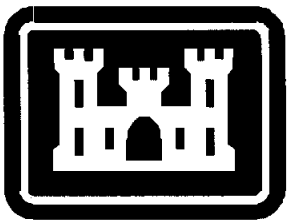
SOUTH MOSQUITO CREEK AND BUCKSKIN CREEK RESTORATION OF ABANDONED MINE SITES PROJECT

Draft Report

Prepared by
U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska



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Acronyms and Abbreviations

CDMG	Colorado Division of Minerals and Geology
CDQAR	Chemical Data Quality Assessment Report
GPS	Global Positioning System
LIMS	Laboratory Identification Management System
MDL	Method Detection Limit
MRL	Method Reporting Limit
NPDES	National Pollutant Discharge Elimination System
RAMS	Restoration of Abandoned Mine Sites
ROE	Right-of-Entry
SOP	Standard Operating Procedure
SSA	Site-Specific Addendum
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
WRDA	Water Resource Development Act

1 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) has been provided authority for Restoration of Abandoned Mine Sites (RAMS) through the Water Resource Development Act (WRDA) 1999 Section 560. The RAMS program is a regionally focused and stakeholder responsive program for the restoration of abandoned and inactive non-coal mines where water resources (ecosystem/habitat) have been degraded by past mining practices. This authority is intended to allow the USACE to provide support to agencies that manage lands impacted by past mining. The USACE coordinated in advance to obtain stakeholder buy-in on all work proposed to be performed by Corps Districts to ensure that the proposed work is supportive of the stakeholders' efforts in the area.

The USACE Omaha District is working in coordination with the Colorado Division of Minerals and Geology (CDMG) and the U.S. Forest Service (USFS) on the South Mosquito Creek and Buckskin Creek RAMS Project. The CDMG and USFS identified the data needs for these two drainages. The USACE obtained the necessary right-of-entry (ROE) to the identified locations. Individuals from the USACE Omaha District and USFS Pike National Forest performed the fieldwork from August 20 through 22, 2002.

The purpose of this report is to submit documentation of the field activities and analytical results to the CDMG and USFS. This report includes the methods and procedures used for collecting surface water quality samples, stream discharge measurements and calculations, field quality control, analytical results and a data quality evaluation.

2 PROJECT INFORMATION

2.1 Site Description

The investigation area includes South Mosquito Creek and Buckskin Creek, both located in Park County, Colorado. The investigation area is largely undeveloped mountainous terrain of the Pike National Forest, and is used extensively for outdoor recreation and livestock grazing. Private landowners, many of them with residences, are located along the lower to middle reaches of both creeks. An extensive amount of mining has occurred within the investigation area. Most of the mines are no longer active.

South Mosquito Creek is located approximately 4 miles west of the town of Alma. South Mosquito Creek is a tributary to Mosquito Creek, which then joins with the North Fork of the South Platte River near Alma.

The London Mine is the only major mine on South Mosquito Creek; however, there are several different levels of the London Mine and mine wastes from different periods of mining that affect the water quality of South Mosquito Creek. These include the drainage from the London Extension Tunnel, drainage from the Water Tunnel, the London Extension mine waste pile, the Water Tunnel mine waste pile, the Butte Mill tailings pile, the Butte Mine waste pile, the American Shaft waste pile, historic tailings piles, and a relatively recent tailings embankment.

Currently, a mine drainage treatment system has been constructed to treat the London Extension mine drainage. In addition, there is a current National Pollutant Discharge Elimination System (NPDES) permit on the discharge from the Water Tunnel. A Total Maximum Daily Load (TMDL) developed by the Colorado Department of Public Health & Environment concluded that even if all the metals from these two mine drainages were removed, South Mosquito Creek would still not meet stream standards.

Buckskin Creek is the next creek to the north of South Mosquito Creek and is also located west of the town of Alma. Buckskin Creek joins with the North Fork of the South Platte River near Alma. Numerous abandoned mines exist on the federal lands in the Buckskin Creek drainage.

During the summer of 2002, the region was experiencing extreme drought, thus lowering water levels/flows in all creeks and rivers.

2.2 Project Objectives

The primary objective of this field investigation is to collect and provide surface water quality and stream discharge data to the USFS and CDMG to support their respective investigations into the South Mosquito Creek and Buckskin Creek

drainages. This data may eventually be used by the CDMG and/or the USFS in order to determine metals loading from various mine sites to these creeks. The sampling locations were selected in consultation with the USFS and CDMG and reflect locations both upgradient and downgradient from potentially contaminated areas as a result of mining.

3 FIELD INVESTIGATION

3.1 Field Investigation Activities

A single round of surface water samples, water quality and stream discharge measurements were collected in accordance with the Restoration of Abandoned Mine Sites Final Work Plan dated July 2002 and Site-Specific Addendum (SSA) to the RAMS Final Work Plan dated 24 July 2002. Sampling locations are shown on Figure 1 and listed in Table 1. Sampling location coordinates were obtained from a hand-held Global Positioning System (GPS) device. These measurements were recorded in the field logbook in longitude and latitude. The device has an approximate accuracy of plus-or-minus 20 feet.

The following Standard Operating Procedures (SOPs) identified in the SSA to the RAMS Final Work Plan were adhered to during the course of this field investigation: A7 (Investigative Derived Waste Procedures); A11 (Surface Water and Sediment Sampling Equipment and Procedures); A12 (Equipment Decontamination Procedures); A13 (Sample Handling, Documentation, and Tracking Procedures); and A14 (Field Documentation).

3.2 Surface Water Samples

A total of twenty-three field samples and two duplicate samples of surface water were obtained from twelve sampling locations along South Mosquito Creek (SMC-1, SMC-3 through SMC-13) and eleven sampling locations along Buckskin Creek (BC-1 through BC-11). Duplicate samples were collected from sampling locations SMC-4 and BC-7. Immediately prior to collecting the surface water sample, field measurements for the following water quality parameters were obtained: pH, specific conductance, turbidity, and temperature. The water quality measurements were obtained using either a Horiba U-10 water quality checker and/or an Oyster water quality meter. These water quality measurements are included on Table 1. All surface water samples were submitted to a laboratory for analysis of total and dissolved metals, chloride, sulfate and alkalinity.

Surface water samples were collected with a disposable plastic cup and poured into the appropriate sample container. All excess water was disposed of by pouring gently out on the stream bank adjacent to the sampling location.

3.3 Stream Discharge Measurements

Measurements for stream discharge rates were obtained at each sampling location immediately following the collection of the surface water sample. Discharge rates were determined by one of three methods. At sampling locations SMC-11, BC-2, BC-5 and BC-7, the time to fill a container of known volume was measured. At sampling locations SMC-1, SMC-3, SMC-4, SMC-5, SMC-6, SMC-8 and SMC-13, either a permanent flume or portable cutthroat flume was used to measure the stream discharge rate. At the remainder of the

sampling locations, a hand-held flow meter and tape measure were used to calculate steam flow velocities and streambed cross-sectional areas.

At each sampling location where the flow meter was used, the stream channel was subdivided into equal segments ranging from 0.2 to 0.5 feet wide. The depth and average velocity of the stream was measured in the middle of each segment. For each stream segment, the average velocity was then multiplied by the calculated cross-sectional area in order to determine the discharge rate for that segment. The total stream discharge rate, which is equal to the sum of the discharge rates for each segment, is presented in Table 1 for each sampling location.

