	2568	329
Temperature Water (ºC)	60	10.6	227	12.2	79	12.4	343	12.6
Zinc Dissolved (µg/l as Zn)	80	9.2	268	9.2	77	7.8	346	15.7
Zinc Total (µg/l as Zn)	75	92.9	224	114.1	71	204.0	306	109.6

Table 3-8
Trace Elements in LaPlata Basin Shallow Groundwater Samples Collected During 1992

Area	Site No.	Site Type	E.C. (µS/cm)	Trace Elements (µg/L)					
				Cu	Hg	Se	Ag	Zn	Mn
Valley lands	115	Drain	1,440	<5	<0.20	4	<0.2	15	<50
Valley lands	111	Drain	3,380	<5	0.35	10	0.4	<10	333
Valley lands	102	Drain. ditch	1,836	<5	<0.20	5	<0.2	<10	<50
Second terrace	110	Surf. drainage	2,410	<5	0.25	<2	0.2	<10	88
Dry side—San Juan Arroyo	140	Seep	6,100	<5	0.30	10.5	0.3	29	190
Dry side—San Juan Arroyo	137	Seep	7,280	<5	0.30	5	2.1	<10	110
Dry side	140	Seeps	888	<5	0.30	<2	<0.1	20	210
Red Mesa	85	Marvel Spring	438	<5	<0.20	2	<0.2	<10	<50
Red Mesa	120	Seep	3,020	8	0.35	<2	0.6	<10	995
Red Mesa	119	Seep	467	10	<0.20	<2	<0.2	<10	<50

WATER QUALITY IMPACT ANALYSIS

Methodology

Introduction

Relevant federal and state regulations and standards were reviewed to identify appropriate significance criteria. Specifically the Colorado, New Mexico and Utah state surface water quality standards were obtained for the various river segments. The water classifications change along each river and the water standards change depending on the location. The methodology adopted in this study was to look at each segment individually calculating

- the mean concentration for the period of reliable record, and
- the number of exceedences

The mean concentration of any parameter was a flow-weighted arithmetic mean of all available values for that parameter. Flow weighting was used because the result is more closely related to the constituent load and it tends to smooth erratic measurements. Further, since Ridges Basin Reservoir integrates the water quality, flow-weighting is the only meaningful way of calculating impact down river. Both the mean concentration and the number of exceedences were compared between the original observations and the observations with Project impacts.

The surface water quality data for the San Juan River basin and the upper Dolores River were compiled from the STORET database (STORET 1999), and data collected by Reclamation (Reclamation, 1999) and the BIA (BIA, 1999). The compiled data set contains approximately 275,000 observations collected mainly in the period of 1950-1998. A subset, 74,000 measurements of the parameters regulated by the states, was selected to form the database for the water quality analysis. Other parameters were selected for biological studies as needed.

In addition to surfacewater quality data, streamflow data were compiled from the USGS hydrologic records (HYDRODATA, 1999 and USGS, 1999) matching the gage location and the period of the water quality collection. Similarly the RiverWare simulated streamflows during project operation were compiled at the same locations utilizing the modeled hydrology data.

Approach

Before starting into the exceedence calculations, the water quality data were examined in some detail. The mean concentrations were calculated for the historic data and then with Refined Alternative 4 in place. The mean values computed in this examination were (1) the mean, (2) the mean monthly values and (3) the mean during specific streamflow intervals. The streamflow intervals are established as the frequency of occurrence bins (10 percent - dry decile, 25 percent - dry quartile, 50 percent - median, 75 percent - wet quartile, 90 percent wet decile). If an impact was noted between the low quartile and the high quartile, it would be shown as 50 percent. Each of the three mean types was analyzed from the view point of measurability. A change in each parameter's concentration (or value) was deemed measurable based on the analytical measurement precision. The analytical methodology has changed over the years, so the detection limit and the precision of the concentration determinations have changed. For a comparison of means, the practical quantitation limit (PQL) based on current analytical chemistry methods was used for the various parameters. The practical quantitation limit is the concentration limit where a chemical parameter can reliably be determined and was assigned a precision of at least 5 percent. Concentrations lower than these limits are approaching the detection limit and are less precise, usually exceeding 10 percent. So the measurable change in the mean concentration depends on the concentration of the parameter itself. So the checks, established for testing measurable changes in the mean concentrations, were:

- ❑ if the mean concentration was greater than the PQL then 5 percent (or greater) change is measurable
- ❑ if the mean concentration was less than the PQL then a 10 percent (or greater) change is measurable

For the state regulated parameters, the estimated PQL is listed in Table 3-9.

If the state standards are compared against the minimum detectable limit (= PQL/5) for each chemical parameter, some exceedence concentrations are near or lower than the minimum detectable concentrations. Selenium in New Mexico and mercury in all states are examples. Hence, the current analytical chemistry method cannot determine the mandated concentration limit.

The water quality data collected historically were broken out into the various river segments and examined from the measurability view point. Concentrations measured at the minimum detection limit were set at one half of the limit. For example, selenium measurements as <1 μg/l were set at 0.5 μg/l. The mean data were compiled by river segments into tables. Each reach will be considered individually and the attributes about measurability summarized for each parameter by reach. Non-detection values cannot be used in calculating exceedences, since the initial concentration to which an increase is applied is not known. Where the standard is lower than the detection limit, as for mercury, it is not possible to discern if a measurement exceeded the standard. For reporting purposes in these cases, the standard used by regulating agencies was employed, whereby concentrations that are below detection are considered to be below the standard. When the standard is above the detection limit, only measurements that are above detection can be used to compute the impact to exceedences. Note that there was not a suitable way to calculate the changes in the mean for dissolved oxygen or pH, so these parameters were assumed not to change under Refined Alternative 4. The results shown should aid in understanding the data variability and be useful in relating concentrations to biological impacts. While the results of this analysis are not used to measure significance, they are reported as overall impacts.

In water quality analysis, a working definition of concentration is simply the mass load of a particular substance divided by volume of water considered. Any changes to either the mass load or the amount of water may change the substance's concentration and the resulting water quality. As a result, any water quality analysis cannot proceed with concentrations alone, but must include mass loads and water volumes to provide insight into potential changes. For these reasons, a water quality database of concentrations compiled from any source must be augmented with streamflow data. The streamflow data should be concurrent with the water sampling. To calculate any projected changes in water quality, the researcher must also have at hand any changes in the mass load and in streamflow (water volume). Hence, the compilation process included (1) the regional water quality data collected since the early 1950s, (2) the regional streamflow data at the same locations and periods, and (3) the projected streamflow and mass loading changes occurring under Project operation.

Table 3-9 The Practical Quantitation Limit for the State Regulated Parameters			
Parameter	**Concentration (mg/l)**	**Parameter**	**Concentration (mg/l)**
Aluminum (Dissolved)	0.005	Lead (Total)	0.0001
Ammonia (Unionized)	0.25	Lead (Total Recoverable)	0.0001
Arsenic (Dissolved)	0.005	Magnesium (Dissolved)	1.0
Arsenic (Total)	0.005	Manganese (Dissolved	0.0005
Arsenic (Total Recoverable)	0.005	Manganese (Total)	0.0005
Beryllium (Dissolved)	0.5	Manganese (Total Recoverable)	0.0005
Beta Total	20 piC/l	Mercury (Dissolved)	0.00025
BOD_5 (5-Day)	5	Mercury (Total)	0.00025
Boron (Dissolved)	0.005	Mercury (Total Recoverable)	0.00025
Cadmium (Dissolved)	0.0005	Nickel (Dissolved)	0.001
Cadmium (Total)	0.0005	Nickel (Total)	0.001
Cadmium (Total Recoverable)	0.0005	Nickel (Total Recoverable)	0.001
Calcium (Dissolved)	1.0	Nitrate (Dissolved)	0.1
Chlordane (Whole Water)	0.00025	Nitrate (Total)	0.1
Chloride (Dissolved)	10	Nitrite (Dissolved)	0.05
Chlorine (Total Residual)	2.5	Oxygen (Dissolved)	0.1
Chromium (Dissolved)	0.0005	pH (Standard Units)	0.1
Chromium (Hexavalent)	0.0005	pH Field (Standard Units)	0.1
Chromium (Total)	0.0005	Phosphorus (Total)	0.05
Chromium (Total Recoverable)	0.0005	Selenium (Dissolved)	0.005
Copper (Dissolved)	0.005	Selenium (Total)	0.005
Copper (Total)	0.005	Selenium (Total Recoverable)	0.005
Copper (Total Recoverable)	0.005	Silver (Dissolved)	0.00025
Cyanide (Total)	0.5	Silver (Total)	0.00025
Fecal Coliforms	5 colonies	Silver (Total Recoverable)	0.00025
Hardness (Calculated)	7	Solids Suspended-residue	20
Hardness (Total)	7	Sulfate (Dissolved)	20
Iron (Dissolved)	0.005	Sulfide (Dissolved)	0.1
Iron (Total)	0.005	Zinc (Dissolved)	0.005
Iron (Total Recoverable)	0.005	Zinc (Total)	0.005
Lead (Dissolved)	0.0001	Zinc (Total Recoverable)	0.005

With these three types of data the change in water quality could be calculated in the following way. The water quality parameters are expressed as concentrations, namely the mass load divided by a unit volume of water. In the setting of M&I water use, the mass load equals the parameter concentration times the inflow (or return flow) volume. So the changes in the mass load of a particular parameter are represented by subtracting loading leaving in the diversion and by summing the loading in the return flows. The concentration of the particular at that point in the stream is found by dividing the net load by the net streamflow volume. In equation form, the new concentration can be calculated as shown in **Equation 3-1**.

$$CONC_{new} = \frac{(CONC_{obs} \cdot FLOW_{obs} - \sum CONC_{div} \cdot DIVERSION + \sum CONC_{rt} \cdot RTFLOW)}{(FLOW_{obs} - \sum DIVERSION + \sum RTFLOW)}$$

Equation 3-1

The summation is over all upstream diversion or return flow points and where:

$CONC_{new}$ = the new concentration calculated for a parameter
$CONC_{obs}$ = the original observed concentration measured for the parameter
$CONC_{div}$ = the parameter's concentration in the diverted water
$CONC_{rt}$ = the parameter's concentration in the return flow
$FLOW_{obs}$ = the original observed or measured streamflow expressed as a volume
DIVERSION = the volume of diverted water
RTFLOW = the volume of return flow

If the parameter concentrations do not change beyond simple dilution or concentration processes (the assumption made for this analysis), then this equation applies as any downstream point in the river network provided all upstream diversions and return flows are accumulated for the downstream calculation.

In this study relative changes in the mean concentrations could be used to determine the impact to surface water in the various rivers. The attached numeric standards were used to calculate exceedences by comparing the observed water quality measurements against the numeric standard. After accounting for the change in the surface water concentrations due to Project operation, the exceedences were then recalculated for each chemical parameter. A change in the number of exceedences could be used as a measure of impact from the project.

Sites with Water Quality Measurements

The water quality sites were selected based on those segments of the river network affected by the project. The location of the sampling sites included in this study are compiled in Table 3-10 and shown on Figures 3-3, 3-4, and 3-5.

Most (99%) of the water quality data in STORET compilation was collected by the USGS in the 1960-1990 decades. Reclamation started collecting water quality in 1989 and is still collecting data. A full summary of data collected through 1995 appears in Appendix B of the Final Supplement to the FEIS (Reclamation , 1996). The BIA started collecting water quality data in 1994 and continues sampling at about 20 sites between Navajo Dam and Mexican Hat. The available compliance monitoring data for City of Farmington under its NPDES permit were also included in the compilation (STORET, 1999). These sites were used to extract a subset consisting of about 74,000 measurements, from the combined STORET-Reclamation-BIA water quality database consisting of the parameters listed in Table 3-9.

Historical Streamflow Data

The historical streamflow data in the San Juan River Basin were extracted from the USGS hydrologic record for gages (HYDRODATA, 1999 and USGS, 1999) to match both the location and time period of water quality sampling. The USGS stations included in this extracted streamflow database are shown on Figure 3-6 and listed in Table 3-11.

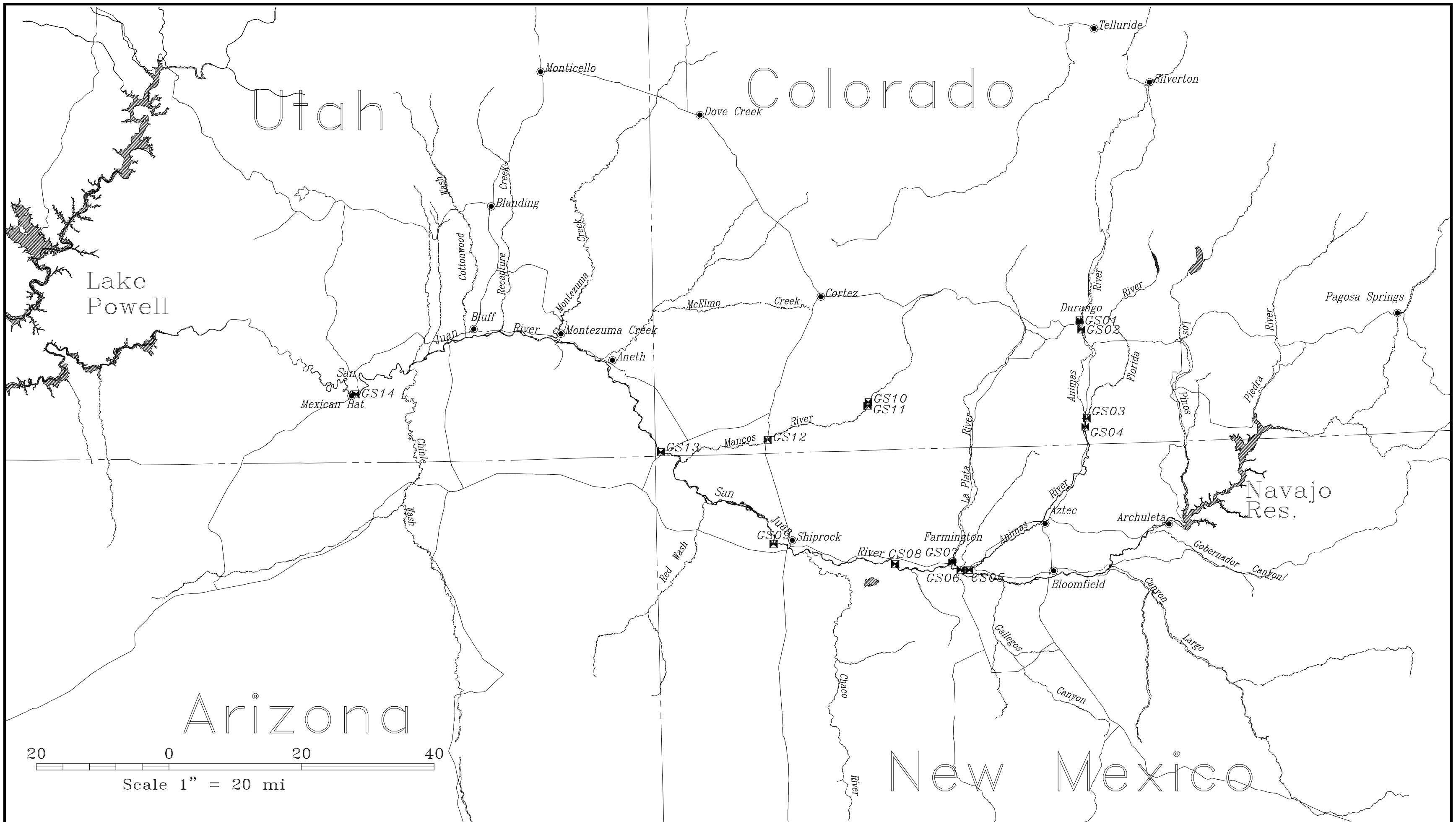
These observed daily flows were compiled as daily and monthly flow volumes for use in the calculation of water quality changes. For streamflow gaging stations with records shorter than the sampling interval for water quality, missing flow data were included using the station's mean monthly flow values.

Table 3-10
The Study Sites Selected with Historical Water Quality Measurements

Station ID	Map ID	Station Name	State	County	Latitude	Longitude
USGS sampling sites (STORET)						
9361500	GS01	Animas River at Durango, CO	CO	LaPlata	37:16:45	107:52:47
9362510	GS02	Animas River below Durango, CO	CO	LaPlata	37:15:29	107:52:32
9363200	GS03	Florida River at Bondad, CO	CO	LaPlata	37:03:24	107:52:09
9363500	GS04	Animas River near Cedar Hill, NM	CO	LaPlata	37:02:17	107:52:25
9364500	GS05	Animas River at Farmington, NM	NM	San Juan	36:43:17	108:12:05
9365000	GS06	San Juan River at Farmington, NM	NM	San Juan	36:43:22	108:13:30
9367500	GS07	LaPlata River near Farmington, NM	NM	San Juan	36:44:23	108:14:51
9367540	GS08	San Juan River near Fruitland, NM	NM	San Juan	36:44:25	108:24:09
9368000	GS09	San Juan River at Shiprock, NM	NM	San Juan	36:47:32	108:43:54
9370800	GS10	Mancos River near Cortez, CO	CO	Montezuma	37:06:28	108:27:48
9370820	GS11	Mancos River below Johnson Canyon near Cortez, CO	CO	Montezuma	37:05:57	108:27:56
9371000	GS12	Mancos River near Towaoc, CO	CO	Montezuma	37:01:39	108:44:27
9371010	GS13	San Juan River at Four Corners, CO	CO	Montezuma	37:00:20	109:02:00
9379500	GS14	San Juan River near Bluff, UT	UT	San Juan	37:08:49	109:51:51
Reclamation Sampling Sites						
DRALP001	BR01	Animas River Red Lion Inn	CO	LaPlata	37:16:26	107:53:09
DRALP002	BR02	Animas River Pumping Plant Site	CO	LaPlata	37:15:46	107:52:39
DRALP003	BR03	Animas River Durango Mall - High Bridge	CO	LaPlata	37:14:31	107:52:36
DRALP134	BR04	Animas River Weaselskin Bridge	CO	LaPlata	37:09:35	107:53:00
DRALP148	BR05	Animas River at Bondad, CO	CO	LaPlata	37:03:05	107:52:30
DRALP198	BR06	Animas River Above Cedar Hill (DRALP133)	CO	LaPlata	36:55:45	107:53:00
DRALP133	BR07	Animas River at Cedar Hill, NM	NM	San Juan	37:02:17	107:52:25
DRALP132	BR08	Animas River at Aztec, NM	NM	San Juan	36:49:40	108:00:00
DRALP195	BR09	Unnamed Gulch, NM	NM	San Juan	36:49:40	108:00:00
DRALP202	BR10	Animas River at Farmington, NM	NM	San Juan	36:43:17	108:12:05
DRALP203	BR11	LaPlata River Hesperus Gage	CO	LaPlata	37:17:23	108:02:24
DRALP125	BR12	LaPlata River CSU Farm	CO	LaPlata	SE1/4 Sec 35 T35N R11W	
DRALP095	BR13	LaPlata River above Cherry Creek.	CO	LaPlata	37:06:58	108:11:58
DRALP118	BR14	LaPlata River above Long Hollow Creek	CO	LaPlata	37:03:15	108:10:39
DRALP116	BR15	LaPlata River CO-NM USGS Gage - Stateline	CO	LaPlata	36:59:59	108:11:17
DRALP151	BR16	LaPlata River West of Prell's Land	NM	San Juan	Sec 15 T32N R13W	

Table 3-10
The Study Sites Selected with Historical Water Quality Measurements (continued)

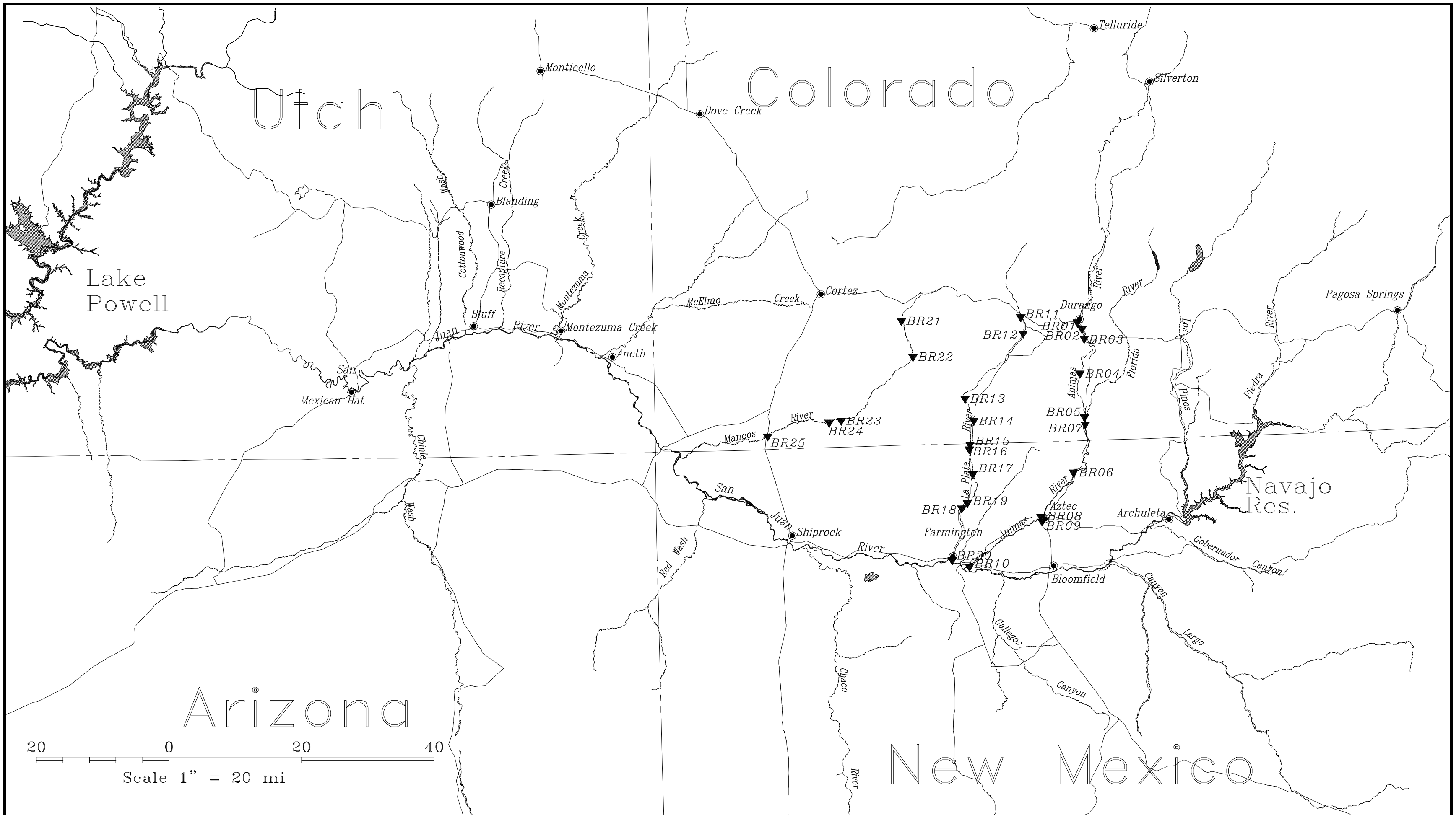
Station ID	Map ID	Station Name	State	County	Latitude	Longitude
DRALP114	BR17	LaPlata River 0.5 Miles East, LaPlata, NM	NM	San Juan	Sec 3	T31N R13W
DRALP112	BR18	LaPlata River Rynehardt's Land (Allen Arroyo)	NM	San Juan	36:5l:48	108:12:11
DRALP109	BR19	LaPlata River County Road 1788, NM (Jackson Lake Diversion)	NM	San Juan	SE1/4 Sec 8	T30N R13W
DRALP200	BR20	LaPlata River near Farmington (At Mouth)	NM	San Juan	36:44:23	108:14:51
DRALPMR2	BR21	Mancos River below Mancos, CO	CO	Montezuma	37:17:30	108:22:00
DRALPMRS	BR22	Mancos River below Weber Canyon	CO	Montezuma	37:12:53	108:20:17
DRALPMR3	BR23	Mancos River at Grass Canyon	CO	Montezuma	37:03:32	108:32:14
DRALPMR4	BR24	Mancos River below Moqui Canyon	CO	Montezuma	37:03:17	108:32:24
DRALPMR1	BR25	Mancos River above Highway 666 Bridge	CO	Montezuma	37:0l:39	108:44:27
		BIA Sampling Sites				
	BAI01	Animas River at Bondad Bridge	CO	LaPlata	37:03:04	107:52:28
	BAI02	Animas River at Aztec Bridge	NM	San Juan	36:49:34	108:00:08
	BIA03	Animas River at Flora Vista Bridge	NM	San Juan	36:43:38	108:11:25
	BIA04	Animas River at Farmington-Miller Bridge	NM	San Juan	36:43:13	108:12:07
	BIA05	San Juan River at Highway 371 Bridge	NM	San Juan	36:43:17	108:13:25
	BIA06	LaPlata River at Breen Bridge	CO	LaPlata	37:12:01	108:04:40
	BIA07	LaPlata River at LaPlata Bridge	NM	San Juan	36:55:44	108:10:60
	BIA08	LaPlata River at Mouth	NM	San Juan	36:44:23	108:14:52
	BIA09	San Juan River at Fruitland Bridge (Kirtland)	NM	San Juan	36:44:21	108:24:10
	BIA10	San Juan River above the Hogback Diversion	NM	San Juan	36:44:43	108:32:11
	BIA11	San Juan River at Shiprock Bridge	NM	San Juan	36:46:51	108:41:30
	BIA12	Mancos River near Four Corners	NM	San Juan	36:59:15	108:57:46
	BIA13	San Juan River at Four Corners Bridge	CO	Montezuma	37:00:08	109:01:54
	BIA14	San Juan River at Aneth	UT	San Juan	37:12:47	109:11:09
	BIA15	San Juan River at Montezuma Creek Bridge	UT	San Juan	37:16:19	109:19:39
	BIA16	San Juan River at Bluff Bridge	UT	San Juan	37:15:28	109:37:06
	BIA17	San Juan River at Mexican Hat Bridge	UT	San Juan	37:09:03	109:52:00