3.4 Sample Identification Scheme

The sample identification scheme presented in the SSA to the RAMS Final Work Plan utilized the following designation:

UU-VVVV-XXXX-ZZ

where:

UU = Project designation which was replaced with **CO** (for Colorado RAMS);
VVVV = Designation of sampling area location which was replaced with **SMC** for South Mosquito Creek and **BC** for Buckskin Creek;
XXXX = **SW** for surface water sample followed by the two-digit sample location number; and
ZZ = Two character designation for samples, where 01 = normal field sample, and 02 = quality control (QC) duplicate sample.

4 LABORATORY ANALYTICAL RESULTS

4.1 Project and Data Quality Objectives

4.1.1 Project Objectives

The primary objective of this field investigation is to collect and provide surface water quality and stream discharge data to the USFS and CDMG to support their respective investigations into the South Mosquito Creek and Buckskin Creek drainages. For this project, a total of twenty-three surface water samples, along with two QC samples, were obtained from selected locations along South Mosquito Creek and Buckskin Creek for laboratory chemical analyses.

4.1.2 Data Quality Objectives

The Data Quality Objectives for this project are those presented in the RAMS Final Work Plan dated July 2002. The criteria in order to attain these objectives are given in the RAMS Final Work Plan and/or presented in this section. The Method Detection Limit (MDL), Method Reporting Limit (MRL), and QC criteria that will meet the data objectives for metals in water samples are given in Table 6-6 of the RAMS Final Work Plan. The MDL, MRL, and QC criteria that will meet the data objectives for alkalinity, chloride and sulfate are given in Table 6-7 of the RAMS Final Work Plan.

4.2 Laboratory Analytical Sample Requirements

All surface water samples were submitted to a laboratory for analysis of total and dissolved metals, chloride, sulfate and alkalinity.

Laboratory analytical sample requirements are given in the following table:

LABORATORY ANALYTICAL SAMPLE REQUIREMENTS

Parameter	Field	Quality Control Duplicate	MS/MSD*	Total
Metals Total**	23	2	--	25
Metals Dissolved**	23	2	--	25
Chloride	23	2	--	25
Alkalinity	23	2	--	25
Sulfate	23	2	--	25

* Required MS/MSD was obtained from the field samples.
** Metals include Al, As, Ca, Cd, Cr, Cu, Fe, Pb, Mg, Mn, K, Ag, and Zn.

4.3 Sample Containers, Preservation and Holding Times

Sample container, preservation, and holding time requirements are given in the following table:

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SURFACE WATER SAMPLES

Parameter	Container	Preservation	Maximum Holding Times:	
			Extraction	Analysis
Dissolved Metals	500 ml Plastic	Filtered and acidified with HNO_3 to a pH <2 by the ECB Lab; Iced to 4°C only in the field.	NA	6 months (Mercury - 28 days)
Total Metals	500 ml Plastic	Preserved in field with HNO_3 to a pH <2 and iced to 4°C.	NA	6 months (Mercury - 28 days)
Alkalinity	500 ml Plastic	Iced to 4°C.	NA	14 days
Sulfate			NA	28 days
Chloride			NA	28 days

1 NA = Not Applicable

4.4 Sample Labeling and Shipment

Immediately after sample collection, the samples were preserved as noted above, labeled, and placed into a cooler filled with ice to keep samples at 4°C. Labeling was performed as specified in the SSA to the RAMS Final Work Plan. The Laboratory Identification Management System (LIMS) number was **LIMS # 6692.** At the end of the day, the samples were transferred to a refrigerator where they were kept overnight at 4°C. At the beginning of the next day, the sample containers were placed in coolers with the appropriate chain-of-custody forms and packed with ice to keep the samples chilled at 4°C. The coolers were sealed and shipped by overnight mail to the USACE ECB Laboratory located in Omaha, Nebraska.

4.5 Sample Analysis

All samples were held at the ECB Laboratory and analyzed in the same sample analytical batch. The following analytical methods were used for the field samples and appropriate required quality control samples for this site:

Parameter	Method	Matrix
Metals	EPA Method 3005/6010B	water
Alkalinity	EPA Method 310.2	water
Chloride	EPA Method 325.2	water
Sulfate	EAP Method 375.2	water

4.6 Analytical Results

The analytical results for this project are provided in Table 2. These tables include the MRL, the analytical results with units specified, and any data qualifiers. Data qualifiers are defined on the table and are described in the Chemical Data Quality Assessment Report (CDQAR), which is included as an attachment to this document (Attachment 1).

5 QUALITY CONTROL REVIEW

Quality control review consists of an evaluation of the field and analytical procedures and a review of the data to ensure that the appropriate QC compliance was met.

5.1 Field Quality Control

All field documentation (field logbook, chain-of-custody forms) was reviewed by the project team for completeness. A review of the placement or coordinates of the sample was performed to ensure that this correlates to sample nomenclature. Placement and frequency of the quality control samples were reviewed to ensure compliance to set criteria. Location coordinates, flow rate measurements, cross-sectional area calculations, and discharge calculations were reviewed for completeness and accuracy by the project technical team.

5.2 Laboratory Quality Control

Laboratory Quality Control is provided in the CDQAR, which is included as an attachment to this document (Attachment 1).

5.3 Data Validation

Data validation information is provided in the CDQAR, which is included as an attachment to this document (Attachment 1).

5.4 Data Quality Summary

The CDQAR presents, in specific terms, the quality control practices utilized to achieve the goals of the site investigation at South Mosquito Creek and Buckskin Creek, Colorado. Samples were also collected and analyzed in accordance with ASTM and EPA methods and laboratory specific QA/QC procedures were used. These procedures were followed to generate high quality data.

The quality issues addressed in the CDQAR do not impact the usability of the data. The required qualifications have been applied to the data in Table 2. The reviewed data are usable and are suitable for addressing the overall objectives of this investigation.

6 SUMMARY

The project was executed in accordance with the RAMS Final Work Plan and the Site Specific Addendum for South Mosquito Creek and Buckskin Creek in Colorado. Samples were also collected and analyzed in accordance with ASTM and EPA methods and laboratory specific QA/QC procedures were used. These procedures were followed to generate high quality data. The quality issues addressed in the CDQAR do not impact the usability of the data. The reviewed data are usable and are suitable for addressing the overall objectives of this investigation.

Tables

Table 1
Sample Location, Sample Identification Number, Location Coordinates,
Discharge Rate, and Water Quality Parameters
South Mosquito Creek and Buckskin Creek
August 2000