GS00 USGS STORET Station Locations

ID	STORET Station Name	ID	STORET Station Name	ID	STORET Station Name
GS01	Animas River at Durango, CO	GS07	La Plata R near Farmington, NM	GS13	San Juan R at Four Corners, CO
GS02	Animas River below Durango, CO	GS08	San Juan R near Fruitland, NM	GS14	San Juan River near Bluff, UT
GS03	Florida River at Bondad, CO	GS09	San Juan River at Shiprock, NM		
GS04	Animas River near Cedar Hill, NM	GS10	Mancos River near Cortez, CO		
GS05	Animas River at Farmington, NM	GS11	Mancos R bel Johnson Can nr Cortez, CO		
GS06	San Juan River at Farmington, NM	GS12	Mancos River near Towaoc, CO		

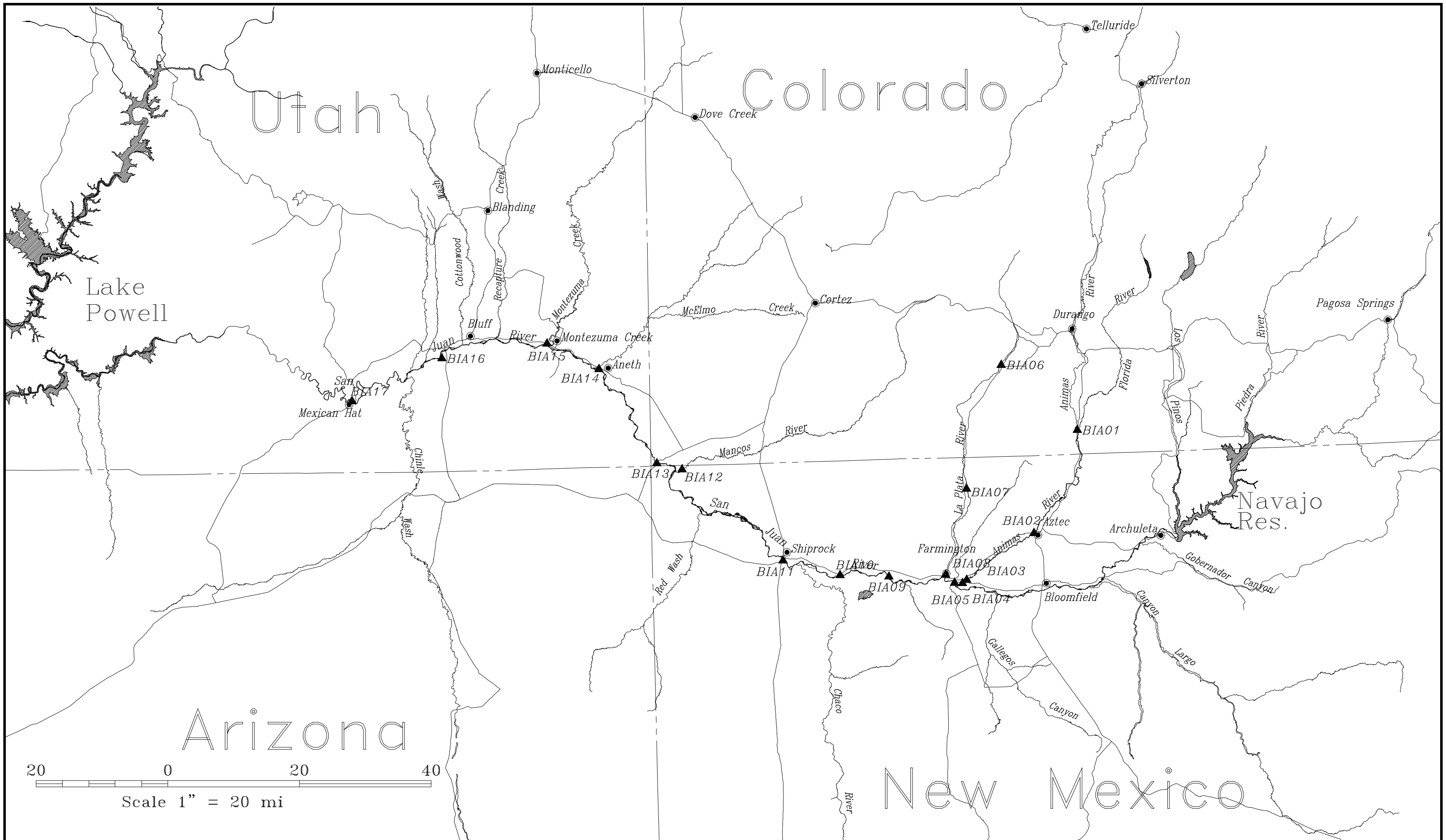
Figure 3-3. USGS Sampling Sites (STORET) with Historical Water Quality Measurements



▼BR00 USBR Sampling Locations

ID	USBR Station Name	ID	USBR Station Name	ID	USBR Station Name
BR01	Red Lion Inn	BR10	Farmington, NM	BR19	Cr 1788, Nm (Jackson Lake Div.)
BR02	Pumping Plant Site	BR11	Hesperus Gage	BR20	Farmington (At Mouth)
BR03	Durango Mall - High Bridge	BR12	CSU Farm	BR21	Mancos River below Mancos, Co
BR04	Weaselskin Bridge	BR13	La Plata R above Conf. W/ Cherry Ck.	BR22	Mancos River below Weber Canyon
BR05	Bondad, Co	BR14	La Plata R above Conf. W/ Long Hollow	BR23	Mancos River at Grass Canyon
BR06	Above Cedar Hill (DRALP133)	BR15	CO-NM USGS Gage - Stateline	BR24	Mancos River below Moqui Canyon
BR07	Cedar Hill, NM	BR16	La Plata R West of Prell's Land	BR25	Mancos River above Hwy 666 Bridge
BR08	Aztec, NM	BR17	0.5 Miles East, La Plata, NM		
BR09	Unnamed Gulch, NM	BR18	Rynehardt's Land (Allen Arroyo)		

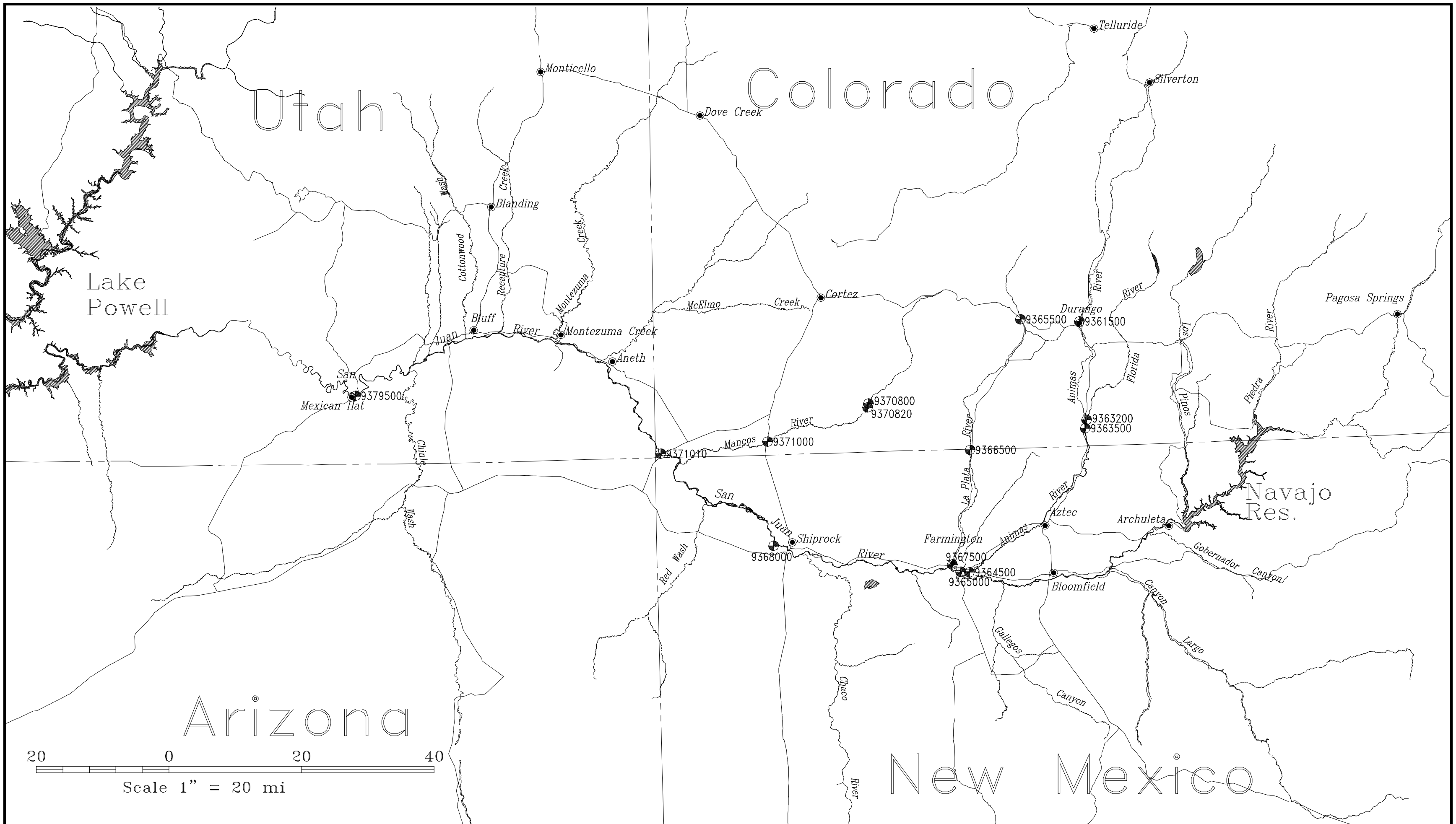
Figure 3-4. Reclamation Sampling Sites with Historical Water Quality Measurements



▲*BIA00* BIA Sampling Locations

ID	BIA Station Name	ID	BIA Station Name	ID	BIA Station Name
BIA01	Animas River at Bondad Bridge	BIA07	LaPlata River at LaPlata Bridge	BIA13	San Juan River at Four Corners Bridge
BIA02	Animas River at Aztec Bridge	BIA08	LaPlata River at Mouth	BIA14	San Juan River at Aneth
BIA03	Animas R at Flora Vista Bridge	BIA09	San Juan River at Fruitland Bridge (Kirtland)	BIA15	San Juan R at Montezuma Crk Br
BIA04	Animas R at Farmington-Miller Bridge	BIA10	San Juan River abv Hogback Diversion	BIA16	San Juan River at Bluff Bridge
BIA05	San Juan River at Hwy 371 Bridge	BIA11	San Juan River at Shiprock Bridge	BIA17	San Juan River at Mexican Hat Bridge
BIA06	LaPlata River at Breen Bridge	BIA12	Mancos River near Four Corners		

Figure 3-5. BIA Sampling Sites with Historical Water Quality Measurements



9300000 USGS Streamflow Station Locations

ID	USGS Station Name	ID	USGS Station Name
9361500	Animas River at Durango, CO	9367500	La Plata River near Farmington, NM
9363200	Florida River at Bondad, CO	9368000	San Juan River at Shiprock, NM
9363500	Animas River near Cedar Hill, NM	9370800	Mancos River near Cortez, CO
9364500	Animas River at Farmington, NM	9370820	Mancos River below Johnson Canyon nr Cortez, CO
9365000	San Juan River at Farmington, NM	9371000	Mancos River near Towaoc, CO
9365500	La Plata River at Hesperus, CO	9371010	San Juan River at Four Corners, CO
9366500	La Plata River at CO-NM State Line, CO	9379500	San Juan River near Bluff, UT

Figure 3-6. USGS Streamflow Gauging Stations Used in the Water Quality Analysis

Table 3-11 The USGS Streamflow Gaging Stations Used in the Water Quality Analysis							
Station ID	**Map ID**	**Station Name**	**State**	**County**	**Latitude**	**Longitude**	**Period of Record**
9361500	GS01	Animas River at Durango, CO	CO	LaPlata	37:16:45	107:52:47	1927-current
9363200	GS03	Florida River at Bondad, CO	CO	LaPlata	37:03:24	107:52:09	1957-1980
9363500	GS04	Animas River near Cedar Hill, NM	CO	LaPlata	37:02:17	107:52:25	1933-current
9364500	GS05	Animas River at Farmington, NM	NM	San Juan	36:43:17	108:12:05	1912-current
9365000	GS06	San Juan River at Farmington, NM	NM	San Juan	36:43:22	108:13:30	1912-current
9365500		LaPlata River at Hesperus, CO	CO	LaPlata	37:17:23	108:02:24	1917-current
9366500		LaPlata River at CO-NM State Line, CO	CO	LaPlata	36:59:59	108:11:17	1920-current
9367500	GS07	LaPlata River near Farmington, NM	NM	San Juan	36:44:23	108:14:51	1938-current
9368000	GS09	San Juan River at Shiprock, NM	NM	San Juan	36:47:32	108:43:54	1927-current
9370800	GS10	Mancos River near Cortez, CO	CO	Montezuma	37:06:28	108:27:48	1976-1980
9370820	GS11	Mancos River below Johnson Canyon near Cortez, CO	CO	Montezuma	37:05:57	108:27:56	1979-1981
9371000	GS12	Mancos River near Towaoc, CO	CO	Montezuma	37:01:39	108:44:27	1921-1943 1951-current
9371010	GS13	San Juan River at Four Corners, CO	CO	Montezuma	37:00:20	109:02:00	1977-current
9379500	GS14	San Juan River near Bluff, UT	UT	San Juan	37:08:49	109:51:51	1914-current

Streamflow Data from the San Juan River Hydrology Model

After the project configuration and the reservoir size were established in the San Juan River Hydrology Model, the calculated flows were selected at suitable nodes. Only the nodes where Project-related water was diverted or returned to the river system were included in the selection process. The nodes or objects extracted from the model output for use in the water quality calculations are listed in Table 3-12.

At each one of these nodes, the monthly streamflow, diversion and return-flow volumes were compiled into the river segments corresponding to the states regulated reaches. The nodes were then linked together to accumulate flow changes and mass changes in the water quality calculations.

Calculation Process for Water Quality Changes

The proposed Ridges Basin Reservoir was modeled using the Tennessee Valley Authority’s (TVA) Box Exchange Transport Temperature and Ecology of a Reservoir (BETTER) water quality simulation model. For periods of stratification, temperature, dissolved oxygen, nutrients (nitrogen and phosphorous), and algae biomass were estimated for three representative hydrologic conditions (dry, average, and wet years) that will be experienced by the reservoir. The chemistry of the reservoir was modeled using the Environmental Protection Agency’s, Metal Speciation Equilibrium Model for Surface and Ground Water (MINTEQA2), Version 3.11. The parameter concentration in the pumped inflow to the reservoir was based on the water quality data at four stations just upstream of the pumping plant location on the Animas River. The models were used to simulate the chemical conditions expected in the impounded water before distribution throughout the project.

Table 3-12
The Names of Extracted Objects Used for Calculating Mass and Water Balances

Animas River

Ridges Basin Reservoir
Ridges Basin Reservoir Evaporation
Ridges Basin Resort Return Flow
Animas Below Ridges Basin Local Inflow (releases)

Upper Diversions
Animas At Durango Pumping Plant Diversion
Durango MI Returns Diversion (Ridges Basin Pump)

Upper Return Flows
Durango MI Returns Return Flow (extracted a portion as Durango ALP M&I Return Flows)
Animas Below Ridges Basin Return Flow (ALP Florida)

Lower Diversions
ALP Animas Div Diversion (ALP Aztec)
ALP Ute Diversion

Lower Return Flows
ALP Animas Div Return Flow
ALP Ute Diversion Return Flow (ALP Aztec)

Flow Nodes
Animas Florida Confluence Inflow 1 (Animas Flow)
Animas Florida Confluence Inflow 2 (Florida Flow)
Animas Below Ridges Basin Return Flow
Florida Outflow (above two combined)
Animas Florida Confluence Outflow
Cedar Hill To Farmington Outflow
Animas At San Juan OutFlow

San Juan River

Diversions
ALP Archuleta To Farmington Diversion

Return Flows
ALP Archuleta To Farmington Outflow
Lagged RF_Fix_SJ Abv Farm Return Flow
ALP Amarillo Kirkland Gas Power Plant
Lagged RF_Fix_SJ Abv Ship

Flow Nodes
San Juan At Farmington OutFlow
San Juan At Shiprock OutFlow
San Juan At Stateline OutFlow
San Juan At Bluff OutFlow

Table 3-12 The Names of Extracted Objects Used for Calculating Mass And Water Balances (continued)
LaPlata River
<u>Upper Return Flow</u> none <u>Lower Return Flow</u> ALP LaPlata Return Flow <u>Flow Nodes</u> Hesperus To Stateline Outflow LaPlata At Confluence OutFlow
Mancos River
<u>Return Flow</u> ALP Mancos ReturnFlow <u>Flow Node</u> Mancos River OutFlow

The water quality measurements, along with the historic streamflow and model diversion and return flow data, were grouped by the river segments defined by each state. The diversion and return flow points in the Animas, LaPlata, Mancos and San Juan Rivers were arranged in a flow network so the diversions and return flows could be accumulated through the river system. The measured concentrations, the expected reservoir concentrations, the model diversions, the model return flows and the historic streamflows were inserted into the network. The mass transfer was simulated from the river into the reservoir, from the reservoir to the various use sites in the Florida, LaPlata, and Mancos drainage basins and from the reservoir back to the Animas River. The direct stream diversions and return flows along the Animas and San Juan Rivers were included in the network calculation.

For the purposes of this report, the following assumptions for this analysis were made:

- ❑ If the measured concentration of a parameter was at its detection limit, its concentration was set at one half of the concentration at the detection limit. This assumption allowed the computation of the changes in the mean concentrations of water quality parameters.

- ❑ Equation 1 describes the change in concentrations expected due to project operations. In this sense, Equation 1 represents only an approximate estimate, albeit a reasonable one when other flow changes are small relative to the modeled flows. Strictly speaking, the equation accounts only for ALP impacts on the water quality. Other minor changes in flow due to nonstructural alternatives or reoperation of Navajo Reservoir would impact water quality. Equation 1 was used because the other effects were indeterminate under Refined Alternative 4.

- ❑ The mass loads and the balance of diversions or return flows were calculated using monthly flows values. The hydrology model flows are monthly and the daily historic streamflows were combined into monthly values. Smaller time increments were not practical because the hydrology flows were modeled at monthly intervals.

- Missing monthly flows, both in the hydrology model output and in the historic streamflow, were filled with the mean monthly flows. The hydrology model computed flows from 1928-1993 and the water quality data were collected as late as early 1999. This was done to insure that the time period of water quality measurements was covered by a full data set of model flows.

- The parameter concentrations in the pumped reservoir inflow were calculated using 1980-1999 water quality data only. Due to reduction in mining activities upstream of Durango, this time period was thought to better represent the expected water quality of reservoir water under Refined Alternative 4. So, the water quality data were compiled from the 1980-1999 data collected on the Animas River at four sites denoted in Table 3-11 of water quality sites: the Red Lion Inn, the Pumping Plant Site, the Animas River below Durango, and the site at Durango Mall Bridge. The mean monthly concentrations or values for each regulated parameter were first calculated, then flow weighted by the pumped inflow and the annual mean computed. This averaged data set was used to simulate the Ridges Basin concentrations over the entire sampling interval. Due to the large storage volume relative to annual demand (approximately 2X), the reservoir will integrate monthly changes in water quality, making the long term flow-weighted mean appropriate for reservoir concentrations.

- The most conservative assumption for modeling purposes was taken that no parameter changed concentration in the reservoir other than by evaporation or by depletion due to the Ridges Basin Resort. Metals and nutrients would likely decrease in concentration within the reservoir. Due to the projected aerobic conditions in the reservoir, selenium concentrations would not change. Similarly chemical equilibrium models showed that concentrations of the regulated parameters would not change. So the water quality model was run assuming no decrease.

- The water quality was assumed not to change during distribution of water throughout the project. The distribution pipeline would be a closed system delivering water to each basin.

- Due to the expected surface return flow from Durango, from the Florida Mesa, and from the regional M&I uses, the change in return flow concentrations was only due to depletions at these locations, meaning at 50 percent depletion the parameter concentrations in the return flows were double those of the delivered water. Granted that this is a very simplifying assumption for M&I return flows, the potential concentrating effects observed in such return flows would be covered by this conservative assumption. For a portion of M&I return flows, the concentrating effects may be less than assumed. But the regional water use could be largely scattered rural domestic uses where septic tanks are in common use. A portion of municipal water is also used in maintaining landscapes. Industrial waste water may also contain unknown substances ignored in this water quality analysis. After weighing the various factors affecting M&I waste water, the depletion assumption was still viewed as a usable conservative assumption for calculation purposes.

- In the LaPlata River basin, the M&I return flow could enter the shallow groundwater. Reclamation collected seep and well data, which were presented in the Table 3-8. The measured concentrations of trace metals and selenium in seeps and shallow groundwater were close to the detection limit. The change in return flow concentrations, even within the shallow groundwater, is also assumed to be due only to depletions and not to leaching. With no leaching, the resulting concentration would be twice the inflow concentration.

- In the Mancos River basin, the bulk of the return flow comes from golf course irrigation. Some parameter concentrations are expected to increase due to leaching from the Mancos Canyon soils. For computational purposes, the parameter concentrations were set at the same concentrations as in the Mancos River averaged during the winter months December through March. This assumption ties the parameter concentrations to the base flow period and excludes the influence of surface irrigation runoff. The effect is to assign the water quality of the return flow from the project to that of the upstream irrigation.

- Due to the lack of field measurements of total-recoverable selenium in water, additional values were estimated in the New Mexico segments of the rivers. The ratio of concentrations of the total selenium and total-recoverable selenium were used in the calculations. The ratio were computed using measured total and total-recoverable values during the same time interval on each segment. Additional total-recoverable values were found by multiplying all total values measured on different days by the ratio. In this manner the number of total-recoverable values could be increased for New Mexico exceedence estimates. Although these estimated values are included in the table category as CALC SELENIUM TOTAL RECOVERABLE IN WATER AS SE (μG/L), the summary number also include the measured concentrations as well. The measured values varied in number from about 10 to 75 depending on the location. This lack of measured total recoverable selenium concentrations forced the use of this calculation.

- The exceedence criteria for each state are divided into chronic and acute standards based on the exposure time that aquatic wildlife experience. The chronic standard is often expressed as a four-day average and the acute standard as a one-hour average. Few of the observed water measurements in the STORET-Reclamation-BIA database were averaged over time nor were they collected on four consecutive days to separate the measurements into chronic or acute exposures. Hence, the measurements were taken individually and each tested on the chronic and the acute basis. Standards for each state contain wording that the exceedence concentrations should not be exceeded more often than once in every three years. Each state interprets the frequency of exceedence on an average basis for scattered single measurements. The Colorado and Utah standards specifically state that the occurrence frequency is to be the average occurrence. The New Mexico standard would require a strict interpretation of having no single sequence of events exceed the frequency standard if the data were collected for four consecutive days in evaluating actual compliance. When historical data are used that are not collected at that frequency, applying the frequency criteria as an average over the period of record is allowable. Therefore, the implication would be that an occasional exceedence might not be deemed significant depending on its average frequency.

- Calculation of mercury exceedences using historic concentration data is complicated by the fact that each state's exceedence standard is lower than the minimum detectable limit. Generally in computing exceedences all values measured as less than the detection limit are excluded from the analysis. After excluding the historic, nondetectable measurements of mercury from consideration, all the remaining measured values exceed the standard. Since these are the only values considered in subsequent water quality analysis, the number of mercury exceedences do not change. The constancy of mercury exceedences under any alternative in this analysis is an artifact of these assumptions

Statistics were computed for the measured concentrations of the regulated water quality parameters in the defined river segments. Exceedences were also calculated using the measured data. The water quality model was run routing the water and parameter mass loads through the river and distribution system network. The new concentrations of the parameters were calculated using Equation 1 from the accumulated mass loadings and water balance components. The new concentrations were arranged by river segments. New statistics and exceedences were then recalculated. The results were compared with the statistics of the original measured data to determine the project impact on the water quality of the lower San Juan River system. This was the method used to assess the impact of Refined Alternative 4 on the rivers.