Sample Location	Sample ID No.	Latitude	Longitude	Discharge (cfs)	Discharge (gpm)	pH	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°C)
SMC-1	CO-SMC-SW01-01	N 39° 16' 25.6"	W 106° 09' 28.6"	0.08	37.3[3]	8.19[1]	0.214	2	14.1
SMC-3	CO-SMC-SW03-01	Recording Error	W 106° 09' 09.6"	0.02	10.4[3]	7.27[1]	0.910	2	11.7
SMC-4	CO-SMC-SW04-01 & -02	N 39° 16' 19.6"	W 106° 08' 56.1"	0.12	54.8[3]	7.65[1]	0.360	1	8.0
SMC-5	CO-SMC-SW05-01	N 39° 16' 15.1"	W 106° 09' 00.1"	0.27	122.0[3]	8.15[1]	0.143	3	7.9
SMC-6	CO-SMC-SW06-01	N 39° 16' 17.2"	W 106° 08' 55.6"	0.41	182.0[3]	7.98[1]	0.168	1	6.8
SMC-7	CO-SMC-SW07-01	N 39° 16' 22.1"	W 106° 08' 41.0"	1.24	556.5	7.82[1]	0.252	4	8.6
SMC-8	CO-SMC-SW08-01	N 39° 16' 22.8"	W 106° 08' 41.4"	1.37	614.9[3]	7.91[1]	0.327	2	8.3
SMC-9	CO-SMC-SW09-01	N 39° 16' 25.8"	W 106° 08' 35.1"	2.40	1077.1	7.82[1]	0.293	2	8.6
SMC-10	CO-SMC-SW10-01	N 39° 16' 29.9"	W 106° 08' 26.6"	2.39	1072.6	7.85[1]	0.292	2	7.7
SMC-11	CO-SMC-SW11-01	N 39° 16' 26.7"	W 106° 08' 27.4"	0.02	8.0[4]	7.14[1]	0.336	4	7.2
SMC-12	CO-SMC-SW12-01	N 39° 16' 37.1"	W 106° 07' 59.0"	2.60	1166.9	7.58[1]	0.320	2	7.3
SMC-13	CO-SMC-SW13-01	N 39° 16' 14.8"	W 106° 08' 59.5"	0.03	13.4[3]	7.71[1]	0.261	3	3.5
BC-1	CO-BC-SW01-01	N 39° 19' 28.3"	W 106° 07' 39.5"	0.81	363.5	7.90[1] 7.06[2]	0.200	17	13.0
BC-2	CO-BC-SW02-01	N 39° 19' 27.9"	W 106° 07' 39.0"	0.05	24.0[4]	7.66[1] 6.88[2]	0.484	31	8.4
BC-3	CO-BC-SW03-01	N 39° 19' 17.0"	W 106° 07' 37.6"	1.23	552.0	7.83[1] 6.93[2]	0.254	28	10.4
BC-4	CO-BC-SW04-01	N 39° 19' 15.0"	W 106° 07' 37.8"	0.59	264.8	7.78[1] 6.10[2]	0.330	1	8.0
BC-5	CO-BC-SW05-01	N 39° 19' 55.6"	W 106° 07' 45.8"	0.03	15.0[4]	7.83[1] 6.95[2]	0.104	39	12.9
BC-6	CO-BC-SW06-01	N 39° 19' 00.6"	W 106° 07' 21.7"	2.06	924.5	7.68[1] 6.11[2]	0.173	6	7.9
BC-7	CO-BC-SW07-01 & -02	N 39° 19' 00.1"	W 106° 07' 09.7"	0.07	30.0[4]	7.75[1] 5.76[2]	0.552	7	3.5
BC-8	CO-BC-SW08-01	N 39° 18' 29.3"	W 106° 07' 05.5"	2.86	1283.6	7.46[1] 5.74[2]	0.227	7	6.1
BC-9	CO-BC-SW09-01	N 39° 17' 39.1"	W 106° 06' 17.2"	3.58	1606.7	7.82[1]	0.118	2	9.9
BC-10	CO-BC-SW10-01	N 39° 17' 29.6"	W 106° 05' 39.2"	3.48	1561.8	7.60[1]	0.118	4	10.5
BC-11	CO-BC-SW11-01	N 39° 17' 08.3"	W 106° 04' 27.1"	3.74	1678.5	8.11[1]	0.196	3	10.7

1. pH measured with an Oyster pH/Temperature/Specific Conductance Meter
2. pH measured with a Horiba U-10 Water Quality Meter
3. Flow rate measured with a flume
4. Flow rate measured using a graduated container

Table 2, South Mosquito Creek/Buckskin Creek Qualified Data

Sample, metals ug/L	MDL	CO-SMC-SW12-01 (DISS)			CO-SMC-SW12-01			CO-SMC-SW11-01 (DISS)			CO-SMC-SW11-01		
Date Collected		**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**
Aluminum	30	< 30	uB	90	< 30	u	90	< 30	uB	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	uB	15	< 3	u	15	< 3	uB	15
Cadmium	0.5	1.5	J	2.5	1.8	J	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	32700		300	32300		300	41000		300	42000		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	73	J	120	57	J	120	943		120
Lead	2	< 2	u	10	2.2	J	10	< 2	u	10	< 2	u	10
Magnesium	40	22400		120	22100		120	21400		120	21700		120
Manganese	1	45		4	45.5		4	353		4	367		4
Potassium	100	741		300	720		300	2070		300	2050		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	593		10	623		10	144		10	156		10
Alkalinity mg/L	7				110		20				130		20
Bicarb Alk as Ca(	7				110		20				130		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				75		20				85		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample, metals ug/L	MDL	CO-SMC-SW07-01 (DISS)			CO-SMC-SW07-01			CO-SMC-SW08-01 (DISS)			CO-SMC-SW08-01		
Date Collected		**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**
Aluminum	30	< 30	uB	90	< 30	uB	90	< 30	uB	90	< 30	uB	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	3.5		2.5	3.41		2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	30600		300	30900		300	31800		300	32200		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	3.7	J	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	95	J	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	15100		120	15200		120	27600		120	27900		120
Manganese	1	31.5		4	32.3		4	18.9		4	19.8		4
Potassium	100	707		300	697		300	614		300	634		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	914		10	939		10	376		10	390		10
Alkalinity mg/L	7				91		20				130		20
Bicarb Alk as Ca(	7				91		20				130		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				63		20				89		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW01-01 (DISS)			CO-SMC-SW01-01			CO-SMC-SW03-01 (DISS)			CO-SMC-SW03-01		
Date Collected		**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**
Aluminum	30	< 30	uB	90	< 30	uB	90	< 30	uB	90	81	JB	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	71.3		2.5	74.4		2.5
Calcium	100	28300		300	28200		300	76500		300	77100		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	2.7	J	10	39.5		10
Iron	40	88	J	120	162		120	< 40	u	120	1980		120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	2.2	J	10
Magnesium	40	14700		120	14700		120	63400		120	64000		120
Manganese	1	4.52		4	5.21		4	2390		4	2410		4
Potassium	100	534		300	551		300	1380		300	1420		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	8.2	J	10	5.6	J	10	20900		30	20900		30
Alkalinity mg/L	7				110		20				45		20
Bicarb Alk as Ca(	7				110		20				45		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				27		20				470	D	120

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW04-01 (DISS)			CO-SMC-SW04-01			CO-SMC-SW04-02 (DISS)			CO-SMC-SW04-02		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	10.5		2.5	10.8		2.5	10.5		2.5	11		2.5
Calcium	100	40000		300	39400		300	39200		300	39400		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	2	J	10	5.5	J	10	2.9	J	10	5.8	J	10
Iron	40	< 40	u	120	192		120	< 40	u	120	194		120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	25000		120	24500		120	24500		120	24600		120
Manganese	1	202		4	199		4	197		4	199		4
Potassium	100	719		300	711		300	700		300	714		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	3160		10	3340		10	3160		10	3340		10
Alkalinity mg/L	7				100		20				100		20
Bicarb Alk as Ca(	7				100		20				100		20
Carb Alk as CaCO:	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				140		20				130		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW06-01 (DISS)			CO-SMC-SW06-01			CO-SMC-SW13-01 (DISS)			CO-SMC-SW13-01		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	61	J	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	24000		300	24300		300	28300		300	28200		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	100	J	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	7970		120	8030		120	19700		120	19600		120
Manganese	1	10.1		4	14.7		4	9.62		4	10.3		4
Potassium	100	504		300	562		300	1510		300	1520		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	75.6		10	24.4		10	28.9		10	15.8		10
Alkalinity mg/L	7				86		20				130		20
Bicarb Alk as Ca(	7				86		20				130		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				21		20				43		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW05-01 (DISS)			CO-SMC-SW05-01			CO-BC-SW11-01 (DISS)			CO-BC-SW11-01		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	22500		300	23200		300	26600		300	26600		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	51	J	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	5540		120	5680		120	9020		120	9020		120
Manganese	1	2.4	J	4	4.46		4	< 1	u	4	1.1	J	4
Potassium	100	346		300	357		300	796		300	786		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	5.1	J	10	< 3	u	10	98.3		10	100		10
Alkalinity mg/L	7				78		20				55		20
Bicarb Alk as Ca(	7				78		20				55		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				10	J	20				59		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW10-01 (DISS)			CO-BC-SW10-01			CO-BC-SW09-01 (DISS)			CO-BC-SW09-01		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	26100		300	26000		300	26300		300	26500		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	8140		120	8120		120	8030		120	8060		120
Manganese	1	< 1	u	4	< 1	u	4	< 1	u	4	< 1	u	4
Potassium	100	754		300	762		300	770		300	781		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	110		10	113		10	121		10	121		10
Alkalinity mg/l	7				45		20				48		20
Bicarb Alk as Ca(	7				45		20				48		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				61		20				64		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW03-01 (DISS)			CO-BC-SW03-01			CO-BC-SW02-01 (DISS)			CO-BC-SW02-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	39900		300	39700		300	79300		300	78500		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	14.3		10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	2.2	J	10	2.3	J	10	< 2	u	10	< 2	u	10
Magnesium	40	10200		120	10200		120	22800		120	22800		120
Manganese	1	1.2	J	4	4.35		4	< 1	u	4	< 1	u	4
Potassium	100	641		300	653		300	972		300	990		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	21.7		10	23.1		10	7.7	J	10	10.5		10
Alkalinity mg/L	7				45		20				63		20
Bicarb Alk as Ca(	7				45		20				63		20
Carb Alk as CaCO3	7				<7	u	20				<7		20
Chloride mg/L	1				<1	u	5				1	J	5
Sulfate mg/L	6				100		20				250	D	40

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW01-01 (DISS)			CO-BC-SW01-01			CO-BC-SW05-01 (DISS)			CO-BC-SW05-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	0.57	J	2.5	0.53	J	2.5
Calcium	100	30800		300	30700		300	13900		300	13900		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	3	J	10	3.7	J	10
Iron	40	< 40	u	120	50	J	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	7500		120	7520		120	3180		120	3190		120
Manganese	1	< 1	u	4	6.42		4	1	J	4	1.1	J	4
Potassium	100	609		300	617		300	501		300	509		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	11.1		10	14.3		10	98.2		10	99.7		10
Alkalinity mg/L	7				43		20				26		20
Bicarb Alk as Ca(	7				43		20				26		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				72		20				27		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW08-01 (DISS)			CO-BC-SW08-01			CO-BC-SW07-01 (DISS)			CO-BC-SW07-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	38	J	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	1.1	J	2.5	1	J	2.5	1.4	J	2.5	1.3	J	2.5
Calcium	100	30400		300	30400		300	78900		300	79600		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	2.2	J	10	< 2	u	10	2.5	J	10
Magnesium	40	7630		120	7610		120	32400		120	32500		120
Manganese	1	1.2	J	4	4.04		4	< 1	u	4	< 1	u	4
Potassium	100	628		300	632		300	1860		300	1890		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	406		10	418		10	208		10	213		10
Alkalinity mg/L	7				36		20				72		20
Bicarb Alk as Ca(	7				36		20				72		20
Carb Alk as CaCO:	7				<7	u	20				<7	u	2
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				74		20				280	D	60

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW07-02 (DISS)			CO-BC-SW07-02			CO-BC-SW06-01 (DISS)			CO-BC-SW06-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	1.3	J	2.5	1.4	J	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	78800		300	79200		300	27000		300	27000		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	2.1	J	10
Magnesium	40	32200		120	32300		120	6440		120	6450		120
Manganese	1	< 1	u	4	< 1	u	4	< 1	u	4	2.1	J	4
Potassium	100	1820		300	1840		300	441		300	447		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	207		10	212		10	20.5		10	18.3		10
Alkalinity mg/L	7				69		20				44		20
Bicarb Alk as Ca(	7				69		20				44		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/l	6				270	D	60				64		20

Table 2 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW04-01 (DISS)			CO-BC-SW04-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	5380		300	5410		300
Chromium	2	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10
Magnesium	40	991		120	998		120
Manganese	1	1.4	J	4	2.3	J	4
Potassium	100	170	J	300	170	J	300
Silver	1	< 1	u	5	< 1	u	5
Zinc	3	10.6		10	11		10
Alkalinity mg/L	7				21		20
Bicarb Alk as Ca(	7				21		20
Carb Alk as CaCO3	7				<7	u	20
Chloride mg/L	1				<1	u	5
Sulfate mg/L	6				8	J	20

J = estimate value due to analyte detected between MDl and RL or data qualification
u = non detect above MDL B = Method blank detection
D = Analysis performed on diluted sample.

Figures

Attachment 1

OMAHA DISTRICT
U.S. ARMY
CORPS OF ENGINEERS

Chemical Data Quality Assessment Report (CDQAR)

For

Surface Water Samples Obtained at

South Mosquito Creek and Buckskin Creek, Colorado

November 2002

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS/ABBREVIATIONS

ADP	Analytical Data Package
ASTM	American Standard Testing Materials
°C	Degrees Celsius
CDQAR	Chemical Data Quality Assessment Report
CENWO	Corps of Engineers, Omaha District
COC	Chain-of-Custody
DQCR	Daily Quality Control Report
DQOs	Data Quality Objectives
DUP	Duplicate
ECB	Environmental Chemistry Branch
eV	Electron volt
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
Ft	Foot/Feet
I.D.	Inner Diameter
IDW	Investigative Derived Waste
Kg	Kilogram
L	Liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
mg	Milligram
Min	Minute
ml	Milliliters
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSL	Mean Sea Level
MW	Monitoring Well
N/A	Not Applicable
ND	non-detect
PID	Photoionization Detector
ppb	Parts per Billion (measured in water as ug/L)
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting Limit
RPD	Relative Percent Difference
SSHP	Site Safety Health Plan

SOP	Standard Operating Procedure
ug/L	Micrograms per Liter
U.S.	United States
USACE	United States Army Corps of Engineers

1 INTRODUCTION

1.1 QUALITY CONTROL SUMMARY

This Chemical Data Quality Assessment Report (CDQAR) describes the operations and procedures followed by U. S. Army Corps of Engineers (USACE) to conduct the investigation of the surface water samples obtained from the South Mosquito and Buckskin Creeks. Field work was performed by USACE Omaha District and U. S. Forest Service personnel. Analytical services were provided by the U. S. Army Corps of Engineers, the Environmental Chemistry Branch (ECB) Laboratory, located in Omaha, Nebraska.

The field and sample analyses was performed in accordance with the Work Plan for the Restoration of Abandoned Mine Sites prepared by U.S. Army Corps of Engineers, Omaha District, Omaha, Nebraska, July 2002 and the Site Specific Addendum for the South Mosquito and Buckskin Creek areas, 24 July, 2002.