For Refined Alternative 6, the methodology was simplified. Under this alternative the various river segments were compared against the historic conditions and those of Refined Alternative 4. Refined Alternative 6 appeared to lie somewhere in between the two sets of conditions. The net impacts were developed using the flow and water quality changes and not on as rigorous basis as for Refined Alternative 4. So the impact analysis was carried out using the historic and Refined Alternative 4 conditions as the extremes.

Significance Criteria

According to each state's regulations the significance of impacts on surface water quality must be based on the number of exceedences for that parameter. Past water quality data show many exceedences. In this study the criteria were used in each river segment to recalculate exceedences under Refined Alternative 4 and to show the changes relative to the concentrations measured in the past. The exceedence criteria for each state are divided into chronic and acute standards based on the exposure time that aquatic wildlife experience. The chronic standard is often expressed as four-day average and the acute standard as one-hour average. Few of the observed water measurements in the STORET-Reclamation-BIA database were averaged over time nor were they collected on four consecutive days to separate the measurements into chronic or acute exposures. Hence , the measurements were taken individually and each tested on the chronic and the acute basis. Standards for each state contain wording that the exceedence concentrations should not be exceeded more often than once in every three years.

Impacts from Refined Alternative 4

Construction Related Impacts

Ridges Basin Reservoir

The main water quality concerns during construction of the reservoir would be resuspension of sediment in Basin Creek. Sediment could arise also from storm runoff during this construction period. The best management practices would be implemented to maximize sediment control. Temporary cofferdams/berms would be used to contain fine materials and placement of fill material during periods of low water flows in Basin Creek.

Durango Pumping Plant

Construction of the pumping plant and its intake bays would temporarily disturb the bank material which could increase the suspended load in the Animas River. In addition, groundwater removed during construction dewatering would need disposal. From the site characterization report (Reclamation, 1990) the groundwater flow rate would be tens of gallons per minute. The contractor for Durango Pumping Plant would be required to secure a discharge permit from the appropriate regulatory entity in the Colorado Department of Health for construction activities at the site. A regular monitoring of the water removed during dewatering operations would be required. A contingency plan would be created for treating the water removed during excavation in the event that groundwater contamination levels exceed anticipated limits.

Navajo Nation Municipal Pipeline

The major water quality impact during the installation of this pipeline would be the two siphons across the San Juan River - one near Farmington and the other near the Hogback. Measures would be implemented to time construction activity to coincide with periods of low flow, and measures to capture sediment would be employed. The duration of placement of fill materials would be minimized to as short a period of time as practicable to reduce the duration of turbidity. Stockpiles of fill materials would be placed above ordinary high water marks and protected by measures to prevent erosion of those materials into the San Juan River. Silt screens or other appropriate methods could be used to confine the suspended particulates and turbidity to small areas where settling or removal can occur.

In addition to the siphon installation, the pipeline would cross various small washes which might have flowing water. Again the impact would be mainly sediment control. Measures similar to those used on the siphon crossing would be implemented. Temporary cofferdams/berms would be used to contain fine materials and placement of fill material during periods of low water flows in the washes.

Non-binding Conveyance Pipelines

Installation of siphons across the LaPlata and the Mancos Rivers could temporarily increase the suspended sediment loads. These impacts would be expected only at the river crossings and not along the pipeline routes. Proper sediment controls as discussed for the Navajo Nation Municipal Pipeline would be used to minimize the impacts of disturbing bank and bed materials at these locations.

Operation Related Impacts

Pine River

The purchase of 2,300 acres of irrigated land with the water remaining on the land in the same use will have no impact on water quality for Refined Alternative 4.

Navajo Reservoir

The change in operational levels in Navajo Reservoir are small and there are no changes in inflow. The impacts to water quality in Navajo Reservoir are insignificant.

Ridges Basin Reservoir

In Appendix B (Reclamation, 1996), the scenario for filling Ridges Basin Reservoir surmised that nutrient enrichment and recycling might occur during the first few years of operation. The possible leaching of trace metals from soils inundated by rising reservoir water were also considered. Based on soil extract studies, upper limiting concentrations were projected, but were discounted due to large dilution factors expected in the reservoir. This study shows similar results. Based on the soil chemistry studies (Reclamation, undated), the mean selenium concentration in 31 extracts was 7.3 µg/l. Assuming on filling that (1) the reservoir bottom soils were saturated and (2) the selenium in the first foot of soil pore water were mixed with incoming reservoir water, the selenium content would increase by 0.2 µg/l in a reservoir volume of 20,000 AF. The change in concentration would be undetectable.

The major contributor of trace metals to the reservoir would be the Animas River. The mean concentrations expected in Ridges Basin Reservoir for 1990-1999 are shown in Table 3-13. The trace metal concentrations were modeled in the reservoir using 1990-1995 water quality data. The old selenium concentration of 2.5 μg/l would be replaced by 1.0 μg/l under this study. The subsequent sampled concentration for the other trace metals have changed only slightly, so their conclusions on the reservoir loadings would be the same. The conclusions of the outflow concentrations in the 1996 Appendix are unchanged except that selenium would be even lower. However for calculation purposes in this study, the trace metal concentrations leaving the reservoir were assumed to be same the input concentrations. No reductions were considered.

Chemical equilibrium modeling, using MINTEQA2, of the reservoir under all temperature and oxygen conditions showed that the trace elements, except iron, manganese and mercury, would remain in solution. Among the parameters of most concern are selenium and mercury. Table 3-14 contains a summary of an equilibrium run at 5ºC.

Table 3-13
Ridges Basin Reservoir - Historic Water Quality Measurements on the Animas River

Parameter	mean
Alkalinity Total (mg/l as CaCO3)	
Aluminum Dissolved (µg/l as Al)	
Aluminum Total (µg/l as Al)	
Arsenic Dissolved (µg/l as As)	5.7
Arsenic Total (µg/l as As)	13.7
Boron Dissolved (µg/l as B)	57.2
Cadmium Dissolved (µg/l as Cd)	0.2
Cadmium Total (µg/l as Cd)	0.6
Calcium Dissolved (mg/l as Ca)	56.9
Calcium Total (mg/l as Ca)	
Chloride Total in Water (mg/l)	13.8
Chromium Dissolved (µg/l as Cr)	2.7
Chromium Total (µg/l as Cr)	6.0
Cobalt Dissolved (µg/l as Co)	
Cobalt Total (µg/l as Co)	
Copper Dissolved (µg/l as Cu)	4.2
Copper Total (µg/l as Cu)	14.6
Hardness Calc. (mg/l as CaCO3)	179
Hardness Total (mg/l as CaCO3)	
Iron Dissolved (µg/l as Fe)	46.8
Iron Total (µg/l as Fe)	531.1
Lead Dissolved (µg/l as Pb)	2.0
Lead Total (µg/l as Pb)	18.6
Magnesium Dissolved (mg/l as Mg)	8.9
Magnesium Total (mg/l as Mg)	
Manganese Dissolved (µg/l as Mn)	99.3
Manganese Total (µg/l as Mn)	157.8
Mercury Dissolved (µg/l as Hg)	0.10
Mercury Total (µg/l as Hg)	0.16
Nickel Dissolved (µg/l as Ni)	2.7
Nickel Total (µg/l as Ni)	6.0
Nitrite + Nitrate Total (mg/l as N)	0.9
Oxygen Dissolved (mg/l)	
pH Lab (Standard Units)	7.9
pH Field (Standard Units)	7.51
Phosphorus Total (mg/l as P)	
Residue Total Filtrable (Dried at 180ºC) mg/l	
Selenium Dissolved (µg/l as Se)	0.8
Selenium Total (µg/l as Se)	1.0
Selenium Total Recoverable in Water as Se µg/l	0.9
Silver Dissolved (µg/l as Ag)	0.10
Silver Total (µg/l as Ag)	0.13
Sodium Dissolved (mg/l as Na)	
Sodium Total (mg/l as Na)	
Solids Susp.-residue on Evap. At 180ºC (mg/l)	258
Specific Conductance (µmhos/cm @ 25ºC)	
Sulfate Total (mg/l as SO4)	
Temperature Water (ºC)	12.0
Zinc Dissolved (µg/l as Zn)	25.9
Zinc Total (µg/l as Zn)	93.8

Table 3-14
Ridges Basin Reservoir - Chemical Equilibrium Simulation

Combined data from four water quality stations

Temperature (Celsius): 5.00
Units of concentration: MG/L
Ionic strength to be computed.
Carbonate concentration represents carbonate alkalinity.
Do not automatically terminate if charge imbalance exceeds 30%
Precipitation is allowed for all solids in the thermodynamic database and the print option for solids is set to: 1
The maximum number of iterations is: 100
The method used to compute activity coefficients is: Davies equation

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
761	HSeO3-1	3.004E-22	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.985E-03	100.0	0.000E-01	0.0	7.878E-08	0.0
150	Ca+2	1.659E-03	100.0	0.000E-01	0.0	6.234E-07	0.0
280	Fe+2	3.444E-24	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.320E-04	100.0	0.000E-01	0.0	9.454E-09	0.0
20	Ag+1	9.273E-10	100.0	0.000E-01	0.0	0.000E-01	0.0
410	K+1	7.162E-05	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	7.222E-04	100.0	0.000E-01	0.0	2.363E-08	0.0
950	Zn+2	3.825E-07	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	8.066E-07	100.0	0.000E-01	0.0	0.000E-01	0.0
580	PO4-3	8.282E-10	0.3	0.000E-01	0.0	3.151E-07	99.7
732	SO4-2	1.728E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
540	Ni+2	5.111E-08	100.0	0.000E-01	0.0	0.000E-01	0.0
210	Cr+2	5.386E-08	100.0	0.000E-01	0.0	0.000E-01	0.0
231	Cu+2	6.296E-08	100.0	0.000E-01	0.0	0.000E-01	0.0
600	Pb+2	9.655E-09	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	4.766E-04	100.0	0.000E-01	0.0	2.265E-07	0.0
762	SeO4-2	7.696E-09	100.0	0.000E-01	0.0	0.000E-01	0.0
281	Fe+3	1.733E-13	0.0	0.000E-01	0.0	7.523E-07	100.0
2	H2O	1.612E-07	100.0	0.000E-01	0.0	0.000E-01	0.0
470	Mn+2	9.401E-19	100.0	0.000E-01	0.0	0.000E-01	0.0
471	Mn+3	6.253E-28	0.0	0.000E-01	0.0	1.711E-06	100.0
1	E-1	6.570E-14	100.0	0.000E-01	0.0	0.000E-01	0.0
330	H+1	3.112E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
360	Hg2+2	6.380E-13	0.2	0.000E-01	0.0	3.983E-10	99.8
270	F-1	5.775E-05	99.7	0.000E-01	0.0	1.628E-07	0.3

Charge Balance: SPECIATED

Sum of CATIONS = 4.889E-03 Sum of ANIONS 3.651E-03

PERCENT DIFFERENCE = 1.450E+01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

NON-CARBONATE ALKALINITY = 4.301E-08

EQUILIBRIUM IONIC STRENGTH (m) = 6.454E-03

EQUILIBRIUM pH = 7.530

EQUILIBRIUM pe = 14.807 or Eh = 817.18 mv

Saturation indices and stoichiometry of minerals which have precipitated

ID #	NAME	Sat. Index	Stoichiometry in [brackets]
4128100	FEOH)2.7CL.3	0.000	[-2.700] H+1 [1.000] Fe+3 [2.700] H2O
7015002	FCO3APATITE	0.000	[9.496] Ca+2 [0.360] Na+1 [0.144] Mg+2 [4.800] PO4-3 [1.200] CO3-2 [2.480] F-1
2047000	PYROLUSITE	0.000	[-4.000] H+1 [-1.000] 1 [1.000] Mn+3 [2.000] H2O
4136000	Calomel	0.000	[1.000] Hg2+2 [2.000] Cl-1

The equilibrium modeling of the selenium in the pumped inflow showed that selenium would remain as selenate, neither change chemical forms nor be removed from solution, during reservoir operation. At equilibrium, the total selenium concentration in the reservoir would approach the mean value, 1.0 μg/l, of measurements taken in the Animas River at Durango. At chemical equilibrium, the total mercury concentration would be 0.00013 μg/l (6.380E-13 mol/Kg). Even though iron, manganese and mercury would precipitate from solution, their measured dissolved or total concentrations were assumed to be unchanged to calculate the potential maximum water quality impacts to all affected streams.

During the first few years the reservoir would be filled without large withdrawals until the structural components are built. The BETTER model showed that after the first year, nutrient recycling was minimal under all precipitation and evaporation scenarios tested for a static reservoir without withdrawals. **Tables 15** and **16** summarize the initial conditions and the simulation results for such reservoir conditions.
No phase or chemical changes, other than iron, manganese and mercury precipitation, were found using MINTEQA2 with up to 20% evaporation losses from the static reservoir. The temperature of the water leaving the reservoir would affect the temperature of the Animas River below Basin Creek. The net water quality result of keeping the reservoir full with no withdrawals would be an inactive system with nutrient poor conditions and unchanging chemistry.

Once the reservoir become fully operational, BETTER was used to model the nutrient recycling, temperature structure and oxygen concentrations. The model showed that the reservoir would remain aerobic at all reservoir stages and pumping conditions. The water temperature in the deep reservoir was predicted to vary from 3°to 12°C depending on the reservoir stage and the time of year. Table 3-17 summarizes the results of these simulations for dry, average, and wet years.

The temperature of the water leaving the reservoir would affect the temperature of the Animas River below Basin Creek. The net water quality result of keeping the reservoir full with no withdrawals would be an inactive system with nutrient poor conditions and unchanging chemistry.

Table 3-15
Initial Conditions for Three-Year Simulation of Reservoir with No Withdrawals*

	Year 1	Year 2	Year 3
Reservoir Elevation (ft)	6881.3	6881.3	6881.3
Temperature (°C)	4.30	3.32	3.31
Suspended Solids (mg/L)	33.90	0.55	0.00
Dissolved Oxygen (mg/L)	11.10	11.57	12.20
pH (SU)	7.60	8.48	8.59
Alkalinity (mg/L)	129	133	137
Algae (mg/L)	2.00	0.043	0.047
Detritus (mg/L)	0.50	0.00	0.00
Dissolved Organics (mg/L)	0.002	0.002	0.002
Ammonia (mg/L)	0.85	0.031	0.020
Nitrate+Nitrite (mg/L)	0.01	0.95	1.00
Dissolved Phosphorus (mg/L)	0.005	0.02	0.02
Dye (mg/L)	0	0	0

**Initial conditions were calculated from the previous year end value. Initial conditions for Year 1 were from the first modeling run. Daily water quality inputs (to compensate for evaporation loss only) were set at Animas River*

Table 3-16
Summary of Simulation Results with No Reservoir Withdrawals

	EPILIMNION	METALIMNION	HYPOLIMNION
YEAR 1			
Epilimnetic Range (ft)	0-25	26-50	51-175
Temperature (°C)	19.7	6.3	4.84
Total Suspended Solids (mg/L)	0.5	1	4.8
Dissolved Organics (mg/L)	0	0	0
Detritus (mg/L)	0	0	0
Ammonia (mg/L)	0.055	0.050	0.156
Nitrate (mg/L)	0.890	0.900	0.792
Orthophosphorus (mg/L)	0.01	0.02	0.02
Algae (mg/L)	0.665	0.08	0.012
BOD (mg/L)	0.805	0.04	0.04
pH (SU)	8.42	8.17	8.13
Alkalinity (mg/L)	131	129	129
Dissolved Oxygen (mg/L)	6.7	8.8	8.2
YEAR 2			
Epilimnetic Range (ft)	0-25	26-50	51-175
Temperature (°C)	19.75	6.3	4.62
Total Suspended Solids (mg/L)	0	0	0
Dissolved Organics (mg/L)	0	0	0
Detritus (mg/L)	0	0	0
Ammonia (mg/L)	0.065	0.010	0.010
Nitrate (mg/L)	0.915	0.990	0.980
Orthophosphorus (mg/L)	0.02	0.02	0.02
Algae (mg/L)	0.75	0.09	0.004
BOD (mg/L)	0.91	0.03	0
pH (SU)	8.45	8.48	8.53
Alkalinity (mg/L)	135	133	133
Dissolved Oxygen (mg/L)	6.7	11.7	11.5
YEAR 3			
Epilimnetic Range (ft)	0-25	26-50	51-175
Temperature (°C)	19.75	6.3	4.62
Total Suspended Solids (mg/L)	0	0	0
Dissolved Organics (mg/L)	0	0	0
Detritus (mg/L)	0	0	0
Ammonia (mg/L)	0.065	0.010	0.008
Nitrate (mg/L)	0.955	1.030	1.020
Orthophosphorus (mg/L)	0.02	0.02	0.02
Algae (mg/L)	0.75	0.09	0.004
BOD (mg/L)	0.91	0.03	0
pH (SU)	8.47	8.50	8.57
Alkalinity (mg/L)	139	137	137
Dissolved Oxygen (mg/L)	6.7	11.8	11.5

Table 3-17 Summary of Simulated Water Quality Conditions in a Dry(1981), Average (1991) and Wet 1983) Year			
	Epilimnion	**Metalimnion**	**Hypolimnion**
YEAR: 1981 (dry)			
Limnotic Range (feet)	0-25	26-75	76-125
Temperature (°C)	22.5	19.8	17.5
Dissolved Oxygen (mg/L)	6.70	4.30	2.40
Algal Biomass (mg/L) (1)	0.561		
YEAR: 1991 (average)			
Limnotic Range (feet)	0-25	26-100	101-150
Temperature (°C)	21.7	14.0	9.4
Dissolved Oxygen (mg/L)	7.05	6.95	6.80
Algal Biomass (mg/L) (1)	0.407		
YEAR: 1983 (wet)			
Limnotic Range (feet)	0-25	26-100	101-175
Temperature (°C)	21.2	12.6	8.2
Dissolved Oxygen (mg/L)	7.85	7.75	7.55
Algal Biomass (mg/L) (1)	0.137		

(1) *Summer Epilimnitic average (June 1 to September 1)*

The profiles predicted by BETTER for dissolved oxygen and temperature are shown in **Figure 7** through **Figure 9**. The vertical profiles for dissolved oxygen and temperature are shown on September 1 for the three different years representing the dry, average and wet conditions.

The annual cyclic change in a 120,000 AF reservoir for both oxygen and temperature was simulated for each condition. **Figures 10**, **11** and **12** show the changes in the dissolved oxygen concentration in the surface and hypolimnion. In these figures two minima in the oxygen concentrations can be seen during the late winter and late summer or early fall. The lowest oxygen concentration, 2.4 mg/l, occur in the late summer during the dry year. The lower initial reservoir volumes in dry years is thought to be the major reason for the low oxygen concentration. During average or wet years, the dissolved oxygen was higher than in the dry year.

Figures 13, **14**, and **15** show the changes in temperature in the surface and hypolimnion of the Ridges Basin Reservoir. The surface water temperature follows very similar cycles independent of reservoir content. The sublimnion temperature would be cooler during wet years with increased reservoir content. The results of the simulation modeling indicate that in dry years, the proposed reservoir will experience mesotrophic to eutrophic conditions with low oxygen concentrations and warm temperatures in the bottom

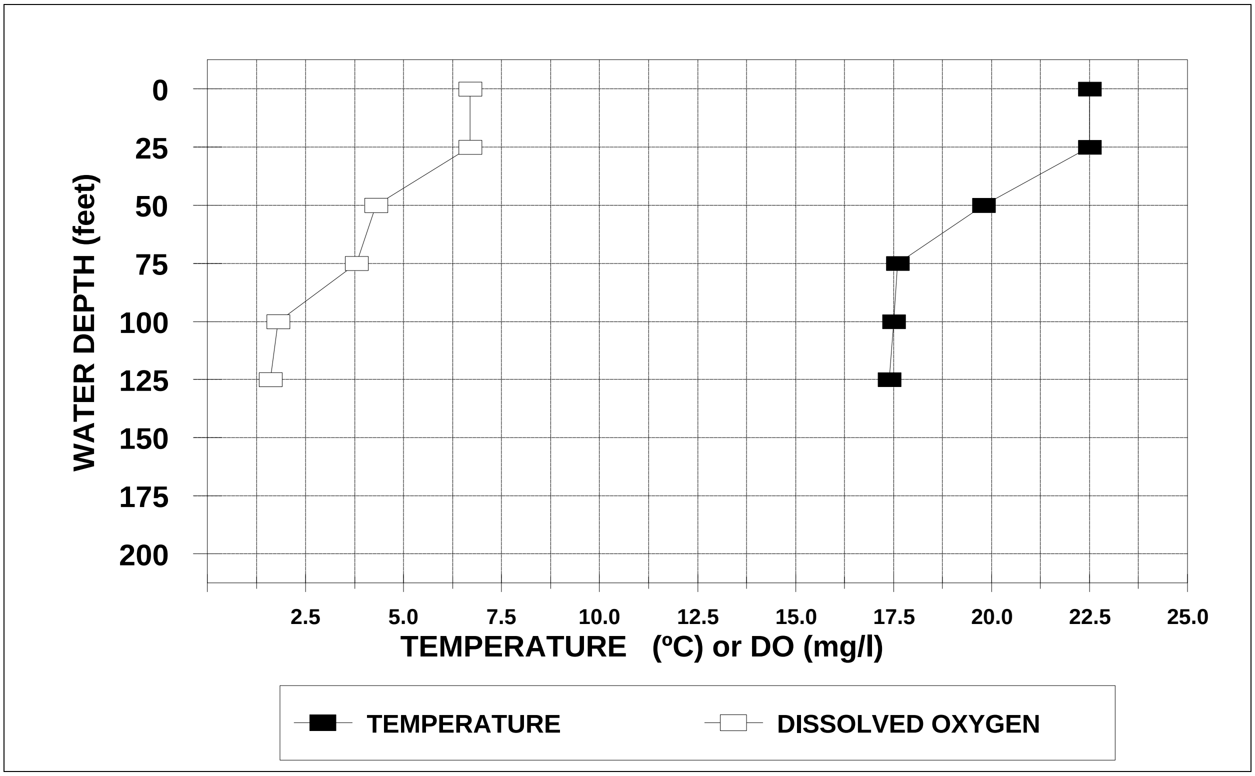


Figure 7. **Oxygen and Temperature Profiles in Ridges Basin Reservoir Simulated for a Dry Year**

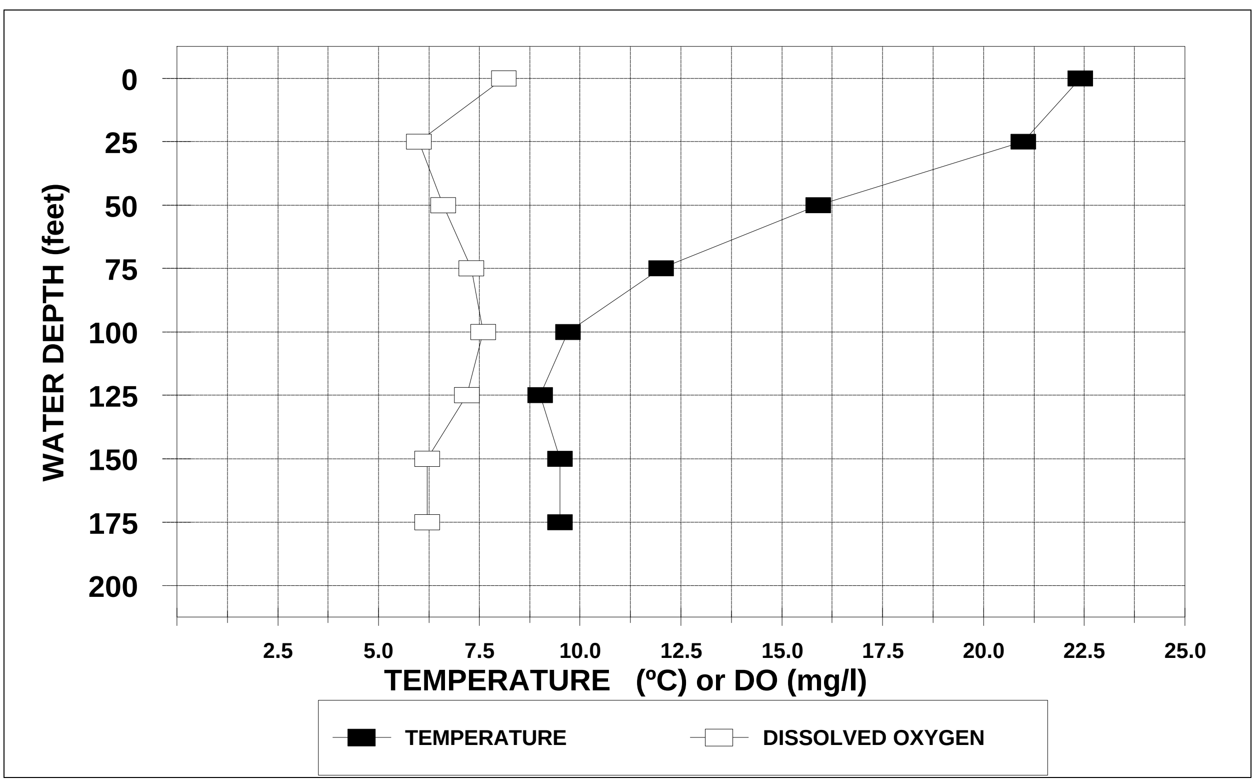


Figure 8. **Oxygen and Temperature Profiles in Ridges Basin Reservoir Simulated for an Average Year**