This CDQAR includes a summary of the quality assurance (QA) and quality control (QC) procedures and an evaluation of data quality and data usability with respect to Data Quality Objectives (DQOs) established for this field investigation.

1.2 REPORT ORGANIZATION

Section 2 of this report provides a discussion of project and data quality objectives. Procedures employed to control and evaluate the quality of sample collection, transportation, storage, and analysis are presented in Section 3. Section 4 discusses data evaluation, and the results of QC evaluations are in Section 5. Conclusions and recommendations are presented in Section 6.

2 PROJECT DESCRIPTION

2.1 PROJECT PURPOSE

The purpose of this investigation is to collect and provide surface water quality and stream discharge data from South Mosquito and Buckskin Creeks, Colorado to determine the impact of mine wastes to the area.

2.2 ANALYTICAL SERVICES

The Environmental Chemistry Branch (ECB) Laboratory provided analytical services for total and dissolved metals, sulfate, alkalinity, and chloride. Field measurements of pH, specific conductance, temperature and turbidity were obtained with a Horiba U-10 water quality checker and/or an Oyster water quality meter. Laboratory address is given below:

US Army Corps of Engineers
Environmental Chemistry Branch (ECB) Laboratory
420 South 18th Street
Omaha, NE 68102

ECB Laboratory reported all non-detect results as "u". The non-detect values are given in the data tables as "u" meaning less than the Method Detection limits (MDL). The MDL is the minimum concentration of a substance that can be measured and reported with 99 per cent confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix containing the analyte. The Reporting Limit (RL) is determined by the laboratory and takes into account impacts from sample matrix, sample preparation, and instrument limitations. The RL represents the concentration at which the laboratory can both determine the presence of an analyte and accurately quantify the amount present. The laboratory reported MDL as sample detection limit and RL as sample quantitation limit or laboratory reporting limit. For this report they can be used interchangeably. The laboratory reported detections below the RL and higher than the MDL with a "J" laboratory qualifier, which indicates a greater degree of uncertainty associated with the quantitative result. The " J" values are considered valid and useable. Reporting limits may increase for an individual environmental sample due to high concentrations of target analytes, matrix effects, or other interferences.

2.3 DATA QUALITY OBJECTIVES

The DQOs for this site are based on the data objective and sensitivity criteria as given in the General Work Plan, July 2002.

2.3.1 Data Collected

The data collected for the South Mosquito Creek and Buckskin Creek was from surface water samples. The data collected included both field measurements (field screening data) and off-site analysis of samples (definitive data).

2.3.1.1 Field Measurements (Field Screening Data)

A Horiba U-10 water quality checker and/or an Oyster water quality meter was used to measure water quality parameters in the field. The Horiba U-10 measured pH, temperature, conductivity, and turbidity. The Oyster measured pH and conductivity. Measurements were recorded in the field logbook.

2.3.1.2 Off-Site Analysis (Definitive Level Data)

Definitive level data was obtained from twenty- three (23) surface water samples. All of these samples were analyzed for total and dissolved metals, alkalinity, chloride, and sulfate. Sections 3 and 4 present the field and laboratory quality control procedures, and the result of the quality control process is presented in Section 5.

3 FIELD QUALITY CONTROL PROCEDURES

3.1 PROJECT PLANNING

The field investigation was conducted as described in the Site Specific Addendum for South Mosquito Creek and Buckskin Creek, 24 July 2002. The plan was written by the Corps of Engineers, Omaha District (CENWO) to ensure the quality of data derived from the investigation. The plan provides a discussion of the project work and general procedures to be followed for field and laboratory activities.

3.2 DOCUMENTED FIELD ACTIVITIES

This section summarizes the equipment, procedures, and methods undertaken to insure quality sample collection activities. Investigation activities and QC procedures were recorded and documented in the field using appropriate field forms. Prior to sample collection, as well as between sample locations, field equipment was decontaminated.

3.2.1 Surface Water Samples

A total twenty- three (23) surface water samples plus two (2) duplicates were obtained by CENWO personnel between August 20 and 22, 2002.

3.2.2 Management of Investigation Derived Waste (IDW)

No IDW was generated during this investigation except for disposable sampling equipment such as gloves, plastic cups, etc., which were disposed of in a dumpster.

3.2.3 Decontamination Procedures

The field instruments were decontaminated in the field as described in the Standard Operating procedures.

3.2.4 Other Documentation and Reporting of Field Activities

All field activities were thoroughly documented in indelible ink using the following forms:

- Field Notebook
- Chain of Custody Record

CENWO field personnel initiated Chain of Custody (COC) documentation as samples were collected and selected for laboratory analysis. Sample custody was maintained from sample collection through the completion of the laboratory analysis.

3.2.5 Sample Labeling, Handling, and Shipping

The sampling team performed sample collection, sample labeling, and sample shipping. Samples were collected in the appropriate sample containers provided by the ECB Laboratory. The sample containers were identified with waterproof labels and all writing was completed in indelible ink.

Labeled samples were placed in sealed plastic bags and packed in waterproof plastic ice chests with sufficient packaging material placed around and between the sample jars. Ice was double bagged and placed on the bottom of the cooler, and around the sample containers, and on top of the sample containers to achieve and maintain preservation at 4 degrees Celsius from the time of collection until receipt by the laboratory. Sample containers, preservatives, and holding times used for this project are shown in Table 3-1.

Every cooler contained a COC form, prepared in triplicate, which identified all of the sample containers, analytical requirements, time and date sampled, preservatives, and other pertinent field data. Samples were shipped by an overnight courier to the ECB Laboratory to enable analysis within the specified holding times. Upon receipt in the laboratory, the Sample Custodian opened the shipping containers, compared the contents with the COC record, ensured that the document control information was accurate and complete, and dated the form. A Sample Receipt Form was also used by the laboratory to log in samples and document their integrity upon arrival. These forms are provided in the Analytical Data Packages.

3.3 FIELD QUALITY CONTROL SAMPLES

Duplicate samples were analyzed at the rate of one for each analytical batch. The results of the field QC samples and their impact on data quality are discussed in Section 4.0.

Table 3-1 Sample Containers, Preservation, and Holding Times for Surface Water Samples

Parameter	Container	Preservation	Maximum Holding Times:	
			Extraction	Analysis
Total Metals	1 - 500 ml plastic	HNO3 to pH<2 Ice to 4°C	6 months (Hg-28 days)	6 months (Hg-28 days)
Dissolved Metals	1 - 500 ml plastic	Ice to 4°C*	6 months (Hg-28 days)	6 months (Hg-28 days)
Alkalinity Chloride sulfate	1- 500 ml plastic	Ice to 4°C		14 days 28 days 28 days

* Acid preserved after filtration through 0.45 micron filter.

4 EVALUATION OF DATA QUALITY

The laboratory analytical data was reviewed and verified by the ECB Laboratory and then evaluated by the CENWO project chemist for compliance with project objectives.

The following section is a description of the laboratory review procedures used to ensure data quality and the project chemists' assessment of project deliverables. Data usability was determined by comparing the project DQOs against the quality of the final analytical results.

4.1 LABORATORY QUALITY CONTROL SAMPLES

This section provides a description of laboratory QC samples: laboratory control samples, method blanks, and matrix spike/matrix spike duplicate.