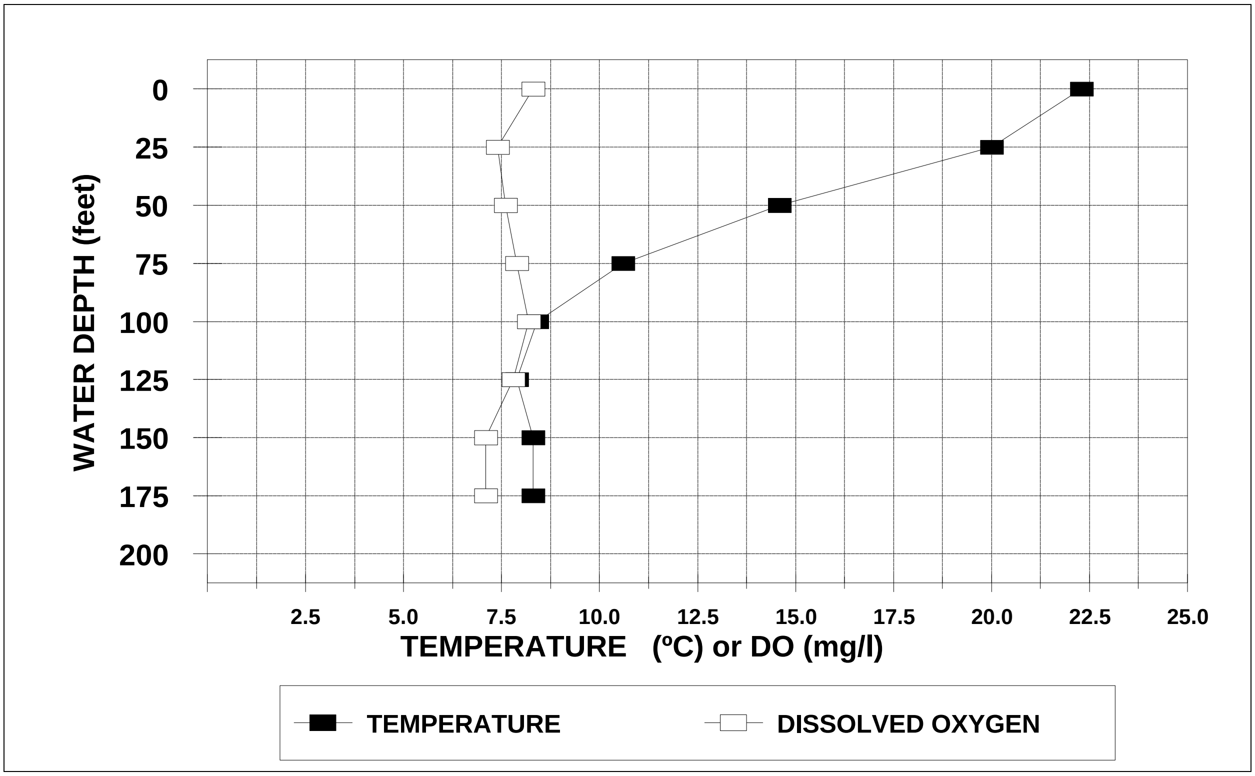


Figure 9. Oxygen and Temperature Profiles in Ridges Basin Reservoir Simulated for a Wet Year

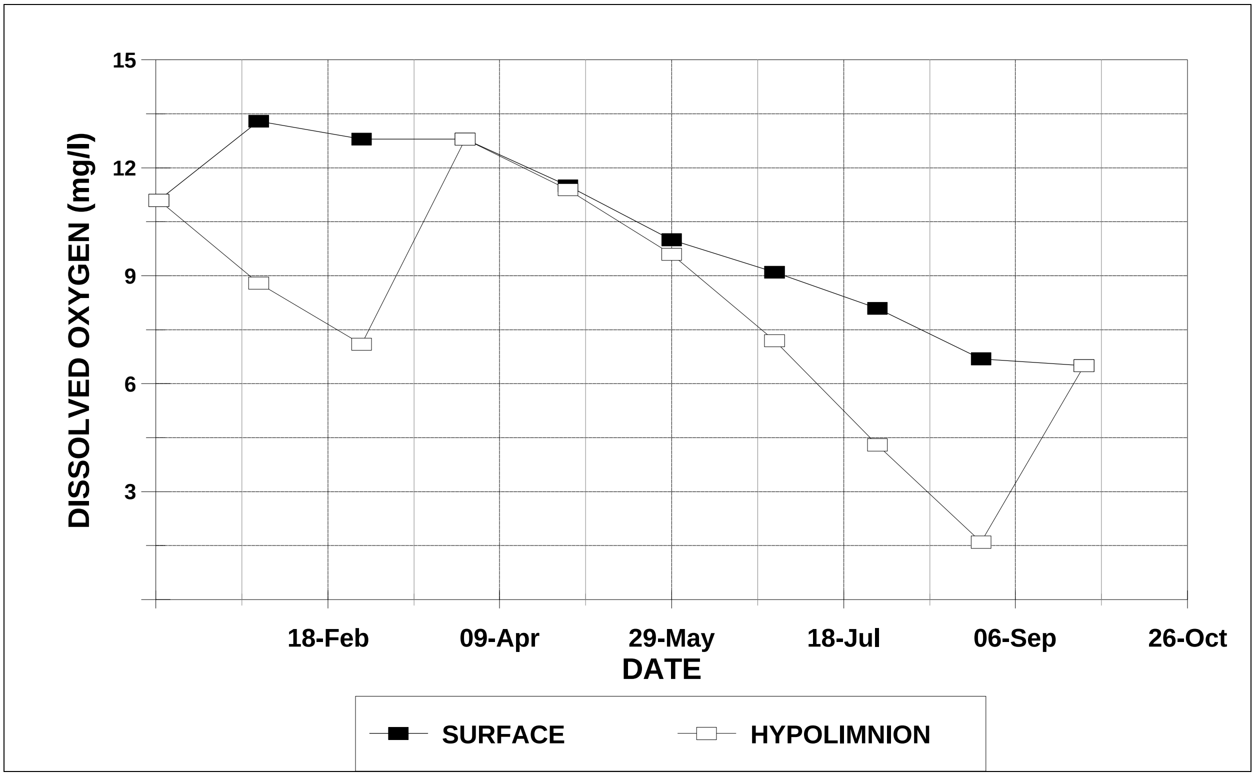


Figure 10. Simulated Oxygen Concentrations in Ridges Basin Reservoir with Time for a Dry Year

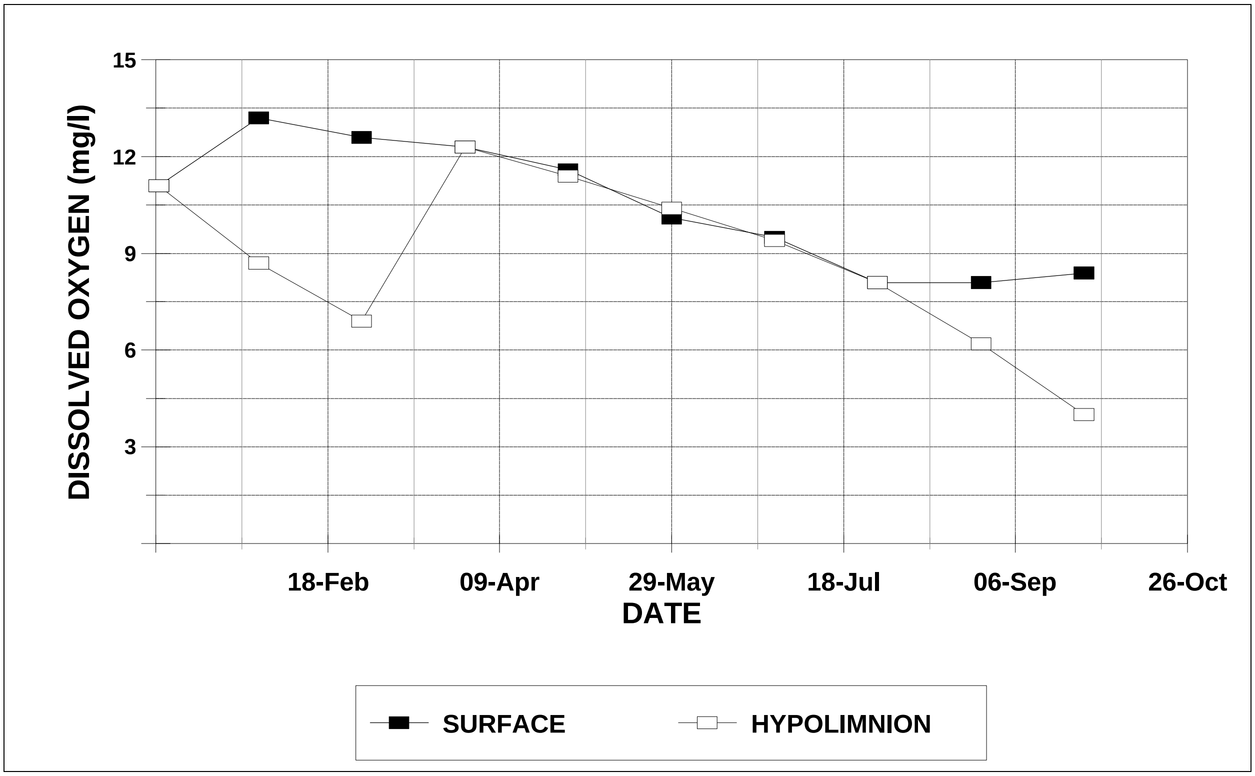


Figure 11. Simulated Oxygen Concentrations in Ridges Basin Reservoir with Time for an Average Year

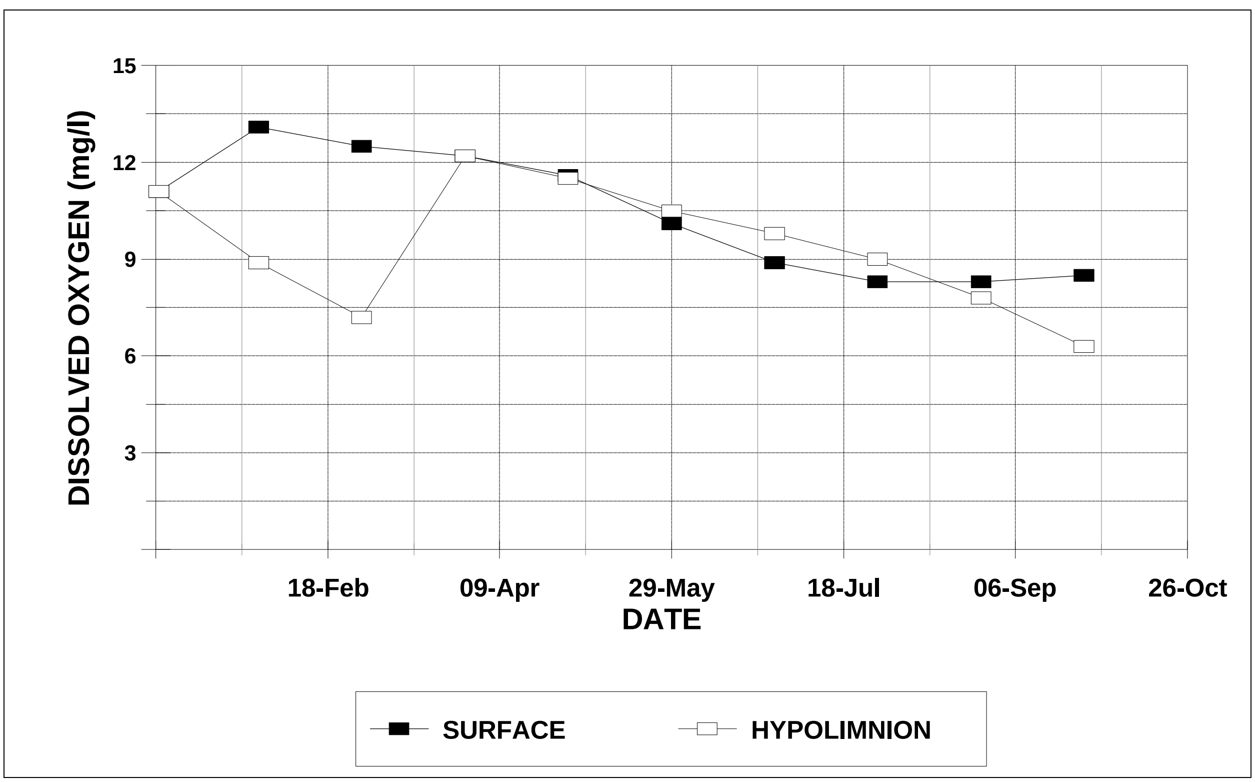


Figure 12. Simulated Oxygen Concentrations in Ridges Basin Reservoir with Time for a Wet Year

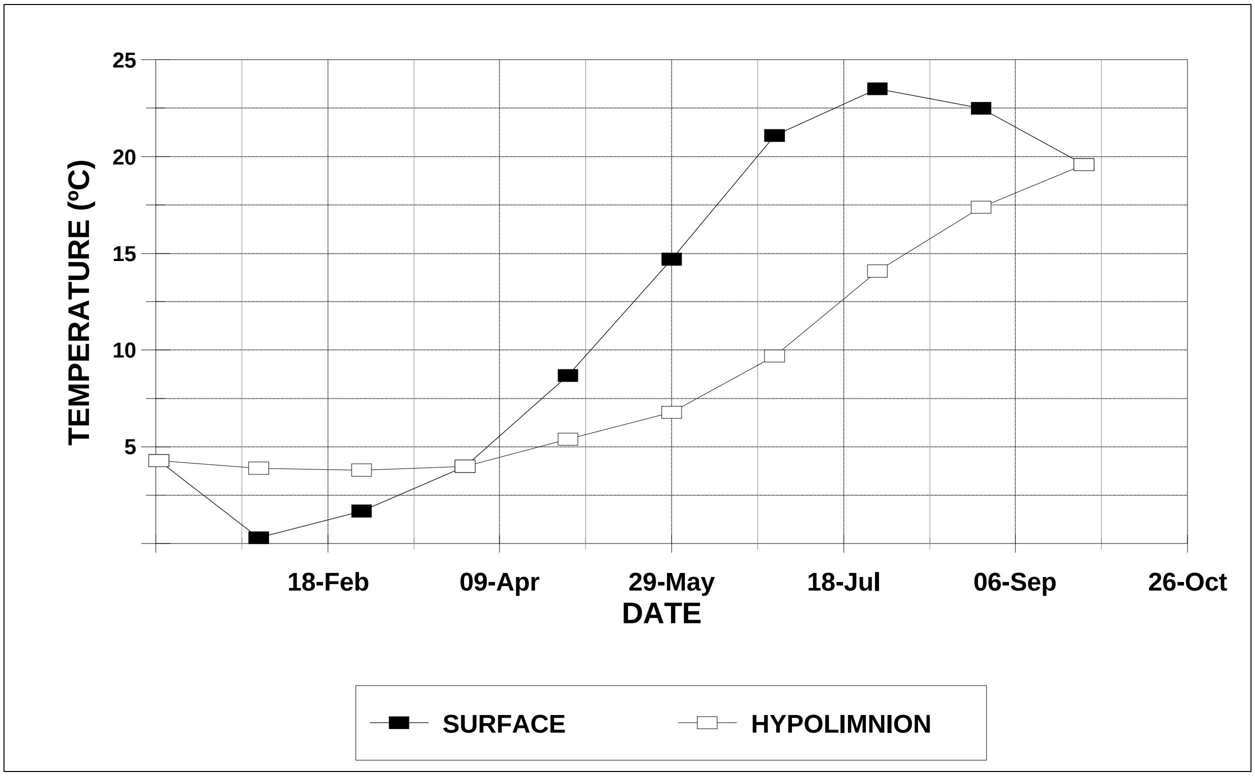


Figure 13. Simulated Temperatures in Ridges Basin Reservoir with Time for a Dry Year

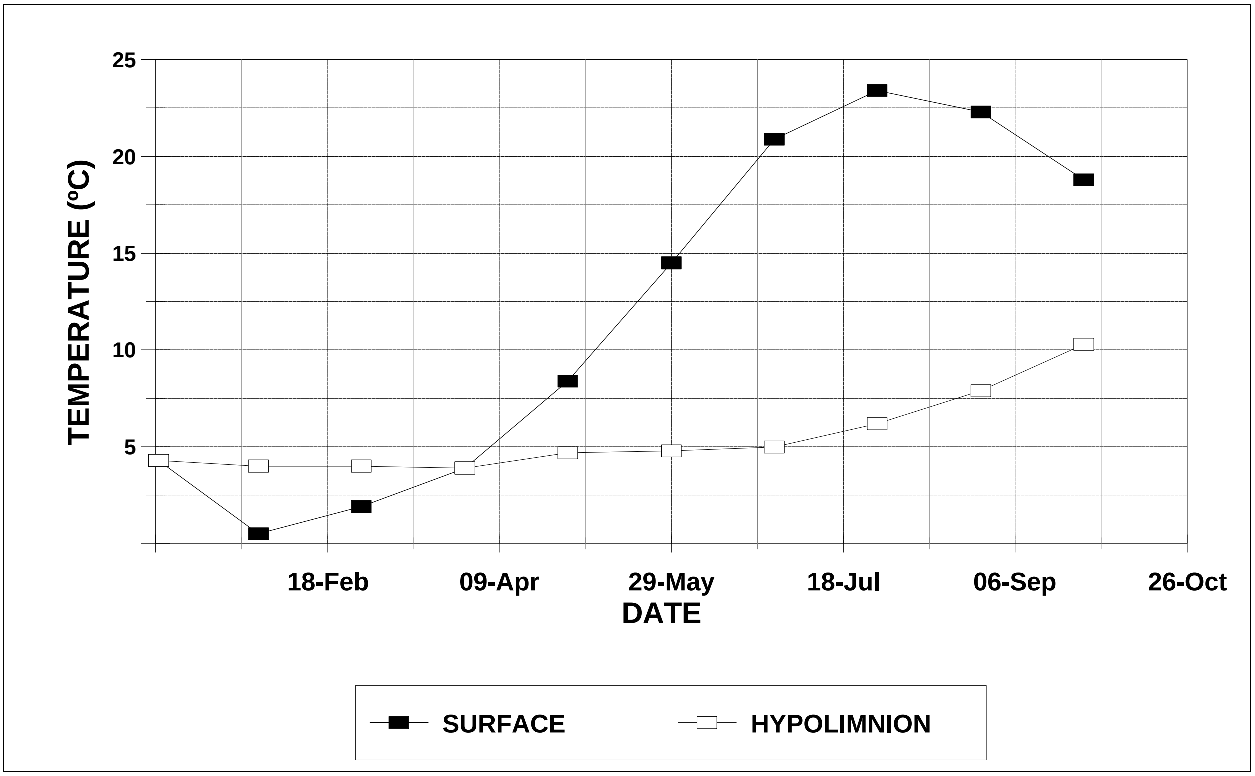


Figure 14. Simulated Temperatures in Ridges Basin Reservoir with Time for an Average Year

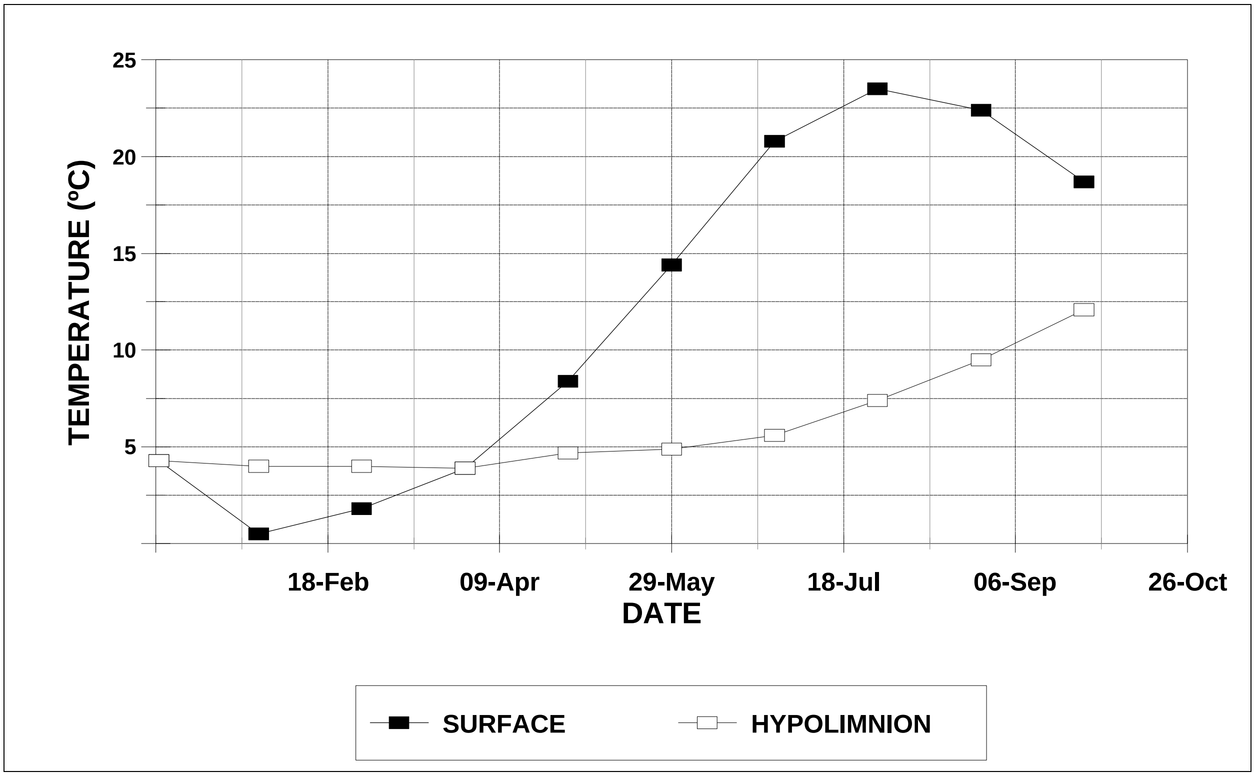


Figure 15. Simulated Temperatures in Ridges Basin Reservoir with Time for a Wet Year

of the reservoir. During average and wet conditions, bottom reservoir conditions improve with more oxygen and cooler water. Algal productivity will also be greater in dry years compared to average or wet conditions.

The implication of mercury concentration in Ridges Basin Reservoir was discussed in Appendix B of the 1996 FSFES (Reclamation, 1996). The conclusion at the time was that resultant mercury concentrations in fish in the reservoir would be similar to that in Ridgeway Reservoir on the Uncompaghre River with a maximum concentration in fish of 0.2 mg/kg. The Uncompaghre was described as having similar water quality to that of the Animas River.

Inflow mercury concentrations are lower for Ridges Basin Reservoir than for McPhee Reservoir. In addition, removal of vegetation from the basin and the low nutrient loading will reduce the potential for methylation of mercury relative to McPhee Reservoir by reducing the carbon source for methylating bacteria. Therefore, the mercury concentration in fish taken from Ridges Basin will likely be lower than in those from McPhee Reservoir.

Recent data on mercury levels in fish taken from Farmington Reservoir, summarized in Table 3-18, indicated levels similar to those in McPhee Reservoir. Although Farmington Reservoir receives its water supply from the Animas River, the inflow point is much lower in the system than that proposed for Ridges Basin Reservoir. There is substantial irrigation return flow above this point, increasing the nutrient load. Farmington Reservoir is algae rich, unlike projections for Ridges Basin Reservoir, providing ample carbon

Table 3-18 Mercury Content of Fish Collected in Farmington Reservoir	
Species	**mercury (mg/kg, dry wt)**
Carp (group)	0.42
Carp (single adult)	0.37
Channel Catfish (single adult)	0.53
Channel Catfish (group- subadult)	0.71
White Bass (adult)	0.92
Rainbow Trout (adult)	0.74
Bluegill (adult)	0.50
Large Mouth Bass (subadult)	0.48

source for methylating bacteria. Mercury levels in fish in Ridges Basin are, therefore, not expected to be as high as those in fish from Farmington Reservoir. None of the recent data contradict the conclusions in the 1996 FSFES.

Other impacts to the reservoir would come from return flows from the resort located in the reservoir drainage area. These could include fertilizer nutrients and herbicides from the golf course. Given the small area of the golf course and typical quantities of fertilizer used, it would not be possible for this impact to be measurable. Pesticide impact is also expected to be negligible based on the results of testing completed in the San Juan River where historic pesticide use has been much greater than the use would be for the Golf Course with no associated concerns in the reservoir. Also the temperature of the water leaving the reservoir could affect the temperature of the Animas River below Basin Creek which is discussed under the Animas River impacts.

Florida River

Under Refined Alternative 4 water would be imported into the Florida Basin from the Animas. The Florida River would then in turn be affected downstream of any M&I return flows.

Animas and Florida Rivers

The water quality of the Animas River would be impacted beginning at the Ridges Basin pumping plant downstream of the City of Durango. Any releases from the reservoir, M&I returns flows from Durango and M&I returns via the Florida River would affect downstream water quality in the Animas River. Under Refined Alternative 4 water would be imported into the Florida Basin from the Animas. The Florida River would then in turn be affected downstream of any M&I return flows. Further diversions and return flow between Aztec and Farmington, New Mexico would propagate changes downstream in the Animas River and into the San Juan River.

Colorado Segments of the Animas River

The nonstructural components on the Animas and Florida Rivers would consist of land purchases. The purchase of 2,300 acres of land in these basins is expected to yield 3,250 AF of depletion. But the water will be left on the land, no impact to water quality is expected.

Under Refined Alternative 4, permanent impacts to water quality in this river reach would arise from pumping into and releases from Ridges Basin Reservoir, M&I return flows from the City of Durango, the Florida Mesa and the Animas River housing unit. The M&I return flows are assumed to be treated with the usual waste water processes and would re-enter the river system as surface return flows. The regional water supplies would be conveyed throughout diffuse areas and some of the return flow would enter the shallow groundwater. Since there is a lack of information about the locations of use and the composition of the shallow groundwater in both the Durango and Florida regions, the changes in the water quality of the return flow in those areas are unknown. In the LaPlata region there are shallow groundwater quality data (1996 FSFES, Appendix B) which show that concentrations of most parameters are near the detection limits. Hence, the composition of groundwater return flow was assumed unchanged from the water conveyed from Ridges Basin, except for the concentrating effect of water depletion.

Table 3-19 presents the measurable increases for the Colorado portion of the Animas River. Various trace metals showed measurable increases in the overall mean concentration. These tended to increase during months with low flow. These periods were later summer into winter. However total iron increased all months. Arsenic increased during the summer months. Measurable changes had tendency to occur during the low 10-percentile flow years.

The changes in exceedence values for the Colorado portion of the Animas River are shown in **Table 20**. The number of exceedences of most parameters was unchanged. The water quality impact would increase in the exceedence of cadmium and copper (chronic - Colorado Public Health, 1998) by two instances each, of iron (chronic) by one instance. These exceedences would have occurred in 35 years of sampling and would meet the criteria of no more than once in three years on average. Every measurement of mercury above the detection limit exceeds the numeric acute standard for the historical and projected conditions, so no impact can be determined. Exceedences for silver (chronic) would decrease. The diversions and return flows in this river reach would have little net impact on the water quality.

In Refined Alternative 4, water from Ridges Basin Reservoir would be released down Basin Creek. The impact on water temperature in the Animas River immediately below the confluence with Basin Creek is shown in Table 3-21. The outflow temperature is assumed to be the same as the San Juan River at Archuleta, below Navajo Reservoir. This is considered a reasonable approximation given the flow distance, comparative size of the channel and the expected beginning temperatures. On average, the temperature in the Animas River would be depressed by about 0.3 ˚C, with the greatest predicted depression being 2.2 ˚C in late summer when the flows are low in the Animas River. This small temperature effect would likely be mitigated by atmospheric warming within 20 miles of the confluence with Basin Creek.

Table 3-19
Calculated Measurable Increases for Colorado Portion of the Animas River

Parameter	Means		Measurable Increase		
	Observed	Calculated w/ALP	means	by month	by flow intervals
OXYGEN DISSOLVED MG/L	9.02	9.02	no		
PH LAB & FIELD STANDARD UNITS	7.78	7.78	no		
FECAL COLIFORMS MEMBR FILTER	91	91	no		
AMMONIA UNIONIZED (MG/L AS N)	0.004	0.004	no		
BORON DISSOLVED (µG/L AS B)	103.2	114.2	yes		
CHLORIDE DISSOLVED IN WATER MG/L	8.8	8.9	no	Aug-Dec	
SULFATE DISSOLVED (MG/L AS SO4)	66.8	67.7	no	Aug-Dec	
ARSENIC DISSOLVED (µG/L AS AS)	10.0	10.4	no	Feb-Apr Jul-Dec	
ARSENIC TOTAL (µG/L AS AS)	28.8	29.9	no	Apr-Sep	
CADMIUM DISSOLVED (µG/L AS CD)	0.31	0.33	no		
CHROMIUM DISSOLVED (µG/L AS CR)	4.3	4.4	no		
CHROMIUM TOTAL (µG/L AS CR)	4.0	4.1	no		
CHROMIUM TOTAL RECOVERABLE IN WATER AS CR µG/L	8.1	8.3	no		
COPPER DISSOLVED (µG/L AS CU)	6.8	7.0	no		<10%
IRON DISSOLVED (µG/L AS FE)	68.1	69.8	no		<10%
IRON TOTAL (µG/L AS FE)	1482	1511	no		
LEAD DISSOLVED (µG/L AS PB)	6.0	6.2	no		
MANGANESE DISSOLVED (µG/L AS MN)	117.1	118.5	no		<10%
MANGANESE TOTAL (µG/L AS MN)	1125	1162	no	Mar	
MERCURY DISSOLVED (µG/L AS HG)	0.16	0.17	no	Mar Apr Jul-Dec	
MERCURY TOTAL (µG/L AS HG)	0.23	0.24	no	Oct-Dec	
NICKEL DISSOLVED (µG/L AS NI)	4.2	4.4	no	Mar Apr Jul-Dec	
SELENIUM DISSOLVED (µG/L AS SE)	1.2	1.2	no	Sep-Nov	<10%
SELENIUM TOTAL (µG/L AS SE)	1.5	1.4	no		
CALC SELENIUM TOTAL RECOVERABLE IN WATER AS SE µG/L	1.4	1.4	no		
SILVER DISSOLVED (µG/L AS AG)	0.16	0.17	no	Mar Apr Jul-Dec	
ZINC DISSOLVED (µG/L AS ZN)	32.1	33.2	no	Sep Oct	

Table 3-20
Exceedence values for the Colorado Portion of the Animas River

Parameter	Number of Observations	Exceedences	
		Observed	Calculated w/ALP
Oxygen (Dissolved)	31	6	6
pH	908	21	21
Temperature (˚C)	-		
Fecal Coliforms	11	2	2
Ammonia(acute)	2	0	0
Ammonia(chronic)	2	0	0
Chlorine(acute)	0	0	0
Chlorine(chronic)	0	0	0
Cyanide	0	0	0
Sulfide	0	0	0
B	6	0	0
Nitrite	0	0	0
Nitrate	0	0	0
Chloride	850	0	0
Sulfate	1094	1	1
As(chronic)	495	2	2
Cd (acute)	255	0	0
Cd (chronic)	255	3	5
CrIII (total recoverable)	343	0	0
CrVI(acute)	0	0	0
CrVI(chronic)	0	0	0
Cu(acute)	492	0	0
Cu(chronic)	492	5	7
Fe(acute)	257	1	1
Fe(chronic)	344	28	29
Pb(acute)	243	0	0
Pb(chronic)	243	4	4
Mn(chronic)	756(263)	493	427
Hg(chronic)	582(482)	100	100
Ni(chronic)	248	0	0
Se(acute)	216	0	0
Se(chronic)	216	0	0
Ag(acute)	487	0	0
Ag(chronic)	487	3	2
Zn(acute)	489	2	2
Zn(chronic)	489	2	2

For manganese and mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit.

Table 3-21 Water Temperature Impacts of Ridges Basin Reservoir Releases Due to Project Operation				
	Animas Water Temperature Below Basin Creek			
Month	**River Temp - C**	**Outflow Temp - C**	**Downstream Temp - C**	**Change Temp - C**
Oct	11.16	8.43	10.69	-0.47
Nov	6.91	6.81	6.89	-0.02
Dec	5.46	5.96	5.49	0.03
Jan	4.31	4.91	4.35	0.04
Feb	4.30	5.19	4.42	0.12
Mar	6.56	5.61	6.43	-0.13
Apr	8.53	6.32	8.39	-0.14
May	10.67	6.99	10.58	-0.09
Jun	13.81	7.46	13.56	-0.25
Jul	16.41	10.13	15.87	-0.54
Aug	17.31	10.76	16.29	-1.02
Sep	17.02	9.89	15.75	-1.27
Minimum	4.30	4.91	4.33	-2.24
Maximum	17.31	10.76	17.01	0.16
Average	10.20	7.37	9.89	-0.31

New Mexico Segments of the Animas River

Under Refined Alternative 4, permanent impacts to water quality in this river reach would arise from Aztec, Farmington and Kirtland M&I diversions and return flows from Aztec and Farmington. The composition of these return flows would be concentrated by the usual water treatment processes for M&I waste water and re-enter the river system as surface return flows.

Table 3-22 presents the measurable increases in water quality parameters for the New Mexico Portion of the Animas River. Dissolved and total mercury, dissolved silver, cadmium, chromium, lead, and nickel would show measurable increases in the means. Beryllium, selenium, chromium, and zinc, all dissolved, showed increases in particular months. The consistent seasonal increases would be in late summer. Dissolved selenium would increase during low flow volume years. There were no consistent trends among the parameters by calendar month nor by flow intervals.

The number of exceedences of most parameters was unchanged as shown in Table 3-23. The water quality impact in this reach of the Animas River would be an increase in the exceedence (New Mexico WQCC, 1999) of phosphorus (one instance), selenium (five instances) and lead (two instances). These exceedences would have occurred in 35 years of sampling and would meet the criteria of no more than once in three years on average. Every historical measurement of mercury above the detection limit exceeded the chronic numeric standard for both historical and projected conditions, so no Project impact could be assessed.

Table 3-22
Calculated Measurable Increases for the New Mexico Portion of the Animas River

Parameter	Means		Measurable Increase		
	Observed	Calculated w/ALP	means	by month	by flow intervals
PH LAB & FIELD STANDARD UNITS	7.76	7.76	no		
TEMPERATURE WATER (˚C)	11.9	11.9	no		
PHOSPHORUS TOTAL (MG/L AS P)	0.09	0.09	no		
FECAL COLIFORMS MEMBR FILTER	443	443	no		
ALUMINUM DISSOLVED (μG/L AS AL)	48.4	48.4	no		
BERYLLIUM DISSOLVED (μG/L AS BE)	0.6	0.6	no	Oct	
MERCURY DISSOLVED (μG/L AS HG)	0.14	0.15	yes		
MERCURY TOTAL (μG/L AS HG)	0.16	0.17	yes		
SELENIUM DISSOLVED (μG/L AS SE)	0.9	0.9	no	Jul	<10%
SELENIUM TOTAL (μG/L AS SE)	1.0	0.9	no		
CALC. SELENIUM TOTAL RECOVERABLE IN WATER AS SE μG/L	1.0	1.0	no		
SILVER DISSOLVED (μG/L AS AG)	0.31	0.36	yes	Feb-Apr Aug-Dec	
CADMIUM DISSOLVED (μG/L AS CD)	1.6	1.7	yes		
CHROMIUM DISSOLVED (μG/L AS CR)	5.0	5.5	yes	Aug-Oct	
COPPER DISSOLVED (μG/L AS CU)	4.3	4.4	no		
LEAD DISSOLVED (μG/L AS PB)	1.6	1.7	no		
NICKEL DISSOLVED (μG/L AS NI)	6.2	6.4	no		
ZINC DISSOLVED (μG/L AS ZN)	14.8	14.4	no	Sep	

Table 3-23 Exceedence values for the New Mexico Portion of the Animas River			
Parameter	**Number of Observations**	**Exceedences**	
		Observed	**Calculated w/ALP**
pH	1053	20	20
Temperature	189	9	9
Phosphorus	35	4	5
Fecal Coliforms	124	19	19
Al(acute)	113	2	2
Al(chronic)	113	9	9
Be(acute)	45	0	0
Be(chronic)	45	0	0
Hg(acute)	314[283]	1	1
Hg(chronic)	314[283]	31	31
Se(acute)	351	0	0
Se(chronic)	351	43	48
Ag(acute)	101(157)	0	0
Cyanide(acute)	0	0	0
Cyanide(chronic)	0	0	0
Chlordane(acute)	0	0	0
Chlordane(chronic)	0	0	0
Cd (acute)	66(74)	0	0
Cd (chronic)	66(74)	5	9
Cr(acute)	54(58)	0	0
Cr(chronic)	54(58)	0	0
Cu(acute)	243(252)	0	0
Cu(chronic)	243(252)	4	4
Pb(acute)	174(231)	0	0
Pb(chronic)	174(231)	6	8
Ni(acute)	113(120)	0	0
Ni(chronic)	113(120)	0	0
Zn(acute)	179(361)	0	0
Zn(chronic)	179(361)	0	0
For mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit. For other metals, the first of the double numbers indicates the number of observations with hardness measurements used in the exceedence calculation			

LaPlata River

Water from the Ridges Basin Reservoir would be conveyed into the LaPlata basin for M&I use. The dissolved load in the water would add to the mass load already in the LaPlata River surface water. Depending on the water use, some impact to the groundwater could also occur. The water quality changes below return flow points on the LaPlata River would propagate downstream into the San Juan River.

Under Refined Alternative 4, permanent impacts to water quality in this river reach would arise from M&I return flows to the LaPlata basin. The M&I return flows are assumed to be treated with the usual waste water processes and would re-enter the river system as surface return flows. The Red Mesa regional supply would likely be dispersed throughout more a diffuse area and some return flow would enter the shallow groundwater. The shallow groundwater in the LaPlata region contains low concentrations of the regulated chemical parameters, hence the composition of groundwater return flow was assumed unchanged from the water conveyed from Ridges Basin, except for the concentrating effect of water depletion. The measured hardness in the lower LaPlata River was higher than in the Animas basin.

Table 3-24 presents the measurable increases in water quality parameters for the New Mexico Portion of the LaPlata River. The mean concentrations for elements - mercury, silver, copper, lead, zinc and selenium - would show measurable increases. When broken out by month, these parameters showed increases for essentially all months. Mean concentrations also increased for all flow volumes. Nickel would show spot increases in the fall months. During low flow years selenium would tend to show increased concentrations. Elements in the LaPlata River would be strongly influenced by their concentrations in return flow from Ridges Basin water diversions which would increase the flow in the river several fold during low flow periods.

In spite of the increased concentrations calculated for uses under Refined Alternative 4, the number of exceedences would not increase for any parameter, as shown in Table 3-25, due to the integration of water quality parameters in Ridges Basin Reservoir. The exceedences would decrease for copper (chronic) and selenium(chronic) presumably by dilution.

Table 3-24
Calculated Measurable Increases for the Lower LaPlata River

Parameter	**Means**		**Measurable Increase**		
	Observed	**Calculated w/ALP**	**means**	**by month**	**by flow intervals**
PH LAB&FIELD STANDARD UNITS	7.87	7.87	no		
TEMPERATURE WATER (˚C)	9.3	9.3	no		
FECAL COLIFORMS MEMBR FILTER M-FC 0.7 µM	528	528	no		
ALUMINUM DISSOLVED (µG/L AS AL)	19.9	19.9	no		
BERYLLIUM DISSOLVED (µG/L AS BE)	3.0	3.0	no		
MERCURY DISSOLVED (µG/L AS HG)	0.11	0.13	yes		
MERCURY TOTAL (µG/L AS HG)	0.14	0.18	yes		
SELENIUM DISSOLVED (µG/L AS SE)	0.9	1.1	no		<10% <25% ~50%
CALC SELENIUM TOTAL RECOVERABLE IN WATER AS SE µG/L	1.3	1.5	yes		<10% ~50%
SELENIUM TOTAL (µG/L AS SE)	1.2	1.3	yes		<10% <25% ~50%
SILVER DISSOLVED (µG/L AS AG)	0.08	0.10	yes		
CADMIUM DISSOLVED (µG/L AS CD)	1.4	1.3	yes		
CHROMIUM DISSOLVED (µG/L AS CR)	10.0	6.3	yes		
COPPER DISSOLVED (µG/L AS CU)	3.4	4.3	yes		
LEAD DISSOLVED (µG/L AS PB)	2.4	3.1	yes		
NICKEL DISSOLVED (µG/L AS NI)	4.4	4.4	no	Sep Oct	
ZINC DISSOLVED (µG/L AS ZN)	6.2	16.7	yes		

Table 3-25 Exceedence values for the lower LaPlata River			
		Exceedences	
Parameter	**Number of Observations**	**Observed**	**Calculated w/ALP**
pH	395	3	3
Temperature	152	1	1
Fecal Coliforms	56	7	7
Al(acute)	83	0	0
Al(chronic)	83	0	0
Be(acute)	15	0	0
Be(chronic)	15	1	1
Hg(acute)	325[282]	2	0
Hg(chronic)	325[282]	31	31
Se(acute)	225	0	0
Se(chronic)	225	54	41
Ag(acute)	152(153)	0	0
Cyanide(acute)	0	0	0
Cyanide(chronic)	0	0	0
Chlordane(acute)	0	0	0
Chlordane(chronic)	0	0	0
Cd (acute)	14(14)	0	0
Cd (chronic)	14(14)	1	1
Cr(acute)	6(6)	0	0
Cr(chronic)	6(6)	0	0
Cu(acute)	236(237)	1	0
Cu(chronic)	236(237)	2	0
Pb(acute)	80(162)	0	0
Pb(chronic)	80(162)	1	1
Ni(acute)	74(74)	0	0
Ni(chronic)	74(74)	0	0
Zn(acute)	240(324)	0	0
Zn(chronic)	240(324)	1	0
Chlorine(acute)	0	0	0
Chlorine(chronic)	0	0	0

For mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit.
For other metals, the first of the double numbers indicates the number of observations with hardness measurements used in the exceedence calculation

Mancos River

Ridges Basin water would be conveyed into the lower Mancos basin for use at the proposed resort. The dissolved load in the water would add to the mass load already in the Mancos River surface water. Some impact to the groundwater could also occur. The water quality changes below the resort on the Mancos River would propagate downstream into the San Juan River.

Under Refined Alternative 4, permanent impacts to water quality in this river reach would arise from the Mancos Canyon golf course. The return flow from the resort was assumed to undergo the usual water treatment processes for M&I waste water and would re-enter the river system as surface return flow. Deep percolation from irrigation of the golf course would enter the shallow groundwater system and leach some constituents from the underlying soils. Since this deep percolation would be a major part of the return flow, the concentration increases were taken into account. Nutrient and herbicide concentrations might increase downstream of the golf course, but there were no data on these constituents nor are they part of the regulated parameters. Similar to the Ridges Basin Golf Course, these impacts are likely too small to be detectable.

Table 3-26 presents the measurable increases in water quality parameters for the lower Mancos River. Although the means for these parameters showed no measurable increases, when broken out by month, the summer months (periods of low flow) would show increases for some parameters. Mean concentrations were also calculated to increase for certain trace metals in low-flow years in the lower 25 percentile.

There would be no additional exceedences from Refined Alternative 4 as shown in Table 3-27.

San Juan River

The water quality analysis was carried out to look at the potential changes occurring along segments of these various rivers and the net effect occurring at each gage in the river system.

San Juan River between Bloomfield and Farmington, NM

Under Refined Alternative 4, impacts to water quality at Farmington, NM would arise from effects of depletion and return flow in the Animas River. Since the return flow at this point along the San Juan River would be small relative to river flow, the water quality impact is small. The main effect would be from the Animas River inflow in this river segment.

Table 3-28 presents the measurable increases in water quality parameters for the San Juan River at Farmington. Although this is the point of greatest depletion in the system, the impact to water quality is very small. Most of the return flow has not returned to the system, so although the volume of water has changed, there is little change in water quality constituent concentration. Only cadmium and chromium showed an increase in the means. Some elements could show selective increases in the late summer, in early fall months or during low-flow years. For the regulated parameters listed there would be no net increase in exceedences from Refined Alternative 4 as shown in Table 3-29.

Table 3-26
Calculated Measurable Increases for the Lower Mancos River

Parameter	Means		Measurable Increase		
	Observed	Calculated w/ALP	means	by month	by flow intervals
OXYGEN DISSOLVED MG/L	8.86	8.86	no	Jan-Mar	
PH LAB & FIELD STANDARD UNITS	7.9	7.9	no	Jan-Mar	
BORON DISSOLVED (μG/L AS B)	84.9	85.0	no		
NITRITE NITROGEN DISSOLVED (MG/L AS N)	0.01	0.01	no		
ARSENIC TOTAL (μG/L AS AS)	21.1	21.3	no	Jan-Mar	<25%
CADMIUM DISSOLVED (μG/L AS CD)	1.2	1.1	no		
CHROMIUM DISSOLVED (μG/L AS CR)	1.3	1.3	no	Jan	
COPPER DISSOLVED (μG/L AS CU)	8.3	8.4	no	Dec-Feb	<25%
LEAD DISSOLVED (μG/L AS PB)	0.8	0.8	no		
MANGANESE DISSOLVED (μG/L AS MN)	54.9	55.1	no	Jan-Mar	<25%
MANGANESE TOTAL (μG/L AS MN)	254	255	no	Jan-Mar	<25%
MERCURY TOTAL (μG/L AS HG)	0.20	0.20	no		
NICKEL DISSOLVED (μG/L AS NI)	11.0	10.9	no	Jan Feb	
SELENIUM DISSOLVED (μG/L AS SE)	2.8	2.9	no	Jan Feb	
SELENIUM TOTAL (μG/L AS SE)	4.0	4.0	no		
SELENIUM TOTAL RECOVERABLE IN WATER AS SE μG/L	1.7	1.8	no	Jan Feb	
SILVER DISSOLVED (μG/L AS AG)	0.17	0.16	no		
ZINC DISSOLVED (μG/L AS ZN)	20.9	20.9	no	Dec-Feb	

Table 3-27
Exceedence Values for the Lower Mancos River

Parameter	Number of Observations	Exceedences Observed	Exceedences Calculated w/ALP
Oxygen (dissolved)	131	2	2
pH	263	6	6
B	8	0	0
Nitrite	3	0	0
As(chronic)	159	0	0
Cd (acute)	6	0	0
Cd (chronic)	6	0	0
CrIII(acute)	6	0	0
CrIII(chronic)	6	0	0
Cu(acute)	139	0	0
Cu(chronic)	139	0	0
Pb(acute)	55	0	0
Pb(chronic)	55	0	0
Mn(chronic)	183[118]	0	0
Hg(chronic)	158[118]	40	40
Se(acute)	92	0	0
Se(chronic)	92	2	2
Ag(acute)	107	0	0
Ag(chronic)	107	0	0
Zn(acute)	162	0	0
Zn(chronic)	162	0	0

For manganese and mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit.

Table 3-28
Calculated Measurable Increases in water quality constituent concentration for the San Juan River at Farmington, NM

Parameter	Means		Measurable Increase		
	Observed	Calculated w/ALP	means	by month	by flow intervals
PH LAB & FIELD STANDARD UNITS	7.95	7.95	no		
TEMPERATURE WATER (˚C)	11.5	11.5	no		
FECAL COLIFORMS MEMBR FILTER	10466	10466	no		
ALUMINUM DISSOLVED (μG/L AS AL)	33.2	33.2	no		
MERCURY DISSOLVED (μG/L AS HG)	0.11	0.11	no	May Aug Sep	<25%
MERCURY TOTAL (μG/L AS HG)	0.12	0.12	no	Aug Sep	<10% <25%
SELENIUM DISSOLVED (μG/L AS SE)	0.5	0.5	no	Sep	<10%
SELENIUM TOTAL (μG/L AS SE)	0.7	0.6	no		<10%
CALC SELENIUM TOTAL RECOVERABLE IN WATER AS SE μG/L	0.5	0.6	no		
SILVER DISSOLVED (μG/L AS AG)	0.64	0.69	yes		
CADMIUM DISSOLVED (μG/L AS CD)	0.76	0.84	yes		
CHROMIUM DISSOLVED (μG/L AS CR)	11.1	12.4	yes		
COPPER DISSOLVED (μG/L AS CU)	3.8	3.9	no	Sep,Oct	<10% <25%
LEAD DISSOLVED (μG/L AS PB)	0.8	0.8	no	Jul Oct	<10%
NICKEL DISSOLVED (μG/L AS NI)	5.4	5.6	no	Sep-Nov	
ZINC DISSOLVED (μG/L AS ZN)	10.0	9.8	no		

Table 3-29
Exceedence values for the San Juan River between Bloomfield and Farmington, NM

		Exceedences	
Parameter	**Number of Observations**	**Observed**	**Calculated w/ALP**
pH	939	4	4
Temperature	60	0	0
Fecal Coliforms	94	58	58
Al(acute)	34	0	0
Al(chronic)	34	5	5
Be(acute)	0	0	0
Be(chronic)	0	0	0
Hg(acute)	78[70]	0	0
Hg(chronic)	78[70]	8	8
Se(acute)	76	0	0
Se(chronic)	76	3	3
Ag(acute)	2(2)	0	0
Cyanide(acute)	0	0	0
Cyanide(chronic)	0	0	0
Chlordane(acute)	0	0	0
Chlordane(chronic)	0	0	0
Cd (acute)	11(11)	0	0
Cd (chronic)	11(11)	1	1
Cr(acute)	4(4)	0	0
Cr(chronic)	4(4)	0	0
Cu(acute)	45(45)	0	0
Cu(chronic)	45(45)	0	0
Pb(acute)	37(67)	0	0
Pb(chronic)	37(67)	1	1
Ni(acute)	28(28)	0	0
Ni(chronic)	28(28)	0	0
Zn(acute)	50(80)	0	0
Zn(chronic)	50(80)	0	0
Chlorine(acute)	0	0	0
Chlorine(chronic)	0	0	0

For mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit.
For other metals, the first of the double numbers indicates the number of observations with hardness measurements used in the exceedence calculation

San Juan River between Farmington and Shiprock, NM

Under Refined Alternative 4, permanent impacts to water quality in the San Juan River between Farmington and Shiprock, NM would arise from the Animas River, the LaPlata River and the regional return flows. Table 3-30 presents the measurable increases in water quality parameters for the San Juan River in this reach The San Juan River at Shiprock is influenced by the return flows that come back to the river below Farmington. Hence various trace metals, present in the LaPlata River, could increase the means. These elements did not show any selective increases by month or by flow year. No parameters showed any increases in exceedences over the historic observations as shown in Table 3-31.