4.1.1 Laboratory Control Samples (LCS)

The laboratory analyzed a spike blank sample in duplicate to evaluate the precision and accuracy within an analytical batch. The nomenclature for these samples is a laboratory control sample (LCS). LCS sample pairs consisted of analyte-free water that was spiked with selected target compounds. LCS results are included in the QC section of each laboratory's data package, which are included in the Analytical Data Packages.

4.1.2 Method Blank Analyses

A laboratory method blank is a contaminant free matrix sample (e.g. a method blank is often a volume of distilled water carried through the entire analytical scheme) that is subjected to the same analytical procedures as the field samples. The method blank is used in all analyses to verify that the determined concentrations do not reflect contamination. One method blank is performed with every batch of samples (approximately 20 samples). If consistent high blank values are observed, laboratory glassware and reagents are checked for contamination and the analysis is halted until adequate blank results are obtained.

4.1.3 Surrogate Spike Analyses

An organic surrogate compounds is spiked into all investigative samples for organic analyses. The surrogate is compared to QC limits to evaluate the matrix effect of each sample and monitor the overall system performance. Low surrogate recoveries are indicative of problems in instrument performance, extraction procedures, or severe matrix effects. Samples which have a surrogate recovery above the laboratory control limits typically do not demonstrate performance problems unless the recoveries are high enough to indicate double spiking of surrogate compounds or extremely low internal standard recoveries.

4.1.4 Matris Spike/Matrix Spike Duplicate (MS/MSD)

The laboratory analyzed a spiked environmental sample and duplicate to evaluate the precision and accuracy within an analytical batch. The matrix spike (MS) is used to assess the performance of the method as applied to a particular project matrix. The MS is an environmental sample io which known concentrations of certain target analytes have been added before sample manipulation from the preparation, cleanup, and determinative procedures have been implemented. The results of the MS are evaluated in conjunction with other QC information to determine the effect of the matrix on the bias of the analysis.

4.2 LABORATORY DATA VALIDATION ACTIVITIES

All analytical data generated by ECB Laboratory was checked for completeness and evaluated for overall quality prior to final report generation as outlined in the Quality Assurance Program Plan (QAPP) and specified in the laboratory's Standard Operating Procedures (SOPs). This process consisted of data generation and reduction plus three levels of documented review. Each step of the review process involved evaluation of data quality based on QC data results and the professional judgement of the reviewer(s). All reviews were documented by the reviewer's signature and the date reviewed.

The first level review was performed by the analyst who generated the raw analytical data. Primary emphasis of the review was on correctness and completeness of the data set. All data were generated and reduced following method-specific SOPs. Each analyst reviewed the quality of the work based on the guidelines established in the SOP. The first review ensured that:

- Sample preparation and analysis information was correct and complete;
- The appropriate SOPs had been followed;
- QC parameters were within method control limits; and
- Documentation was complete

The second level review was structured so that all calibration data and QC sample results were reviewed and 10 percent of the analytical results were confirmed against the bench and instrument sheets. This includes a complete review of instrument data scans to ensure accurate peaks and retention time, and correct peak integrations have been performed. If no problems were found with the data package, the review was considered complete. If any problems were found with the data package, an additional 10 percent of the samples were checked to the bench sheet. The process was continued for each batch until no errors were found or until each data package was reviewed in its entirety. All second level reviews were performed by a laboratory supervisor, data review specialist, or QA officer to ensure that:

- Calibration data were appropriate to the method and completely documented;
- QC samples were within established guidelines;
- Qualitative identification of sample components was correct;
- Quantitative values were calculated correctly;
- Documentation was complete and correct;
- The data were ready for final reporting; and;
- The data package was complete and ready for data archive.

An important element of the second review was the documentation of any errors identified and corrected during the review process.

Before the final report was released, a third review was performed to check each data package for completeness and to ensure that the data met the overall objectives of the project. This review was done by the laboratory Program Administrator, as stated in the QAPP. The review was performed to ensure that:

- Target analyte lists were complete as specified in the sampling and analysis plan;
- Data package checklist items were present;
- Case narratives accurately documented analytical conditions;
- All non-conformances were addressed and closed.

The Analytical Data Packages (ADPs) contain the following:

- Cover page, identifying project and remarks;
- Summary and discussion of method QC and shipping and/or chain-of-custody errors;
- Sample receipt information including copies of Cooler Receipt Forms;
- Chain-of-Custody (COC) information including copies of COCs;
- Analytical Test Results;

As part of the review process, the laboratory applied data qualifiers to specific results to indicate usability and/or special analytical conditions. The following qualifiers were used to flag data:

B	The compound was also observed in the method blank.
J	Estimated concentration below the Reporting Limit.
u	The compound was not detected.
M	Reporting limit higher than normal due to matrix interferences.
D	Derived from a dilution of extract.

All investigative and QC sample summary results have been submitted in the Analytical Data Packages.

4.3 PROJECT CHEMIST QUALITY EVALUATION

In addition to the internal validation conducted by the ECB Laboratory, the project chemist performed data validation of the data set. This included an evaluation and validation of samples based on:

- Initial sample inspection and COC documentation;
- Holding Times;
- Field Duplicate Analyses;
- Laboratory Control Samples;
- Method Blank Analyses;
- Matrix Spike/Matrix Spike Duplicate recoveries;
- Surrogate recoveries;
- Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as they apply to this CDQAR; and
- An overall assessment of data compared to the project DQOs.

The CENWO project chemist received data from the laboratory in hard copy format. The USACE Guidance for the Review of Performance-Based Definitive Chemical Data was used to

perform the review and validation of the data.

The first step in evaluating and validating the data was to group the samples according to analytical batch or work group. A table was generated which show all analytical batches (project samples and laboratory QC samples). The batches are shown on Table 4-1. After analytical batching, the batches were reviewed to ensure that the proper QC (type and frequency) was analyzed according to the QAPP for each batch. Next, sample duplicate frequency was evaluated for compliance with the QAPP. Chain-of-custody forms and Cooler Receipt Forms were then reviewed. Any problems found were documented and the impact on sample results was determined and explained.

Holding times were evaluated for compliance with extraction and analysis holding time requirements. Matrix spike recoveries were evaluated for all samples. MS/MSD results were re-calculated on at least one sample per batch. Data qualifier flags were applied as appropriate. Surrogate spike recoveries were evaluated for all samples and surrogate recoveries were re-calculated on at least one sample per batch for organic analyses.

Next, LCS results were reviewed for all samples. LCS recoveries were re-calculated on one sample per batch. Relative Percent Differences (RPDs) for MS/MSD and LCS/LCSD pair calculations were verified for all batches. The 5X and 10X rule (as discussed in the Functional Guidelines for the Evaluation of Chemical Data) was used for evaluation of method blank results. The completeness percentage for surrogates, LCS, MS/MSD and holding times was then calculated.

A summary of the data review/validation results is given in Section 5.

As discussed previously, data qualifier flags were applied to out-of-control data as appropriate. The following qualifiers were used to indicate data usability:

u: The analyte was not detected relative to the method reporting limit.

UN: The result is reported as a tentative nondetection. There is uncertainty with whether or not the non detection is valid at the stated method reporting limit.

X: The data is tentatively rejected because project-specific data quality objectives have not been met or have not been demonstrated.

J: The target analyte is positively identified but the quantitative result is an estimate and the direction of bias is unknown. The flag indicates a significant quantitative (rather than a qualitative) uncertainty exists.