Table 3-30
Calculated Measurable Increases for the San Juan River Between Farmington and Shiprock, NM

Parameter	Means		Measurable Increase		
	Observed	Calculated w/ALP	means	By Month	By Flow Intervals
PH LAB&FIELD STANDARD UNITS	7.90	7.90	no		
TEMPERATURE WATER (˚C)	12.7	12.7	no		
FECAL COLIFORMS MEMBR FILTER M-FC BROTH 44.5 C	1884	1884	no		
FECAL COLIFORMS MEMBR FILTER M-FC 0.7 µM	920	920	no		
ALUMINUM DISSOLVED (µG/L AS AL)	51.6	51.6	no		
BERYLLIUM DISSOLVED (µG/L AS BE)	0.8	0.8	no		
MERCURY DISSOLVED (µG/L AS HG)	0.19	0.20	no		
MERCURY TOTAL (µG/L AS HG)	0.21	0.22	no		
SELENIUM DISSOLVED (µG/L AS SE)	1.1	1.1	no		
SELENIUM TOTAL (µG/L AS SE)	1.3	1.3	no		
CALC SELENIUM TOTAL RECOVERABLE IN WATER AS SE µG/L	1.1	1.2	no		
SILVER DISSOLVED (µG/L AS AG)	0.98	1.02	no		
CYANIDE TOTAL (MG/L AS CN) MG/L	0.03	0.03	no		
CHLORDANE(TECH MIX & METABS) WHOLE WATER µG/L	0.10	0.10	no		
CADMIUM DISSOLVED (µG/L AS CD)	1.2	1.3	yes		
CHROMIUM DISSOLVED (µG/L AS CR)	4.0	4.2	yes		
COPPER DISSOLVED (µG/L AS CU)	4.4	4.5	no		
LEAD DISSOLVED (µG/L AS PB)	1.8	1.9	no		
NICKEL DISSOLVED (µG/L AS NI)	6.4	6.7	no		
ZINC DISSOLVED (µG/L AS ZN)	11.6	12.0	no		

Table 3-31
Exceedence Values for the San Juan River Between Farmington and Shiprock, NM

		Exceedences	
Parameter	**Number of Observations**	**Observed**	**Calculated w/ALP**
pH	1287	33	33
Temperature	227	0	0
Fecal Coliforms	173	73	73
Al(acute)	138	2	2
Al(chronic)	138	15	15
Be(acute)	46	0	0
Be(chronic)	46	0	0
Hg(acute)	225[193]	0	0
Hg(chronic)	225[193]	32	32
Se(acute)	83	0	0
Se(chronic)	83	28	28
Ag(acute)	51(51)	0	0
Cyanide(acute)	1	0	0
Cyanide(chronic)	1	0	0
Chlordane(acute)	13	0	0
Chlordane(chronic)	13	13	13
Cd (acute)	68(71)	0	0
Cd (chronic)	68(71)	11	11
Cr(acute)	52(53)	0	0
Cr(chronic)	52(53)	0	0
Cu(acute)	162(165)	0	0
Cu(chronic)	162(165)	1	1
Pb(acute)	150(256)	0	0
Pb(chronic)	162(165)	13	13
Ni(acute)	143(146)	0	0
Ni(chronic)	143(146)	0	0
Zn(acute)	163(268)	0	0
Zn(chronic)	163(268)	1	1
Chlorine(acute)	0	0	0
Chlorine(chronic)	0	0	0

For mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit.
For other metals, the first of the double numbers indicates the number of observations with hardness measurements used in the exceedence calculation

San Juan River between Shiprock and Four Corners, NM

Under Refined Alternative 4, permanent impacts to water quality in the San Juan River between Shiprock and Four Corners, New Mexico Note that a small section of the San Juan River is in Colorado beginning at Four Corners. This Colorado segment of the river which has different standards, was included in the impact for this reach, although it technically occurs in the next reach. Inclusion here is due to its proximity to the Four Corners gage.

Table 3-32 presents the measurable increases in water quality parameters for this reach of the San Juan River All of the return flow from project diversions has returned at this point, so all water quality impacts occur at this location. The selected trace metals - mercury, cadmium, copper, lead, manganese, nickel, and zinc - would show increases in the means concentration. Mercury could increase selectively during non-winter months. Most elements could show increases in the early spring or fall months. Any element showing potential increased concentration would do so during low flow years.

The trace metal, cadmium, would show an increase of one exceedence each over the historic observations as shown in Table 3-33. Every historical measurement of mercury above the detection limit exceeded the chronic numeric standard for both historical and projected conditions, so no impact could be assessed. For the other parameters there would be no additional exceedences from Refined Alternative 4.

San Juan River between Four Corners, NM and Mexican Hat, UT

Under Refined Alternative 4, permanent impacts to water quality in the San Juan River between Four Corners, NM and Mexican Hat, UT would arise from other tributary inflows not influenced by Refined Alternative 4, although any impacts above Four Corners, NM would carry downstream into this reach. Table 3-34 presents the measurable increases in water quality parameters for the San Juan River Below Four Corners, NM. Impacts in this reach are typically during low flow periods when dilution waters from Navajo dam are not present. Only increases in the arsenic, copper, total iron, mercury, silver and zinc concentrations would be considered measurable.

The calculations show that the additional load above Four Corners would add to the exceedences of cadmium (acute) by one and total suspended solids by three as shown in Table 3-35. Every historical measurement of mercury above the detection limit exceeded the chronic numeric standard, so no impact could be assessed. For the other parameters there would be no additional exceedences from Refined Alternative 4. The one exceedence of the Cd acute standard is within the allowance for one year in three for Utah. The total suspended solids standard is exceeded most of the time in this reach of the San Juan. The increase in occurrences of exceedence is not considered significant in this turbid river.

Table 3-32
Calculated Measurable Increases for the San Juan River Between Shiprock, NM and Four Corners, NM

	Means		Measurable Increase		
Parameter	**Observed**	**Calculated w/ALP**	**Means**	**By Month**	**By Flow Intervals**
PH (LAB&FIELD) STANDARD UNITS	8.15	8.15	no		
TEMPERATURE WATER (˚C)	13.8	13.8	no		
FECAL COLIFORMS MEMBR FILTER M-FC 0.7 μM	193	193	no		
ALUMINUM DISSOLVED (μG/L AS AL)	40.8	40.8	no		
BERYLLIUM DISSOLVED (μG/L AS BE)	1.6	1.6	no		
MERCURY DISSOLVED (μG/L AS HG)	0.10	0.10	no	Jul-Oct	<10%
MERCURY TOTAL (μG/L AS HG)	0.14	0.15	no	Jul-Nov	<10%
SELENIUM DISSOLVED (μG/L AS SE)	1.1	1.2	no	May Jul-Sep	<25%
SELENIUM TOTAL (μG/L AS SE)	1.4	1.4	no	Aug Sep	<25%
CALC SELENIUM TOTAL RECOVERABLE IN WATER AS SE μG/L	1.1	1.2	no	May Jul-Sep	<25%
CADMIUM DISSOLVED (μG/L AS CD)	1.2	1.3	yes		<10% <25%
CHROMIUM DISSOLVED (μG/L AS CR)	4.6	5.0	no		
COPPER DISSOLVED (μG/L AS CU)	4.4	4.6	no	Jul	
LEAD DISSOLVED (μG/L AS PB)	1.0	1.0	no	Feb Apr Jul Sep Oct	<10%
NICKEL DISSOLVED (μG/L AS NI)	5.5	5.7	no	Aug-Nov	<10%
ZINC DISSOLVED (μG/L AS ZN)	8.1	8.2	no	Feb Aug-Nov	<10%
Additional parameters in Colorado portion of the river at Four Corners					
OXYGEN DISSOLVED MG/L	9.12	9.12	no		
AMMONIA UNIONIZED (MG/L AS N)	0.003	0.003	no		
BORON DISSOLVED (μG/L AS B)	100.1	103.8	no		
NITRITE NITROGEN DISSOLVED (MG/L AS N)	0.006	0.006	no		
ARSENIC TOTAL (μG/L AS AS)	3.9	4.0	no		
IRON TOTAL (μG/L AS FE)	13400	14340	yes		
MANGANESE DISSOLVED (μG/L AS MN)	6.6	6.0	yes		
MANGANESE TOTAL (μG/L AS MN)	620	647	no		

Table 3-33
Exceedence values for the San Juan River between Shiprock, NM and Four Corners, CO

Parameter	Number of Observations	Exceedences Observed	Exceedences Calculated w/ALP
pH	167	1	1
Temperature	79	0	0
Fecal Coliforms	23	4	4
Al(acute)	40	1	1
Al(chronic)	40	1	1
Be(acute)	14	0	0
Be(chronic)	14	0	0
Hg(acute)	71[64]	0	0
Hg(chronic)	71[64]	7	7
Se(acute)	71	0	0
Se(chronic)	71	10	10
Ag(acute)	0	0	0
Cyanide(acute)	0	0	0
Cyanide(chronic)	0	0	0
Chlordane(acute)	0	0	0
Chlordane(chronic)	0	0	0
Cd (acute)	15(15)	0	0
Cd (chronic)	15(15)	2	3
Cr(acute)	4(4)	0	0
Cr(chronic)	4(4)	0	0
Cu(acute)	48(48)	0	0
Cu(chronic)	48(48)	0	0
Pb(acute)	41(70)	0	0
Pb(chronic)	41(70)	0	0
Ni(acute)	36(36)	0	0
Ni(chronic)	36(36)	0	0
Zn(acute)	48(77)	0	0
Zn(chronic)	48(77)	0	0
Chlorine(acute)	0	0	0
Chlorine(chronic)	0	0	0
Additional Parameters in Colorado Portion of River at Four Corners			
Ammonia(acute)	26	0	0
Ammonia(chronic)	26	0	0
Fecal Coliforms	23	13	13
Sulfide	0	0	0
B	45	0	0
Nitrite	7	0	0
As(chronic)	72	0	0
Cd (acute)	15	1	2
Fe(chronic)	13	7	7
Mn(chronic)	27[27]	0	0
Ag(acute)	0	0	0
Ag(chronic)	0	0	0

For manganese and mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit.
For other metals, the first of the double numbers indicates the number of observations with hardness measurements used in the exceedence calculation

Table 3-34
Calculated Measurable Increases for the San Juan River Between Four Corners, NM and Mexican Hat, UT

	Means		Measurable Increase		
Parameter	Observed	Calculated w/ALP	Mean	By Month	Parameter
OXYGEN DISSOLVED MG/L	8.74	8.74	no		
TEMPERATURE WATER (˚C)	13.9	13.9	no		
PH (LAB&FIELD) STANDARD UNITS	7.82	7.82	no		
ALUMINUM DISSOLVED (μG/L AS AL)	54.9	54.9	no		
ARSENIC DISSOLVED (μG/L AS AS)	3.1	3.2	no	Jul-Nov	<10%
CADMIUM DISSOLVED (μG/L AS CD)	1.6	1.7	no		<25%
CHROMIUM DISSOLVED (μG/L AS CR)	3.2	3.3	no		<25%
COPPER DISSOLVED (μG/L AS CU)	5.2	5.4	no	Jul-Nov	<10% <25%
IRON TOTAL (μG/L AS FE)	4218	4466	yes	Jul-Sep	
LEAD DISSOLVED (μG/L AS PB)	1.6	1.6	no	Aug-Sep	<10% <25%
MERCURY DISSOLVED (μG/L AS HG)	0.21	0.22	no	Jul-Oct	<10% <25%
NICKEL DISSOLVED (μG/L AS NI)	8.1	8.4	no	Jul-Oct	<10%
SELENIUM DISSOLVED (μG/L AS SE)	1.2	1.2	no	Jul-Sep	
SILVER DISSOLVED (μG/L AS AG)	1.00	1.04	no		<25%
ZINC DISSOLVED (μG/L AS ZN)	19.3	20.0	no	Jul-Sep	<10%
AMMONIA UNIONIZED (MG/L AS N)	0.002	0.002	no		
NITRATE NITROGEN DISSOLVED (MG/L AS N)	0.49	0.51	no		
PHOSPHORUS TOTAL (MG/L AS P)	0.51	0.51	no		
SOLIDS SUSP.-RESIDUE ON EVAP. AT 180 C (MG/L)	745	771	no	Jul-Oct	<10%

Table 3-35
Exceedence values for the San Juan River between Four Corners, CO and Mexican Hat, UT

		Exceedences	
Parameter	**Number of Observations**	**Observed**	**Calculated w/ALP**
Oxygen (dissolved)	478	9	9
Temperature	309	0	0
pH	1607	3	3
Al(acute)	174	3	3
Al(chronic)	174	22	22
As(acute)	345	0	0
As(chronic)	345	0	0
Cd (acute)	53(56)	1	1
Cd (chronic)	53(56)	5	6
CrVI(acute)	0	0	0
CrVI(chronic)	0	0	0
Cr(acute)	45(48)	0	0
Cr(chronic)	45(48)	0	0
Cu(acute)	201(203)	0	0
Cu(chronic)	201(203)	0	0
Cyanide(acute)	0	0	0
Cyanide(chronic)	0	0	0
Fe	201	18	18
Pb(acute)	198(343)	0	0
Pb(chronic)	198(343)	4	4
Hg(acute)	338[305]	1	1
Hg(chronic)	338[305]	33	33
Ni(acute)	183(184)	0	0
Ni(chronic)	198(343)	0	0
Se(acute)	349	0	0
Se(chronic)	349	6	6
Ag(acute)	44(45)	0	0
Zn(acute)	93(95)	0	0
Zn(chronic)	93(95)	0	0
Ammonia(acute)	612	0	0
Ammonia(chronic)	612	0	0
Chlorine(acute)	0	0	0
Chlorine(chronic)	0	0	0
Sulfide	0	0	0
gross Beta	0	0	0
BOD_5	0	0	0
Nitrate	1891	15	15
Phosphorus	95	80	80
Total Suspended Solids	283	194	197

For mercury, the first value shows total number of measurements and the second value shows the number of measurements below the detection limit.
For other metals, the first of the double numbers indicates the number of observations with hardness measurements used in the exceedence calculation

Groundwater

The salt load passed to the ground water depends on the type of depletion. With irrigation depletions most of the dissolved load percolates into the ground water with minor amounts leaving by surface return flow. With M&I depletions a major fraction of the dissolved load can leave in surface return flow which is a usually larger proportion than under irrigation. Even M&I demands can have variable fractions lost to deep percolation. The rural M&I uses approach fractional losses similar to irrigation deep percolation. Under the assumption of 50% depletion for M&I uses and of salt equilibrium with these alternatives, the salt content of groundwater would reach a new concentration and remain there. The equilibrium concentration would depend on the partitioning of the M&I return flows between the surface water and the shallow groundwater. The impact to ground water quality would be directly related to the pre-project concentration and the post-project equilibrium concentration. Under equilibrium conditions assumed in both alternatives, the impact of post-project groundwater has already been considered in the impact analysis of stream water quality. Since groundwater salt concentrations are typically higher than the associated surface water in this area and the quality of the return flow from the project is often equal to or better than the groundwater based on the few measurements available, the overall impact is expected to be less than significant. In some cases there may be improvement in groundwater quality and in some cases deterioration. Additional data would be needed to specifically identify these local impacts.

Refined Alternative 6 Impact Analysis

Construction Related Impacts

Pumping Plants (Animas near Durango, LaPlata, Mancos)

Construction of the various pumping plants would temporarily disturb the bank material which could increase the suspended load in the rivers. In addition, groundwater removed during construction dewatering would need disposal. The ground water quality at these sites would presumably be better than at the Ridges Basin Pumping Plant site, so other options for disposal such as sprinkler disposal of the water might be possible. The impacts and their mitigation would be similar to the construction related impacts under Refined Alternative 4 but less in magnitude due to the smaller pumping plants.

Lemon Reservoir

Under this alternative, Lemon Reservoir would be enlarged. The best management practices would be implemented to maximize sediment control. Temporary cofferdams/berms would be used to contain fine materials and placement of fill material. The change in water quality would be minimized during construction

Horse Gulch Reservoir

Under this alternative, a new reservoir, Horse Gulch Reservoir, would be constructed to store water from Lemon Reservoir and to convey for Durango M&I uses. The best management practices would be implemented to maximize sediment control during construction and after filling. No change in the quality of the conveyed water would occur. This is not a project feature, however, so any such impacts would be addressed separately.

Navajo Nation Municipal Pipeline

Since this pipeline is the same pipeline under both alternatives, the water quality impacts would be the same as discussed under Refined Alternative 4.

Non-binding Conveyance Pipelines

Impacts due to the installation of pipeline and siphons would be similar those under Refined Alternative 4. The locations would be different, but the concerns about crossing streams and increased sediments load would be the same.

Operation Related Impacts

Navajo Dam

The operation of the Navajo Dam would be tailored to supplement available Animas River flows. Navajo Reservoir water, especially with the additional Pine River water, would tend to improve San Juan River water quality during release periods. During low releases the water quality in the San Juan River would be slightly better than historical water quality. The impact would not be significant.

Pine River

The conversion of irrigation to M&I uses with releases downstream to Navajo Reservoir would improve water quality in the Pine River. The winter flows would remain unchanged do the winter water quality would remain the same. During the summer months the stream flow would increase up to an average of approximately 10% of the historic flows. Since the depletion has been eliminated, the water quality would improve correspondingly: the concentrations would be at 90% of the historic values. The improvement would propagate downstream through the Navajo Reservoir. During low periods the water quality in the Pine River would be no worst than under Refined Alternative 4. Since Refined Alternative 4 impact was not considered significant, then the impact on the water quality of the Pine River would still be insignificant.

Florida River

Most Florida River water would be used within the Florida Basin and some would be exported to Durango. The net effect of the M&I depletions in the Florida basin would be similar to the water quality effects of Refined Alternative 4. Due to the better quality of Florida water, the effect on Durango would be a slight improvement of the water quality in the Animas River relative to Refined Alternative 4. The net effect of the M&I depletions in the Florida basin would be similar to the water quality effects of Refined Alternative 4.

Animas River

Under this alternative, the retirement of lands with no water taken off the land would improve water quality in the general river. As a result there would be permanent impacts to water quality in the river reaches with the development regions. At Durango, the average monthly flows are reduced from the without project condition by about 13 CFS, compared to 109 CFS for Refined Alternative 4. No diversion is taken when flows are below the target levels described earlier. Supplemental water is delivered from Lemon or Horse Gulch reservoir during these times. The quality of water would not change on passing through Horse Gulch Reservoir. During Durango diversions the water quality in the

Animas River would be only slightly worst than historic conditions, but better than under Refined Alternative 4.

At the confluence of the Animas River with the Florida, this alternative reduces the average monthly flow by 16 CFS compared to 63 CFS for Refined Alternative 4. The minimum flow is reduced by about 5 CFS. Correspondingly the water quality at the confluence would be better than under Refined Alternative 4.

The average flow at Farmington with Refined Alternative 6 would be impacted more than 16 CFS but less than 128 CFS, the impact resulting from Refined Alternative 4. Minimum flows will remain about the same. The timing of the Animas flows would be slightly different, but the low-flow periods, during times of likely exceedences, would see larger flows. In this Animas River reach, the M&I depletions would be similar under both alternatives, so the net effect of water quality changes would be almost identical. However, since the quality of upstream water would be better under the Refined Alternative 6, the net water quality at the mouth of the Animas River would improve relative to Refined Alternative 4. Since Refined Alternative 4 impact was not considered significant, then the impact on the water quality of the Animas River would still be insignificant.

LaPlata River

Retirement of 785 acres of agricultural land and conversion of the irrigation depletion to M&I will change the timing of flows slightly above the Colorado-New Mexico state line and decrease flows by an average of 60 AF per year or 0.2% of the annual runoff. So there would be no net effect on water quality at the state line from this alternative. Upstream there would be some impacts. Although the flow impact will be during winter months and during snowmelt runoff, there would be little water quality change during those periods. During late summer water will come from storage (maximum = 124 AF) in Red Mesa Reservoir during the years storage is required. During the summer season, the water quality impacts would be along the irrigated reaches of the River. At the Colorado-New Mexico state line, there would be no net change in water quality parameters relative to historic conditions.

From the State Line to the confluence with the San Juan River return flows from non-binding uses served by diversions from the San Juan River will increase flow by about 13,500 AF or 60%. Since these non-binding uses are under both alternatives, the water quality impacts in this river reach would be the same as discussed under Refined Alternative 4. The depletions for the non-binding uses would be met with San Juan River water piped to the coal mine and power plant. Use of San Juan River water, being of better quality than water from the Ridges Basin Reservoir, would improve water quality of the M&I return flows relative to the historic conditions. Since Refined Alternative 4 impact was not considered significant, then the impact on the water quality of the LaPlata River would still be insignificant.

Mancos River

Under the refined Alternative 6, flow in the Mancos river will be about the same as historical flows in volume due to the retirement of 500 acres of agricultural lands and transfer of the water to the resort and golf course. The water quality in the Mancos River would improve down to the resort diversion point relative to historic conditions. Under both alternative the M&I locations and depletion are same, Hence, the salt loading in each river basin would be the under both alternatives. Since the quality of upstream water would be better under the Refined Alternative 6, the net water quality at the mouth of the Mancos River would improve relative to Refined Alternative 4. The impact would not be considered significant.

San Juan River

Along the San Juan River between Navajo Dam and the Animas River confluence, the water quality would be slightly, probably not measurable, due the retirement of lands in the Pine River Basin. Since under the Refined Alternative 6, each tributary from the Animas to the Mancos Rivers has improved water quality the net effect in the San Juan River would be improved water quality relative to Refined Alternative 4.
The reduced depletions of this alternative would help in reducing water quality impacts in the San Juan River. Since Refined Alternative 4 impact was not considered significant, then the impact on the water quality of the San Juan River would still be insignificant.

Dolores River

The purchase of 657 acres served by the Montezuma Valley Irrigation Company (MVIC) with transfer of 1,051 AF of depletion to meet regional M&I demand in the Cortez, Colorado area will modify the timing of demands and return flows. Since the main water supply is from tributaries upstream of McPhie reservoir, timing could change slightly due to the change in demand pattern. The change in timing represents less than 0.3% of the MVIC diversion. The impact to water quality of return flows would be less than 0.3% or insignificant.

McElmo Creek

As part of 1,036 AF of depletion to meet regional M&I demand in the Cortez, Colorado area, the McElmo Creek depletions will modify the timing of demands and return flows. The change in timing represents less than 1% of the McElmo Creek flow at the Colorado-Utah state line. The impact to water quality of return flows would be less than 1% or insignificant.

Groundwater

Since the M&I depletions are the same under both alternatives the local ground water quality impacts would be identical given same quality of diversions. However the diverted water would of better quality in each basin so the net effect of ground water quality would be less than under Refined Alternative 4. Since Refined Alternative 4 impact was not considered significant, then the impact on ground water quality would still be insignificant.

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Attachment 1

Extracted from

Colorado Department of Public Health and Environment and Water Quality Control Commission

Regulation No. 34 Classifications and Numeric Standards for San Juan and Dolores River Basins

Last amended: November 30, 1998
Effective: December 30, 1998

34.5 BASIC STANDARDS

(1) All waters of the San Juan/Dolores River Basin are subject to the following standard for temperature. (Discharges regulated by permits, which are within the permit limitations, shall not be subject to enforcement proceedings under this standard). 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 four-hour o period, lasting 13 hours maximum, is deemed acceptable for discharges fluctuating in volume or temperature. Where temperature increases cannot be maintained within this range using Best Management Practices (BMP), Best Available Technology Economically Achievable (BATEA), and Best Practical Waste Treatment Technology (BPWTT) control measures, the Commission may determine by a rulemaking hearing in accordance with the requirements of.the applicable statutes and the basic regulations, whether or not a change in classification is warranted.