J-: The target analyte is present but the reported concentration is an estimated value that is believed to be biased low. (i.e. the actual concentration in the environmental sample believed to be higher than the reported concentration)

J+: The target analyte is present but the reported concentration is an estimated value that is believed to be biased high. (i.e. the actual concentration in the environmental sample is believed to be lower than the reported concentration)

R: Data is rejected due to the serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. The data is not useable.

Field and COC documentation were compared against laboratory reports to check conformity of sample identification numbers. Analytical results were compared to daily activity logs to identify sampling procedures/activities that may have impacted data quality.

Table 4-1 Analytical Batches
South Mosquito Creek and Buckskin Creek

Batch	Analyses	Sample ID
WG11100	Metals (water)	CO-SMC-SW12 (diss)
		CO-SMC-SW11 (diss)
		CO-SMC-SW10 (diss)
		CO-SMC-SW09
		CO-SMC-SW09 (diss)
		CO-SMC-SW07
		CO-SMC-SW07 (diss)
		CO-SMC-SW08
		CO-SMC-SW08(diss)
		CO-SMC-SW01
		CO-SMC-SW01 (diss)
		CO-SMC-SW03
		CO-SMC-SW03 (diss)
		Method Blank
		Laboratory Matrix Duplicate
		Matrix Spike (MS)/Matrix Spike Duplicate (MSD)
		Laboratory Control Sample (LCS)
WG11088	Metals (water)	CO-SMC-SW12
		CO-SMC-SW11
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11101	Metals (water)	CO-SMC-SW11
		Method Blank
		Laboratory Matrix Duplicate
		MD/MSD
		LCS
WG11117	Metals (water)	CO-SMC-SW04
		CO-SMC-SW04 (diss)
		CO-SMC-SW04 -02 (dup)
		CO-SMC-SW04-02 (dup) (diss)
		CO-SMC-SW06
		CO-SMC-SW06 (diss)
		CO-SMC-SW13
		CO-SMC-SW13 (diss)
		CO-SMC-SW05

Batch	Analyses	Sample ID
		CO-SMC-SW05 (diss)
		CO-BC-SW11
		CO-BC-SW11 (diss)
		CO-BC-SW10
		CO-BC-SW10 (diss)
		CO-BC-SW09
		CO-BC-SW09 (diss)
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11118	Metals (water)	CO-BC-SW03
		CO-BC-SW03 (diss)
		CO-BC-SW02
		CO-BC-SW02 diss)
		CO-BC-SW01
		CO-BC-SW01 (diss)
		CO-BC-SW05
		CO-BC-SW05 (diss)
		CO-BC-SW08
		CO-BC-SW08 (diss)
		CO-BC-SW07-02 (dup)
		CO-BC-SW07-02 (dup) (diss)
		CO-BC-SW06
		CO-BC-SW06 (diss)
		CO-BC-SW04
		CO-BC-SW04 (diss)
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11113	Alkalinity (Water)	CO-SMC-SW12
		CO-SMC-SW11
		CO-SMC-SW10
		CO-SMC-SW09
		CO-SMC-SW07
		CO-SMC-SW08
		CO-SMC-SW01
		CO-SMC-SW03
		CO-SMC-SW04)
		CO-SMC-SW04-02 (dup)
		CO-SMC-SW06

Batch	Analyses	Sample ID
		CO-SMC-SW13
		CO-SMC-SW05
		CO-BC-SW011
		CO-BC-SW10
		CO-BC-SW09
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11115	Alkalinity (Water)	CO-BC-SW02
		CO-BC-SW01
		CO-BC-SW05
		CO-BC-SW08
		CO-BC-SW07
		CO-BC-SW07-02 (dup)
		CO-BC-SW06
		CO-BC-SW04
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS
WG11127	Chloride (Water)	CO-SMC-SW12
		CO-SMC-SW11
		CO-SMC-SW10
		CO-SMC-SW09
		CO-SMC-SW07
		CO-SMC-SW08
		CO-SMC-SW01
		CO-SMC-SW03
		CO-SMC-SW04
		CO-SMC-SW04-02 (dup)
		CO-SMC-SW06
		CO-SMC-SW13
		CO-SMC-SW05
		CO-BC-SW011
		CO-BC-SW10
		CO-BC-SW09
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS

Batch	Analyses	Sample ID
WG11125	Chloride	CO-BC-SW03
		CO-BC-SW02
		CO-BC-SW01
		CO-BC-SW05
		CO-BC-SW08
		CO-BC-SW07
		CO-BC-SW07-02 (dup)
		CO-BC-SW06
		CO-BC-SW04
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS
WG11134	Sulfate (Water)	CO-SMC-SW12
		CO-SMC-SW11
		CO-SMC-SW10
		CO-SMC-SW09
		CO-SMC-SW07
		CO-SMC-SW08
		CO-SMC-SW01
		CO-SMC-SW03
		CO-SMC-SW04
		CO-SMC-SW04-02 (dup)
		CO-SMC-SW06
		CO-SMC-SW13
		CO-SMC-SW05
		CO-BC-SW011
		CO-BC-SW10
		CO-BC-SW09
WG11143	Sulfate (Water)	CO-BC-SW03
		CO-BC-SW02
		CO-BC-SW01
		CO-BC-SW05
		CO-BC-SW08
		CO-BC-SW07
		CO-BC-SW07-02 (dup)
		CO-BC-SW06
		CO-BC-SW04
		Method Blank
		Lab Matrix Dup
		MS/MSD
		LCS

5 RESULTS OF QUALITY CONTROL ACTIVITIES AND ANALYSES

Field QC activities consisted of collecting appropriate field QC samples (field duplicates, trip blanks), daily communication between the CENWO field team and the ECB Lab, and consistent interaction between the CENWO field team and CENWO Technical Manager.

5.1 FIELD QC PROCEDURES AND FIELD QC ANALYSES

5.1.1 Documentation of Field Quality Procedures

Daily field notes were completed to summarize daily investigation procedures and document QC activities. These reports summarize samples collected, environmental conditions, instrument problems, and any non-routine situations that may have impacted sample integrity. These reports were reviewed concurrently with the COC forms and the analytical results from the laboratory to identify potential sampling anomalies or confirm sample identifications. These reports show collection procedures were adequate to ensure data results met project objectives.

5.1.2 Field Duplicate Analyses

Field duplicate samples were collected during the sampling event to evaluate sampling and laboratory precision. Each duplicate sample was analyzed for total and dissolved metals, sulfate, alkalinity, and chloride and the analytical data agreed between the field sample and the field duplicate sample. See Table 4-1 for the duplicate samples obtained.

5.2 LABORATORY QC PROCEDURES AND LABORATORY QC ANALYSES

A review of laboratory QC procedures was conducted by the USACE project chemist. All issues identified, and their respective solutions are discussed below and required qualifications are discussed and are included in the data tables of Appendix A.

5.2.1 Initial Sample Inspection and COC Documentation

The ECB Laboratory inspected all shipping containers and compared the contents with the appropriate COC documentation. Information from the sample check-in procedures was recorded on the Cooler Receipt Form. This form was used to document that samples listed on the COC forms agreed with samples contained in the coolers, COC forms were filled out properly, samples were not broken, custody seals were intact, and cooler temperatures were less than or equal to 4°C. These forms are included in the Analytical Data Packages. No problems or deficiencies were found with the sample shipments or COC documentation.

5.2.2 Holding Times

Samples were delivered daily by the overnight courier to ECB Laboratory to ensure all analyses were completed within the required holding times. Part of the CENWO chemist evaluation included reviewing sample extraction and analysis dates to ensure holding times were met. Based on CENWO's review of the laboratory data, all samples were extracted and analyzed within the required holding times.