(2) See Basic Standards and Methodologies for Surface Water, Regulation No. 31, section 31.11 for a listing of organic standards. The column in the tables headed "Water Fish" are presumptively applied to all aquatic life class 1 streams and are applied to aquatic life class 2 streams on a case-by-case basis as shown in the tables in Section 34.6.

(3) URANIUM

- (a) All waters of the San Juan/Dolores River Basin, are subject to the following basic standard for uranium, unless otherwise specified by a water quality standard applicable to a particular segment. However, discharges of uranium regulated by permits which are within these permit limitations shall not be a basis for enforcement proceedings under this basic standard.
- (b) Uranium level in surface waters shall be maintained at the lowest practicable level.
- (c) In no case shall uranium levels in waters assigned a water supply classification be increased by any cause attributable to municipal, industrial, or agricultural discharges so as to exceed 40 pCi/l or naturally-occurring concentrations (as determined by the State of Colorado), whichever is greater.
- (d) In no case shall uranium levels in waters assigned a water supply classification be increased by a cause attributable to municipal, industrial, or agricultural discharges so as to exceed 40 pCi/l where naturally-occurring concentrations are less than 40 pCi/l.

34.6 TABLES

(1) Introduction

The numeric standards for various parameters in the attached tables were assigned by the Commission after a careful analysis of the data presented on actual stream conditions and on actual and potential water uses.
Numeric standards are not assigned for all parameters listed in the tables attached to Regulation No. 31 . If additional numeric standards are found to be needed during future periodic reviews, they can be assigned by following the proper hearing procedures.

(2) Abbreviations:

The following abbreviations are used in the attached tables:

ac = acute (1-day)
Ag = silver
Al = aluminum
As = arsenic
B = boron
Ba = barium
Be = beryllium
Cd = cadmium
ch = chronic (30-day)
Cl = chloride
Cl_2 = residual chlorine
CN = free cyanide
CrIII = trivalent chromium
CrVI = hexavalent chromium
Cu = copper
dis = dissolved
D.O. = dissolved oxygen
F = fluoride
F.Coli = fecal coliforms
Fe = iron
Hg = mercury
mg/l = milligrams per liter
ml = milliliters
Mn = manganese
NH_3 = un-ionized ammonia as N(nitrogen)
Ni = nickel
NO_2 = nitrite as N (nitrogen)
NO_3 = nitrate as N (nitrogen)
OW = outstanding waters
P = phosphorus
Pb = lead
S = sulfide as undissociated H_2S (hydrogensulfide)
Sb = antimony
Se = selenium
SO_4 = sulfate
sp = spawning
Tl = thallium.
tr = trout
Trec = total recoverable
TVS = table value standard
U = uranium
ug/l = micrograms per liter
UP = use-protected
Zn = zinc

(3) Table Value Standards:

In certain instances in the attached tables, the designation "TVS" is used to indicate that for a particular parameter a "table value standard" has been adopted. This designation refers to numerical criteria set forth in the Basic Standards and Methodologies for Surface Water. The criteria for which the TVS are applicable are listed.

Table Value Standards (Concentrations in ug/l unless noted)	
Parameter[a]	**Table Value Standards** [B,c]
Ammonia	Cold Water Acute = 0.43/FT/FPH/2 in mg/l[d] Warm Water Acute = 0.62/FT/FPH/2 in mg/l[d]
Cadmium	Acute = $e^{(1.128[\ln(hardness)]-2.905)}$ "(Trout) = $e^{(1.128[\ln(hardness)]-3.828)}$ Chronic = $e^{(0.7852[\ln(hardness)]-3.490)}$
Chromium III	Acute = $e^{(0.819[\ln(hardness)]+3.688)}$ Chronic = $e^{(0.819[\ln(hardness)]+1.561)}$
Chromium VI	Acute = 16 Chronic = 11
Copper	Acute =$e^{(0.9422[\ln(hardness)]-1.4634)}$ Chronic = $e^{(0.8545[\ln(hardness)]-1.465)}$
Lead	Acute = $e^{(1.6148[\ln(hardness)] - 2.8736)}$ Chronic = $e^{(1.417[\ln(hardness)] - 5.167)}$
Nickel	Acute = $e^{(0.76[\ln(hardness)]+3.33)}$ Chronic=$e^{(0.76[\ln(hardness)]+1.06)}$
Selenium	Acute = 135 Chronic = 17
Silver	Acute = $e^{(1.72[\ln(hardness)]-7.21)}$ Chronic = $e^{(1.72\{\ln(hardness)]-9.06)}$ "(Trout) = $e^{(1.72[\ln(hardness)]-10.51)}$
Uranium	Acute = $e^{(1.102[\ln(hardness)]+2.7088)}$ Chronic = $e^{(1.102[\ln(hardness)]+2.2382)}$
Zinc	Acute = $e^{(0.8473[\ln(hardness)]+0.8604)}$

Table Value Standards
(Concentrations in ug/l unless noted) (continued)

a Metals are stated as dissolved unless otherwise specified.

b Hardness values to be used in equations are in mg/l as calcium carbonate. The hardness values used in calculating the appropriate metal standard should be based on the lower 95 per cent confidence limit of the mean hardness value at the periodic low flow criteria as determined from a regression analysis of site-specific data. Where insufficient site-specific data exists to define the mean hardness value at the periodic low flow criteria, representative regional data shall be used to perform the regression analysis. Where a regression analysis is not appropriate, a site-specific method should be used. In calculating a hardness value, regression analyses should not be extrapolated past the point that data exist.

c Both acute and chronic numbers adopted as stream standards are levels not to be exceeded more than once every three years on the average.

d FT = 10 ; $^{.03\ (20-TCAP)}$
TCAP less than or equal to T less than or equal to 30
FT = 10 ; $^{.03(20-T)}$
0 less or equal to T less than or equal to TCAP
TCAP = 20 C cold water aquatic life species present 0
TCAP = 25 C cold water aquatic life species absent
FPH = 1; 8 less than pH less than or equal to 9
FPH = $\frac{1 + 10^{(7.4-pH)}}{1.25}$; 6.5 less than or equal to pH less than or equal to 8
FPH means the acute pH adjustment factor; defined by the above formulas.
FT Means the acute temperature adjustment factor, defined by the above formulas.
T means temperature measured in degrees celsius.
TCAP means temperature CAP; the maximum temperature which affects the toxicity of ammonia to salmonid and non-salmonid fish groups.

NOTE: If the calculated acute value is less than the calculated chronic value, then the calculated chronic value shall be used as the acute standard.

Stream Classifications and Water Quality Standards								
Region: 9	**Desig**	**Classifications**	**Numeric Standards**					
Basin: Animas and Florida River **Stream Segment Description**			**Physical And Biological**	**Inorganic mg/l**		**Metals µg/l**		
5a. Mainstem of the Animas River, including wetlands, to the Southern Ute Indian Reservation boundary.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3 (ac)=TVS NH_3 (ch)=0.02 Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2 =0.05 NO_3 =10 Cl=250 SO_4 =250	As(ch)=50 Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Hg(ch)=0.01(tot) Ni(ch)=TVS	Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
5b. Mainstem of the Animas River, including wetlands, from the Southern Ute Indian Reservation boundary to the Colorado/New Mexico border.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 Cl=250 NO_2=0.05 NO_3=10 SO_4=250	As(ch)=50 Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Hg(ch)=0.01(tot) Ni(ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
11. Mainstem of the Florida River from the Florida Farmers Canal Headgate to the confluence with the Animas River.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3 (ac)=TVS NH_3 (ch)=0.02 Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS

Stream Classifications and Water Quality Standards

Region: 9	**Desig**	**Classifications**	**Numeric Standards**					
Basin: LaPlata River, Mancos River, McElmo Creek, and San Juan River in Montezuma County and Dolores County			**Physical And Biological**	**Inorganic mg/l**		**Metals µg/l**		
Stream Segment Description								
12. Mainstem of the LaPlata River, including all wetlands, tributaries, lakes, and reservoirs, from the source to the Hay Gulch diversion south of Hesperus.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3 (ac)=TVS NH_3 (ch)=0.02 Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2 =0.05 NO_3 =10 Cl=250 SO_4 =250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
2b. Mainstem to the LaPlata River, including all wetlands, lakes and reservoirs, from the boundary of the Southern Ute Indian Reservation to the Colorado/New Mexico border.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O.=5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3 (ac)=TVS NH_3 (ch)=0.1 100ml Cl_2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO =0.05 2	As(ch)=100(Trec) Cd(ch)=.1 CrIII(ch)=100 CrVI(ch)=25 Cu(cu)=10	Fe(ch)=1000 Pb(ch)=43 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=100	Se(ch)=20 Ag(ch)=.1 Zn(ch)=140
5b. Mainstem of the Mancos River from the boundary of the Ute Mountain Indian Reservation to the Colorado/New Mexico border.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3 (ac)=TVS NH_3 (ch)=0.01 100ml Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 2 CN=0.005	S=0.002 B=0.75 NO =0.05 2	As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1800(Trec) Pb(ac/ch)=TVS Mn(ch)=1000 Hg(ch)=0.01(tot)	Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
9. Mainstem of the San Juan River in Montezuma County.		Aq Life Warm 1 Recreation 1 Agriculture	D.O. = 5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml	NH_3 (ac)=TVS NH_3 (ch)=0.06 Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 2 CN=0.005	S=0.002 B=0.75 NO =0.5 2	As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Fe(ch)=2200(Trec) Pb(ac/ch)=TVS Mn(ch)=1000	Hg(ch)=0.01(tot) Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS

Attachment 2

Extracted from

State of New Mexico
Standards for Interstate and Intrastate Streams

Filed with State Records Center, December 23, 1994 as 20 NMAC 6.1, effective January 23, 1995

2400. SAN JUAN RIVER BASIN.

2401. The main stem of the San Juan River from the point where the San Juan leaves New Mexico and enters Colorado upstream to U.S. Highway 64 at Blanco, and any flow which enters the San Juan River from the Mancos and Chaco Rivers.

A. Designated Uses: municipal and industrial water supply, irrigation, livestock watering, wildlife habitat, secondary contact, marginal coldwater fishery, and warmwater fishery.

B. Standards:

1. In any single sample: pH shall be within the range of 6.6 to 8.8, and temperature shall not exceed 32.2 C (90 F). The use-specific numeric standards set forth in Section 3101 are applicable to the designated uses listed above in Section 2401.A.

2. The monthly geometric mean of fecal coliform bacteria shall not exceed 200/100 ml; no single sample shall exceed 400/100 ml (see Section 1103.B).

2402. LaPlata River from its confluence with the San Juan River upstream to the New Mexico-Colorado line.

A. Designated Uses: irrigation, limited warmwater fishery, marginal coldwater fishery, livestock watering, wildlife habitat, and secondary contact.

B. Standards:

1. In any single sample: pH shall be within the range of 6.6 to 8.8 and temperature shall not exceed 32.2 C (90 F). The use-specific numeric standards set forth in Section 3101 are applicable to the designated uses listed above in Section 2402.A.

2. The monthly geometric mean of fecal coliform bacteria shall not exceed 200/100 ml; no single sample shall exceed 400/100 ml (see Section1103.B).

2403. The Animas River from its confluence with the San Juan upstream to U.S. Highway 550 at Aztec.

A. Designated Uses: municipal and industrial water supply, irrigation, livestock watering, wildlife habitat, marginal coldwater fishery, secondary contact, and warmwater fishery.

B. Standards:

1. In any single sample: pH shall be within the range of 6.6 to 8.8, and temperature shall not exceed 27 C (80.6 F). The use-specific numeric standards set forth in Section 3101 are applicable to the designated uses listed above in Section 2403.A.

2. The monthly geometric mean of fecal coliform bacteria shall not exceed 200/100 ml; no single sample shall exceed 400/100 ml (see Section1103.B).

2404. The Animas River from U.S. Highway 550 upstream to the New Mexico-Colorado line.

A. Designated Uses: coldwater fishery, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply, and secondary contact.

B. Standards:

1. In any single sample: pH shall be within the range of 6.6 to 8.8, temperature shall not exceed 20 C (68 F), and total phosphorus (as P) shall not exceed 0.l mg/l. The use-specific numeric standards set forth in Section 3101 are applicable to the designated uses listed above in Section 2404.A.

2. The monthly geometric mean of fecal coliform bacteria shall not exceed 200/100 ml; no single sample shall exceed 400/100 ml (see Section 1103.B).

3101. STANDARDS (2) APPLICABLE TO ATTAINABLE OR DESIGNATED USES UNLESS OTHERWISE SPECIFIED IN SUBPART II OF THESE STANDARDS (SECTIONS 2100 through 2805).

A. Coldwater Fishery: Dissolved oxygen shall not be less than 6.0 mg/l, temperature shall not exceed 20 C (68 F), and pH shall be within the range of 6.6 to 8.8. The acute and chronic standards set out in Section 3101.J are applicable to this use. The total ammonia standards set out in Section 3101.N are applicable to this use.

B. Domestic Water Supply . . .

C. High Quality Coldwater Fishery: Dissolved oxygen shall not be less than 6.0 mg/l, temperature shall not exceed 20 C (68 F), pH shall be within the range of 6.6 to 8.8, total phosphorus (as P) shall not exceed 0.1 mg/l, total organic carbon shall not exceed 7 mg/l, turbidity shall not exceed 10 NTU (25 NTU in certain reaches where natural background prevents attainment of lower turbidity), and conductivity (at 25 C) shall not exceed a limit varying between 300 umhos/cm and 1,500 umhos/cm depending on the natural background in particular stream reaches (the intent of this standard is to prevent excessive increases in dissolved solids which would result in changes in stream community structure). The acute and chronic standards set out in Section 3101.J are applicable to this use. The total ammonia standards set out in Section 3101.N are applicable to this use.

D. Irrigation: The monthly geometric mean of fecal coliform bacteria shall not exceed 1,000/100 ml; no single sample shall exceed 2,000/100 ml. The following numeric standards shall not be exceeded:

Dissolved aluminum	5.0 mg/l
Dissolved arsenic	0.10 mg/l
Dissolved boron	0.75 mg/l
Dissolved cadmium	0.01 mg/l
Dissolved chromium	0.10 mg/l
Dissolved cobalt	0.05 mg/l
Dissolved copper	0.20 mg/l
Dissolved lead	5.0 mg/l
Dissolved molybdenum	1.0 mg/l
Dissolved selenium	0.13 mg/l
Dissolved selenium in presence of >500 mg/l SO4	0.25 mg/l
Dissolved vanadium	0.1 mg/l
Dissolved zinc	2.0 mg/l

E. Limited Warmwater Fishery: Dissolved oxygen shall not be less than 5 mg/l, pH shall be within the range of 6.5 to 9.0, and on a case by case basis maximum temperatures may exceed 32.2 C. The acute and chronic standards set out in Section 3101.J are applicable to this use. The total ammonia standards set out in Section 3101.M are applicable to this use.

F. Marginal Coldwater Fishery: Dissolved oxygen shall not be less than 6 mg/l, on a case by case basis maximum temperatures may exceed 25 C and the pH may range from 6.6 to 9.0. The acute and chronic standards set out in Section 3101.J are applicable to this use. The total ammonia standards set out in Section 3101.N are applicable to this use.

G. Primary Contact: The monthly geometric mean of fecal coliform bacteria shall not exceed 200/100 ml, no single sample shall exceed 400/100 ml, pH shall be within the range of 6.6 to 8.8 and turbidity shall not exceed 25 NTU.

H. Warmwater Fishery: Dissolved oxygen shall not be less than 5 mg/l, temperature shall not exceed 32.2 C (90 F), and pH shall be within the range of 6.5 to 9.0. The acute and chronic standards set out in Section 3101.J are applicable to this use. The total ammonia standards set out in Section 3101.M are applicable to this use.

I. Fish culture, secondary contact, and municipal and industrial water supply and storage are also designated in particular stream reaches where these uses are actually being realized. However, no numeric standards apply uniquely to these uses. Water quality adequate for these uses is ensured by the general standards and numeric standards for bacterial quality, pH, and temperature which are established for all stream reaches listed in Subpart II of these standards (Sections 2100 through 2805).

J. The following schedule of numeric standards and equations for the substances listed shall apply to the subcategories of fisheries identified in Section 3101 of these standards:

1. Acute Standards (3)

Dissolved aluminum	750 ug/l
Dissolved beryllium	130 ug/l

Total mercury	2.4 ug/l
Total recoverable selenium	20.0 ug/l
Dissolved silver (5)	e(1.72[ln(hardness)]-6.52) ug/l
Cyanide, amenable to chlorination	22.0 ug/l
Total chlordane	2.4 ug/l
Dissolved cadmium	e(1.128[ln(hardness)]-3.828) ug/l
Dissolved chromium (6)	e(0.819[ln(hardness)]+3.688) ug/l
Dissolved copper	e(0.9422[ln(hardness)]-1.464) ug/l
Dissolved lead	e(1.273[ln(hardness)]-1.46) ug/l
Dissolved nickel	e(0.8460[ln(hardness)]+3.3612) ug/l
Dissolved zinc	e(0.8473[ln(hardness)]+0.8604) ug/l
Total chlorine residual	19 g/l

2. Chronic Standards (4)

Dissolved aluminum	87.0 ug/l
Dissolved beryllium	5.3 ug/l
Total mercury	0.012 ug/l
Total recoverable selenium	2.0 ug/l
Cyanide, amenable to chlorination	5.2 ug/l
Total chlordane	0.0043 ug/l
Dissolved cadmium (5)	e(0.7852[ln(hardness)]-3.49) ug/l
Dissolved chromium (6)	e(0.819[ln(hardness)]+1.561) ug/l
Dissolved copper	e(0.8545[ln(hardness)]-1.465) ug/l
Dissolved lead	e(1.273[ln(hardness)]-4.705) ug/l
Dissolved nickel	e(0.846[ln(hardness)]+1.1645) ug/l
Dissolved zinc	e(0.8473[ln(hardness)]+0.7614) ug/l
Total chlorine residual	11 ug/l

K. Livestock Watering: The following numeric standards shall not be exceeded:

Dissolved aluminum	5.0 mg/l
Dissolved arsenic	0.2 mg/l
Dissolved boron	5.0 mg/l
Dissolved cadmium	0.05 mg/l
Dissolved chromium (6)	1.0 mg/l
Dissolved cobalt	1.0 mg/l
Dissolved copper	0.5 mg/l
Dissolved lead	0.1 mg/l
Total mercury	0.01 mg/l
Dissolved selenium	0.05 mg/l
Dissolved vanadium	0.1 mg/l
Dissolved zinc	25.0 mg/l
Radium-226 + radium-228	30.0 pCi/l
Tritium	20,000 pCi/l
Gross alpha	15 pCi/l

L. Wildlife Habitat: The following narrative standard shall apply:

1. Except as provided below in Paragraph 2 of this section, no discharge shall contain any substance, including, but not limited to selenium, DDT, PCB's and dioxin, at a level which, when added to background concentrations, can lead to bioaccumulation to toxic levels in any animal species. In the absence of site-specific information, this requirement shall be interpreted as establishing a stream standard of 2 ug/l for total recoverable selenium and of 0.012 ug/l for total mercury.

2. The discharge of substances that bioaccumulate in excess of levels pecified above in Paragraph 1, is allowed if, and only to the extent that, the substances are present in the intake waters which are diverted and utilized prior to discharge, and then only if the discharger utilizes best available treatment technology to reduce the amount of bioaccumulating substances which are discharged.

3. Discharges to waters which are designated for wildlife habitat uses, but not for fisheries uses, shall not contain levels of ammonia or chlorine in amounts which reduce biological productivity and/or species diversity to levels below those which occur naturally, and in no case shall contain chlorine in excess of 1 mg/l nor ammonia in excess of levels which can be accomplished through best reasonable operating practices at existing treatment facilities.

4. A discharge which contains any heavy metal at concentrations in excess of the concentrations set forth in Section 3101.J.1 of these standards shall not be permitted in an amount, measured by total mass, which exceeds by more than 5 percent the amount present in the intake waters which are diverted and utilized prior to the discharge, unless the discharger has taken steps (an approved program to require industrial pretreatment; or a corrosion program) appropriate to reduce influent concentrations to the extent practicable.

M. Total Ammonia (mg/l as N), Warmwater Fisheries:

1. Acute Standards(3)

Temp. C	pH 6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00
0	29	26	23	19	14	10	6.6	3.7	2.1	1.2	0.70
1	28	26	23	19	14	9.9	6.5	3.7	2.1	1.2	0.70
2	28	26	22	18	14	9.7	6.4	3.6	2.1	1.2	0.69
3	28	25	22	18	14	9.6	6.3	3.6	2.0	1.2	0.69
4	27	25	22	18	14	9.5	6.2	3.5	2.0	1.2	0.69
5	27	25	22	18	13	9.4	6.1	3.5	2.0	1.2	0.68
6	27	24	21	18	13	9.3	6.1	3.5	2.0	1.1	0.68
7	26	24	21	17	13	9.2	6.0	3.4	2.0	1.1	0.68
8	26	24	21	17	13	9.1	6.0	3.4	1.9	1.1	0.68
9	26	24	21	17	13	9.0	5.9	3.4	1.9	1.1	0.68
10	25	23	21	17	13	8.9	5.9	3.3	1.9	1.1	0.68
11	25	23	20	17	13	8.9	5.8	3.3	1.9	1.1	0.68
12	25	23	20	17	13	8.8	5.8	3.3	1.9	1.1	0.69
13	25	23	20	16	12	8.7	5.7	3.3	1.9	1.1	0.69
14	25	23	20	16	12	8.7	5.7	3.3	1.9	1.1	0.70
15	24	23	20	16	12	8.6	5.7	3.3	1.9	1.1	0.70
16	24	22	20	16	12	8.6	5.7	3.3	1.9	1.1	0.71
17	24	22	20	16	12	8.5	5.6	3.2	1.9	1.1	0.72
18	24	22	19	16	12	8.5	5.6	3.2	1.9	1.2	0.73
19	24	22	19	16	12	8.5	5.6	3.2	1.9	1.2	0.74
20	24	22	19	16	12	8.5	5.6	3.2	1.9	1.2	0.75
21	24	22	19	16	12	8.4	5.6	3.2	1.9	1.2	0.77
22	24	22	19	16	12	8.4	5.6	3.3	1.9	1.2	0.78
23	24	22	19	16	12	8.4	5.6	3.3	1.9	1.2	0.80
24	24	22	19	16	12	8.4	5.6	3.3	2.0	1.2	0.81
25	24	22	19	16	12	8.4	5.6	3.3	2.0	1.2	0.83
26	22	20	18	15	11	7.9	5.2	3.1	1.9	1.2	0.80
27	20	19	17	14	10	7.3	4.9	2.9	1.8	1.1	0.76
28	19	18	15	13	9.7	6.9	4.6	2.7	1.7	1.1	0.73
29	18	16	14	12	9.1	6.4	4.3	2.6	1.6	1.0	0.70
30	17	15	13	11	8.5	6.0	4.1	2.4	1.5	0.97	0.68

2. Chronic Standards (4)

	pH										
Temp. C	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00
0	2.5	2.5	2.5	2.5	2.5	2.3	1.5	0.84	0.48	0.28	0.16
1	2.5	2.5	2.5	2.5	2.5	2.3	1.5	0.8	0.47	0.27	0.16
2	2.4	2.4	2.4	2.4	2.4	2.2	1.5	0.82	0.47	0.27	0.16
3	2.4	2.4	2.4	2.4	2.4	2.2	1.4	0.81	0.46	0.27	0.16
4	2.4	2.4	2.4	2.4	2.4	2.2	1.4	0.80	0.46	0.27	0.16
5	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.80	0.45	0.26	0.16
6	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.79	0.45	0.26	0.16
7	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.78	0.45	0.26	0.16
8	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.77	0.44	0.26	0.15
9	2.2	2.2	2.2	2.2	2.2	2.1	1.3	0.77	0.44	0.26	0.16
10	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.76	0.44	0.26	0.16
11	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.76	0.44	0.26	0.16
12	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.75	0.44	0.26	0.16
13	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.75	0.43	0.26	0.16
14	2.1	2.1	2.1	2.1	2.2	2.0	1.3	0.75	0.43	0.26	0.16
15	2.1	2.1	2.1	2.1	2.1	2.0	1.3	0.74	0.43	0.26	0.16
16	2.1	2.1	2.1	2.1	2.1	2.0	1.3	0.74	0.43	0.26	0.16
17	2.1	2.1	2.1	2.1	2.1	1.9	1.3	0.74	0.43	0.26	0.16
18	2.1	2.1	2.1	2.1	2.1	1.9	1.3	0.74	0.43	0.26	0.17
19	2.1	2.1	2.1	2.1	2.1	1.9	1.3	0.74	0.44	0.26	0.17
20	2.1	2.1	2.1	2.1	2.1	1.9	1.3	0.74	0.44	0.27	0.17
21	1.9	1.9	1.9	1.9	1.9	1.8	1.2	0.69	0.41	0.25	0.16
22	1.8	1.8	1.8	1.8	1.8	1.7	1.1	0.65	0.38	0.24	0.15
23	1.7	1.7	1.7	1.7	1.7	1.6	1.0	0.60	0.36	0.22	0.15
24	1.6	1.6	1.6	1.6	1.6	1.5	0.97	0.57	0.34	0.21	0.14
25	1.4	1.4	1.5	1.5	1.5	1.4	0.91	0.53	0.32	0.20	0.13
26	1.3	1.3	1.4	1.4	1.4	1.3	0.85	0.50	0.30	0.19	0.13
27	1.3	1.3	1.3	1.3	1.3	1.2	0.79	0.47	0.28	0.18	0.12
28	1.2	1.2	1.2	1.2	1.2	1.1	0.74	0.44	0.27	0.17	0.12
29	1.1	1.1	1.1	1.1	1.1	1.0	0.70	0.41	0.25	0.16	0.11
30	1.0	1.0	1.0	1.0	1.0	0.97	0.65	0.39	0.24	0.16	0.11

N. Total Ammonia (mg/l as N), Coldwater Fisheries:

1. Acute Standards(3)

pH

Temp. C	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00
0	29	26	23	19	14	10	6.6	3.7	2.1	1.2	0.70
1	28	26	23	19	14	9.9	6.5	3.7	2.1	1.2	0.70
2	28	26	22	18	14	9.7	6.4	3.6	2.1	1.2	0.69
3	28	25	22	18	14	9.6	6.3	3.6	2.0	1.2	0.69
4	27	25	22	18	14	9.5	6.2	3.5	2.0	1.2	0.69
5	27	25	22	18	13	9.4	6.1	3.5	2.0	1.2	0.68
6	27	24	2	18	13	9.3	6.1	3.5	2.0	1.1	0.68
7	26	24	21	17	13	9.2	6.0	3.4	2.0	1.1	0.68
8	26	24	21	17	13	9.1	6.0	3.4	1.9	1.1	0.68
9	26	24	21	17	13	9.0	5.9	3.4	1.9	1.1	0.68
10	25	23	21	17	13	8.9	5.9	3.3	1.9	1.1	0.68
11	25	23	20	17	13	8.9	5.8	3.3	1.9	1.1	0.68
12	25	23	20	17	13	8.8	5.8	3.3	1.9	1.1	0.69
13	25	23	20	16	12	8.7	5.7	3.3	1.9	1.1	0.69
14	25	23	20	16	12	8.7	5.7	3.3	1.9	1.1	0.70
15	24	23	20	16	12	8.6	5.7	3.3	1.9	1.1	0.70
16	24	22	20	16	12	8.6	5.7	3.3	1.9	1.1	0.71
17	24	22	20	16	12	8.5	5.6	3.2	1.9	1.1	0.72
18	24	22	19	16	12	8.5	5.6	3.2	1.9	1.2	0.73
19	24	22	19	16	12	8.5	5.6	3.2	1.9	1.2	0.74
20	24	22	19	16	12	8.5	5.6	3.2	1.9	1.2	0.75
21	22	20	18	15	11	7.9	5.2	3.0	1.8	1.1	0.71
22	21	19	17	14	10	7.3	4.9	2.8	1.7	1.0	0.68
23	19	18	15	13	9.7	6.8	4.5	2.7	1.6	0.98	0.65
24	18	16	14	12	9.0	6.4	4.2	2.5	1.5	0.93	0.62
25	17	15	13	11	8.4	6.0	4.0	2.3	1.4	0.88	0.59
26	16	14	13	10	7.9	5.6	3.7	2.2	1.3	0.84	0.56
27	14	13	12	9.6	7.3	5.2	3.5	2.1	1.2	0.79	0.54
28	13	12	11	9.0	6.9	4.9	3.3	1.9	1.2	0.76	0.52
29	13	12	10	8.4	6.4	4.6	3.1	1.8	1.1	0.72	0.50
30	12	1	10	7.8	6.0	4.3	2.9	1.7	1.1	0.69	0.48

2. Chronic Standards (4)

Temp. C	pH 6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00
0	2.5	2.5	2.5	2.5	2.5	2.3	1.5	0.84	0.48	0.28	0.16
1	2.5	2.5	2.5	2.5	2.5	2.3	1.5	0.83	0.47	0.27	0.16
2	2.4	2.4	2.4	2.4	2.4	2.2	1.5	0.82	0.47	0.27	0.16
3	2.4	2.4	2.4	2.4	2.4	2.2	1.4	0.81	0.46	0.27	0.16
4	2.4	2.4	2.4	2.4	2.4	2.2	1.4	0.80	0.46	0.27	0.16
5	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.80	0.45	0.26	0.16
6	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.79	0.45	0.26	0.16
7	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.78	0.45	0.26	0.16
8	2.3	2.3	2.3	2.3	2.3	2.1	1.4	0.77	0.44	0.26	0.15
9	2.2	2.2	2.2	2.2	2.2	2.1	1.3	0.77	0.44	0.26	0.16
10	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.76	0.44	0.26	0.16
11	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.76	0.44	0.26	0.16
12	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.75	0.44	0.26	0.16
13	2.2	2.2	2.2	2.2	2.2	2.0	1.3	0.75	0.43	0.26	0.16
14	2.1	2.1	2.1	2.1	2.2	2.0	1.3	0.75	0.43	0.26	0.16
15	2.1	2.1	2.1	2.1	2.1	2.0	1.3	0.74	0.43	0.26	0.16
16	2.0	2.0	2.0	2.0	2.0	1.8	1.2	0.69	0.40	0.24	0.15
17	1.8	1.8	1.8	1.8	1.8	1.7	1.1	0.64	0.38	0.23	0.14
18	1.7	1.7	1.7	1.7	1.7	1.6	1.0	0.60	0.35	0.21	0.14
19	1.6	1.6	1.6	1.6	1.6	1.5	0.97	0.56	0.33	0.20	0.13
20	1.5	1.5	1.5	1.5	1.5	1.4	0.90	0.52	0.31	0.19	0.12
21	1.4	1.4	1.4	1.4	1.4	1.3	0.84	0.49	0.29	0.18	0.12
22	1.3	1.3	1.3	1.3	1.3	1.2	0.79	0.46	0.27	0.17	0.11
23	1.2	1.2	1.2	1.2	1.2	1.1	0.73	0.43	0.26	0.16	0.10
24	1.1	1.1	1.1	1.1	1.1	1.0	0.69	0.40	0.24	0.15	0.10
25	1.0	1.0	1.0	1.0	1.0	0.96	0.64	0.38	0.23	0.14	0.095
26	0.95	0.95	0.96	0.96	0.97	0.9	0.60	0.35	0.21	0.13	0.091
27	0.89	0.89	0.89	0.90	0.91	0.84	0.56	0.33	0.20	0.13	0.087
28	0.83	0.83	0.83	0.84	0.85	0.79	0.53	0.31	0.19	0.12	0.084
29	0.77	0.78	0.78	0.78	0.79	0.73	0.49	0.29	0.18	0.12	0.080
30	0.72	0.72	0.73	0.73	0.74	0.69	0.46	0.28	0.17	0.11	0.077

2. When a classified water of the State has more than a single designated use, the applicable numeric standards shall be the most stringent of those established for such classified water.

3. The acute standards shall be applied to any single grab sample. Acute standards shall not be exceeded.

4. The chronic standards shall be applied to the arithmetic mean of four samples collected on each of four consecutive days. Chronic standards shall not be exceeded more than once every three years.

5. For numeric standards dependent on hardness, hardness (as mg $CaCO_3$/l) shall be determined as needed from available verifiable data sources including, but not limited to, the U.S. Environmental Protection Agency's STORET water quality database.

6. The standards for chromium shall be applied to an analysis which measures both the trivalent and hexavalent ions.

Attachment 3

Extracted from

Utah Water Quality Board

R317. Environmental Quality, Water Quality.
December 19, 1997

R317-2-13. Classification of Waters of the State.

13.1 Upper Colorado River Basin

a. Colorado River Drainage

	Use Classification			
San Juan River and tributaries, from Lake Powell to state line:	1C	2B	3B	4

R317-2-14. Numeric Criteria.

TABLE 2.14.1
NUMERIC CRITERIA FOR DOMESTIC,
RECREATION, AND AGRICULTURAL USES

Parameter	Domestic Source	Recreation and Aesthetics		Agri-culture
	1C	2A	2B	4
BACTERIOLOGICAL (30-DAY GEOMETRIC MEAN) (NO.)/100 ML) (7)				
Max. Total Coliforms	5000	1000	5000	
Max. Fecal Coliforms	2000	200	200	
PHYSICAL				
pH (RANGE)	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Turbidity Increase (NTU)		10	10	
METALS (DISSOLVED, MAXIMUM MG/L) (2)				
Arsenic	0.05			0.1
Barium	1.0			
Cadmium	0.01			0.01
Chromium	0.05			0.10
Copper				0.2
Lead	0.05			0.1
Mercury	0.002			
Selenium	0.01			0.05
Silver	0.05			
INORGANICS				

(MAXIMUM MG/L)				
Boron				0.75
Fluoride (3)	1.4-2.4			
Nitrates as N	10			
Total Dissolved Solids (4)				1200
RADIOLOGICAL (MAXIMUM pCi/L)				
Gross Alpha	15			15
Radium 226, 228 (Combined)	5			
Strontium 90	8			
Tritium	20000			
ORGANICS (MAXIMUM UG/L)				
Chlorophenoxy Herbicides				
2,4-D	100			
2,4,5-TP	10			
Endrin	0.2			
Hexachlorocyclohexane (Lindane)	4			
Methoxychlor	100			
Toxaphene	5			
POLLUTION INDICATORS (5)				
Gross Beta (pCi/L)	50			50
BOD (MG/L)		5	5	5
Nitrate as N (MG/L)		4	4	
Total Phosphorus as P (MG/L)(6)		0.05	0.05	
Total Suspended Solids (MG/L)		90	90	

FOOTNOTES:

(1) These limits are not applicable to lower water levels in deep impoundments.

(2 The dissolved metals method involves filtration of the sample in the field, acidification of the sample in the field, no digestion process in the laboratory, and analysis by atomic absorption or inductively coupled plasma (ICP) spectrophotometry.

(3 Maximum concentration varies according to the daily maximum mean air temperature.

TEMP (C)	MG/L
12.0	2.4
12.1-14.6	2.2
14.7-17.6	2.0
17.7-21.4	1.8
21.5-26.2	1.6
26.3-32.5	1.4

(4) Total dissolved solids (TDS) limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water.
(5) Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.
(6) Total Phosphorus as P (mg/l) limit for lakes and reservoirs shall be 0.025.
(7) Exceedences of bacteriological numeric criteria from nonhuman nonpoint sources will generally be addressed through appropriate Federal, State, and Local nonpoint source programs.

TABLE 2.14.2
NUMERIC CRITERIA FOR AQUATIC WILDLIFE

Parameter	Aquatic Wildlife			
	3A	3B	3C	3D
PHYSICAL				
Total Dissolved Gases	(1)	(1)		
Minimum Dissolved Oxygen (MG/L) (2)				
30 Day Average	6.5	5.5	5.0	5.0
7 Day Average	9.5/5.0	6.0/4.0		
1 Day Average	8.0/4.0	5.0/3.0	3.0	3.0
Max. Temperature (C)	20	27	27	
Max. Temperature Change (C)	2	4	4	
pH (Range)	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Turbidity Increase (NTU)	10	10	15	15
METALS (3) (DISSOLVED, UG/L) (4)				
Aluminum				
4 Day Average	87	87	87	87
1 Hour Average	750	750	750	750
Arsenic (Trivalent)				
4 Day Average	190	190	190	190
1 Hour Average	360	360	360	360
Cadmium (5)				
4 Day Average	1.1	1.1	1.1	1.1
1 Hour Average	3.9	3.9	3.9	3.9
Chromium (12) (Hexavalent)				
4 Day Average	11	11	11	11
1 Hour Average	16	16	16	16
Chromium (Trivalent) (5)				
4 Day Average	210	210	210	210
1 Hour Average	1700	1700	1700	1700
Copper (5)				
4 Day Average	12	12	12	
1 Hour Average	18	18	18	18
Cyanide (Free)				
4 Day Average	5.2	5.2	5.2	
1 Hour Average	22	22	22	22

Iron (Maximum)	1000	1000	1000	1000
Lead (5)				
4 Day Average	3.2	3.2	3.2	3.2
1 Hour Average	82	82	82	82
Mercury				
4 Day Average	0.012	0.012	0.012	0.012
1 Hour Average (12)	2.4	2.4	2.4	2.4
Nickel (5)				
4 Day Average	160	160	160	160
1 Hour Average	1400	1400	1400	1400
Selenium				
4 Day Average	5.0	5.0	5.0	5.0
1 Hour Average	20	20	20	20
Silver				
1 Hour Average (5)	4.1	4.1	4.1	4.1
Zinc (5)				
4 Day Average	110	110	110	110
1 Hour Average	120	120	120	120
INORGANICS (MG/L) (3)				
Total Ammonia as N (6)				
4 Day Average	(6a)	(6a)		
1 Hour Average	(6b)	(6b)	(6b)	(6b)
Chlorine (Total Residual) (7)				
4 Day Average	0.011	0.011		
1 Hour Average	0.019	0.019	0.2	(8)
Hydrogen Sulfide (Undissociated, Max. UG/L)	2.0	2.0	2.0	2.0
Phenol (Maximum)	0.01	0.01	0.01	0.01
RADIOLOGICAL (MAXIMUM pCi/L)				
Gross Alpha (9)	15	15	15	15
ORGANICS (UG/L) (3)				
Aldrin (Maximum)	1.5	1.5	1.5	1.5
Chlordane				
4 Day Average	0.0043	0.0043	0.0043	0.0043
1 Hour Average	1.2	1.2	1.2	1.2
DDT and Metabolites				
4 Day Average	0.0010	0.0010	0.0010	0.0010
1 Hour Average	0.55	0.55	0.55	0.55
Dieldrin				
4 Day Average	0.0019	0.0019	0.0019	0.0019
1 Hour Average	1.25	1.25	1.25	1.25
Endosulfan				
4 Day Average	0.056	0.056	0.056	0.056
1 Hour Average	0.11	0.11	0.11	0.11
Endrin				
4 Day Average	0.0023	0.0023	0.0023	0.0023
1 Hour Average	0.09	0.09	0.09	0.09
Guthion (Maximum)	0.01	0.01	0.01	0.01
Heptachlor				

4 Day Average	0.0038	0.0038	0.0038	0.0038
1 Hour Average	0.26	0.26	0.26	0.26
Hexachlorocyclohexane (Lindane)				
4 Day Average	0.08	0.08	0.08	0.08
1 Hour Average	1.0	1.0	1.0	1.0
Methoxychlor (Maximum)	0.03	0.03	0.03	0.03
Mirex (Maximum)	0.001	0.001	0.001	0.001
Parathion (Maximum)	0.04	0.04	0.04	0.04
PCB's				
4 Day Average	0.014	0.014	0.014	0.014
1 Hour Average	2.0	2.0	2.0	2.0
Pentachlorophenol (10)				
4 Day Average	13	13	13	13
1 Hour Average	20	20	20	20
Toxaphene				
4 Day Average	0.0002	0.0002	0.0002	0.0002
1 Hour Average	0.73	0.73	0.73	0.73
POLLUTION INDICATORS (9)				
Gross Beta (pCi/L)	50	50	50	50
BOD (MG/L)	5	5	5	5
Nitrate as N (MG/L)	4	4	4	
Total Phosphorus as P (MG/L) (11)	0.05	0.05		
Total Suspended Solids (MG/L)(9)	35	90	90	

FOOTNOTES:

(1) Not to exceed 110% of saturation.

(2) These limits are not applicable to lower water levels in deep impoundments. First number in column is for when early life stages are present, second number is for when all other life stages present.

(3) Where criteria are listed as 4-day average and 1-hour average concentrations, these concentrations should not be exceeded more often than once every three years on the average.

(4) The dissolved metals method involves filtration of the sample in the field, acidification of the sample in the field, no digestion process in the laboratory, and analysis by atomic absorption spectrophotometry or inductively coupled plasma (ICP).

(5) Hardness dependent criteria. 100 mg/l used. Conversion factors for ratio of total recoverable metals to dissolved metals must also be appied. See Table 2.14.3 for complete equations for hardness and conversion factors.

(6) Un-ionized ammonia toxicity is dependent upon the temperature and pH of the waterbody. For detailed explanation refer to Federal Register, vol. 50, 30784, July 29, 1985.

The following equations are used to calculate criteria concentrations:

(6a) The 4-Day average (chronic) concentration of un-ionized ammonia in mg/l as N is (0.80 / FT / FPH / RATIO) * 0.822, where:

FT = $10^{0.03(20 - TCAP)}$; T is greater than or equal to TCAP and less than or equal to 30

= $10^{0.03(20 - T)}$; T is greater than or equal to 0 and less than or equal to TCAP.

FPH = 1; pH is greater than or equal to 8.0 and less than or equal to 9.0.

= $(1 + 10^{7.4 - pH}) / 1.25$ pH is greater than or equal to 6.5 and less than 8.0
T = degrees C, and
TCAP = 15 C for salmonids or other sensitive coldwater species, or
= 20 C for salmonids and other sensitive coldwater species absent.
RATIO = 13.5; pH is greater than or equal to 7.7 and less than or equal to 9.0.
= $20(10^{7.7 - pH}) / 1 + 10^{7.4 - pH})$; pH is greater than or equal to 6.5 and less than or equal to.

(6b) The 1-Hour average (acute) concentration of un-ionized ammonia in mg/l as N is (0.52 / FT / FPH / 2) * 0.822

Where:
FT = $10^{0.03(20 - TCAP)}$; T is greater or equal to TCAP and less than or equal to 30.
= $10^{0.03(20 - T)}$; T is greater than or equal to 0 and less than or equal to TACP.
FPH = 1; pH is greater than or equal to 8.0 and less than or equal to 9.0.
= $(1 + 10^{7.4 - pH}) / 1.25$ pH is greater than or equal to 6.5 or less than
T = degrees C, and
TCAP = 20 C for salmonids or other sensitive coldwater species, or
TCAP = 25 C for salmonids and other sensitive coldwater species absent.

(6c) Total Ammonia in mg/l as N is Un-ionized Ammonia in mg/l as N x $(1 + 10^{pKa - pH})$, where:

pKa = 0.09018 + 2729.92 / T
T = Temperature (C) + 273.2
For Tables of values, see following page.

(7) Special case segments and maximum TRC concentrations as follows:
Mill Race from Interstate Highway 15 to the Provo City wastewater treatment plant discharge 0.2 mg/l
Ironton Canal (Utah County), from Utah Lake (Provo Bay) to East boundary of Denver and Rio Grande Western
Railroad right-of-way 0.05 mg/l
Beer Creek (Utah County) from 4850 West (in NE1/4NE1/4 sec. 36, T.8 S., R.1 E.) to headwaters 0.3 mg/l
Box Elder Creek from confluence with Black Slough to Brigham City Reservoir (the Mayor's Pond) 0.019 mg/l l day average, 0.011 mg/l 4 day average.
Powell Slough 0.019 mg/l 1 day average, 0.011 mg/l 4 day average.

(8) Numeric criteria will be established based on a site-specific assessment of potential impacts to aquatic wildlife.

(9) Investigations should be conducted to develop more information where these levels are exceeded.

(10) pH dependent criteria. pH 7.8 used in table. See Table 2.14.4 for equation.

(11) Total Phosphorus as P (mg/l) limit for lakes and reservoirs shall be 0.025.

(12) Total recoverable metals to dissolved metals conversion factors must be applied to arrive at correct dissolved metals criteria. The conversion factors are: chronic helavalent chromium criteria, 0.962; acute hexavalent chromium criteria, 0.982; acute mercury criteria, 0.850.

TABLE
1-HOUR AVERAGE (ACUTE) CONCENTRATION OF
TOTAL AMMONIA AS N (MG/L)
FOR CLASS 3A WATERS
TEMPERATURE (C)

pH	0.00	5.00	10.00	15.00	20.00	25.00	30.00
6.50	28.7	26.8	25.4	24.4	23.8	16.6	11.8
7.00	23.1	21.6	20.5	19.7	19.2	13.4	9.52
7.50	14.3	13.4	12.7	12.3	12.0	8.42	5.99
8.00	6.55	6.14	5.86	5.68	5.59	3.97	2.87
8.50	2.11	1.99	1.93	1.90	1.92	1.40	1.05
9.00	0.70	0.68	0.68	0.70	0.75	0.59	0.48

TABLE
4-DAY AVERAGE (CHRONIC)CONCENTRATION OF
TOTAL AMMONIA AS N (MG/L)
FOR CLASS 3A WATERS
TEMPERATURE (C)

pH	0.00	5.00	10.00	15.00	20.00	25.00	30.00
6.50	2.49	2.33	2.21	2.12	1.46	1.02	0.72
7.00	2.49	2.33	2.21	2.13	1.47	1.03	0.73
7.50	2.50	2.34	2.22	2.14	1.48	1.04	0.74
8.00	1.49	1.40	1.33	1.29	0.90	0.64	0.46
8.50	0.48	0.45	0.44	0.43	0.31	0.23	0.17
9.00	0.16	0.16	0.16	0.16	0.12	0.10	0.08

TABLE
1-HOUR AVERAGE (ACUTE)CONCENTRATION OF
TOTAL AMMONIA AS N (MG/L)
FOR CLASS 3B, 3C, 3D WATERS
TEMPERATURE (C)

pH	0.00	5.00	10.00	15.00	20.00	25.00	30.00
6.50	28.7	26.8	25.4	24.4	23.8	23.5	16.6
7.00	23.1	21.6	20.5	19.7	19.2	19.0	13.5
7.50	14.3	13.4	12.7	12.3	12.0	11.9	8.47
8.00	6.55	6.14	5.86	5,68	5.59	5.61	4.05
8.50	2.11	1.99	1.93	1.90	1.92	1.98	1.49
9.00	0.70	0.68	0.68	0.70	0.75	0.83	0.68

TABLE
4-DAY AVERAGE (CHRONIC) CONCENTRATION OF
TOTAL AMMONIA AS N (MG/L)
FOR CLASS 3B WATERS
TEMPERATURE (C)

pH	0.00	5.00	10.00	15.00	20.00	25.00	30.00
6.50	2.49	2.33	2.21	2.12	2.07	1.44	1.02
7.00	2.49	2.33	2.21	2.13	2.07	1.45	1.03
7.50	2.50	2.34	2.22	2.14	2.09	1.47	1.04
8.00	1.49	1.14	1.33	1.29	1.27	0.90	0.65
8.50	0.48	0.45	0.44	0.43	0.44	0.32	0.24
9.00	0.16	0.16	0.16	0.16	0.17	0.13	0.11

TABLE 2.14.3a
EQUATIONS FOR PARAMETERS WITH
HARDNESS (1) DEPENDENCE, INCLUDING CONVERSION FACTORS
FOR TOTAL RECOVERABLE TO DISSOLVED METALS

Parameter	4-Day Average (Chronic) Concentration (UG/L)	
CADMIUM	CFx $e^{(0.7852(\ln(hardness))-3.490)}$	CF = 1.101672 - (ln hardness)(0.041838)
CHROMIUM (TRIVALENT)	CFx $e^{(0.8190(\ln(hardness))+1.561)}$	CF = 0.860
COPPER	CFx $e^{(0.8545(\ln(hardness))-1.465)}$	CF = 0.960
LEAD	CFx $e^{(1.273(\ln(hardness))-4.705)}$	CF = 1.46203 - (ln hardness)(0.145712)
NICKEL	CFx $e^{(0.8460(\ln(hardness))+1.1645)}$	CF = 0.997
SILVER	N/A	
ZINC	Cfx $e^{(0.8473(\ln(hardness))+0.7614)}$	CF = 0.986

TABLE 2.14.3b
EQUATIONS FOR PARAMETERS WITH
HARDNESS (1) DEPENDENCE, INCLUDING CONVERSION FACTORS
FOR TOTAL RECOVERABLE TO DISSOLVED METALS

Parameter	1-Hour Average (Acute) Concentration (UG/L)	
CADMIUM	CFx $e^{(1.128(\ln(hardness))-3.828)}$	CF = 1.136672 -(ln hardness)(0.41383)
CHROMIUM (TRIVALENT)	CFx $e^{(0.8190(\ln(hardness))+3.688)}$	CF = 0.316
COPPER	CFx $e^{(0.9422(\ln(hardness))-1.464)}$	CF = 0.960
LEAD	CFx $e^{(1.273(\ln(hardness))-1.460)}$	CF = 1.46203 - (ln hardness)(0.145712)
NICKEL	CFx $e^{(0.8460(\ln(hardness))+3.3612}$	CF= 0.998
SILVER	CFx $e^{(1.72(\ln(hardness))-6.52}$	CF = 0.85
ZINC	CFx $e^{(0.8473(\ln(hardness))+0.8604}$	CF = 0.978

FOOTNOTE:
(1) Hardness as mg/l $CaCO_3$.