5.2.3 Method Blank Analyses

Method blanks were analyzed to assess existence and magnitude of contamination problems and measure the representativeness of the analytical process. Blanks reflect the amount of contamination introduced into the environmental samples during sample collection, transfer from the site to the laboratory or analysis. In particular, method blanks reflect laboratory contamination from both the determinative and preparatory method. At least one method blank must be reported for each preparation batch of samples. All blanks were clean except in the following:

Analytical Batch: WG11100. This method blanks contained aluminum at 40 J ug/L. All samples were non detect for aluminum except one. The non detect samples had no qualification applied to the aluminum values. Sample SMC-SW03 had an aluminum value of 80 J ug/L so this value would have a J qualification since the sample value was not greater than 5 times the blank value. The samples will be qualified J for estimate with B designation because of the blank contamination.

Analytical Batch: WG11088. This method blanks contained arsenic at 4 J ug/L, but the samples had arsenic values of non detect so no qualification was applied to the arsenic values.

5.2.4 Laboratory Control Samples

Laboratory control samples are evaluated to assess overall method performance and are the primary indicators of laboratory performance. Laboratory control samples are method blanks which are typically spiked with all target analytes of interest. The percent recovery is used as a measure of accuracy and bias. The relative percent difference (RPD) for duplicate LCS recoveries is normally used as a measure of precision. When both a laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) are processed for a batch of samples, there is no significant physical distinction between the LCS and the LCSD. Both the LCS and the LCSD must satisfy the same recovery acceptance criteria. At least one LCS must be reported with each batch of samples. Multiple LCSs may be required to evaluate method precision. For example, a laboratory control sample and a laboratory control sample duplicate (LCSD) may be analyzed to provide information on the precision of the analytical method. The generation of control chart limits for precision via the analysis of LCS/LCSD pairs is an effective means to measure method precision. LCS and LCSD results are included in the QC section of the laboratory's data package.

Metals: An LCS was analyzed with each metals analytical batch. The percent recovery was compared to set criteria for each analyte. The LCS percent recoveries were all within set criteria so no qualifications were applied to metals results.

Sulfate: An LCS was analyzed as part of the sulfate quality control to determine precision. The RPD results met set criteria so no qualification was applied to the sulfate results.

Alkalinity: An LCS was analyzed as part of the alkalinity quality control to determine

precision. The RPD results met set criteria so no qualification was applied to the alkalinity results.

Chloride: An LCS was analyzed as part of the chloride quality control to determine precision. The RPD results met set criteria so no qualification was applied to the chloride results.

5.2.5 Surrogate Recovery

Surrogates are organic compounds that are similar in chemical composition to the analytes of interest. Surrogates are spiked into environmental and batch QC samples prior to sample preparation and analysis. Surrogate recoveries for environmental samples are used to evaluate matrix interference on a sample-specific basis. High or low surrogate recoveries indicate problems in instrument performance, extraction procedures, or severe matrix effects. Samples for metals analysis are not spiked with surrogate analytes. No surrogate is added to samples for cyanide analysis.

5.2.6 MS/MSD Recovery

Matrix Spike (MS) and matrix spike duplicate (MSD) results are examined to evaluate the impact of matrix effects on overall analytical performance. A matrix spike is a representative environmental sample that is spiked with target analytes of interest prior to being taken through the entire analytical process in order to evaluate analytical bias for an actual matrix. A matrix duplicate is a collocated or a homogenized sample that is processed through the entire analytical procedure in order to evaluate overall precision for an actual matrix.

It should be noted that MS recovery failure and poor precision may arise because of (i) poor sampling technique, (ii) inadequate homogenization, or (iii) from matrix effects associated with the preparatory or determinative portion of an analytical method. Matrix interferences may be "positive" or "negative" in nature. Results of MS/MSD analyses are included in the Analytical Data Packages. The percent recovery and RPD for the MS/MSD for the metals, sulfate, alkalinity, and chloride were within criteria so no qualification was applied to the data.

5.2.7 Completeness of Data Packages

The CENWO Chemist reviewed the data package and confirmed the completeness of the data package. All the planned sampling activities were executed and all the laboratory analyses were performed.

5.3 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS AND COMPARABILITY (PARCC)

DQOs and their corresponding measurement indicators were specified in the Site Specific Addendum for the South Mosquito and Buckskin Creek areas, 24 July, 2002. To achieve the project DQOs, specific PARCC goals are established for laboratory and field sampling

procedures. These PARCC parameters are the measurement tools for determining the usability of generated data.

Precision and accuracy goals were based on knowledge of each analytical measurement system. For this CDQAR, precision was measured using the RPD between two replicated sample analyses. The precision evaluation encompassed laboratory precision (LCS samples), and combined field/laboratory precision (MS/MSD samples).

Accuracy was measured using the percent recovery of surrogates, MS/MSD samples, and LCS sample pairs. Spike recoveries form field samples and laboratory QC samples are compared to established control limits to determine a laboratory's ability to accurately determine both qualitative and quantitative results.

Representativeness is the degree to which the data accurately and precisely portrayed the environmental conditions being studied. For the site investigation, sampling procedures and sample locations were selected to bias samples in areas of potential places of contamination. All sampling was conducted using known approved field procedures to minimize variability.

Completeness refers to the amount of valid data obtainable from a measurement system compared to the expected amount of data. The SAP established a completeness goal of 90 percent for laboratory QC requirements. This goal was attained by the data for this project.

5.4 Data Tables

The qualified data is given in Table 5-1 of Appendix A.

5.5 Analytical Data Package

Data Sheets as obtained from the Environmental Chemistry Laboratory are available upon request as a hard copy of the Analytical Data Package. The Analytical Data Package is available at the following address:

USACE Omaha District
Attn: RAMS Program Manager (CENWO-PM-C)
106 South 15th Street
Omaha, NE 68102

6 CONCLUSIONS

This CDQAR presents, in specific terms, the quality control practices utilized to achieve the goals of the site investigation at South Mosquito and Buckskin Creeks, Colorado. The analytical program for this project conformed with the General Work Plan for the Restoration of Abandoned Mines Sites prepared by U.S. Army Corps of Engineers, Omaha District, Omaha, Nebraska, July 2002 and the Site Specific Addendum for the South Mosquito and Buckskin Creeks areas, Colorado, 24 July, 2002. Samples were also collected and analyzed in accordance with ASTM and EPA methods and laboratory specific QA/QC procedures were used. These procedures were followed to generate high quality data.

The quality issues addressed in this report do not impact the usability of the data. These issues have all been addressed on Section 5 and the qualified data is given in Appendix A. The reviewed data are usable and are suitable for addressing the overall objective of this investigation.

Appendix A

Table 5-1, South Mosquito Creek/Buckskin Creek Qualified Data

Sample, metals ug/L	MDL	CO-SMC-SW12-01 (DISS)			CO-SMC-SW12-01			CO-SMC-SW11-01 (DISS)			CO-SMC-SW11-01		
Date Collected		**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**
Aluminum	30	< 30	uB	90	< 30	u	90	< 30	uB	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	uB	15	< 3	u	15	< 3	uB	15
Cadmium	0.5	1.5	J	2.5	1.8	J	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	32700		300	32300		300	41000		300	42000		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	73	J	120	57	J	120	943		120
Lead	2	< 2	u	10	2.2	J	10	< 2	u	10	< 2	u	10
Magnesium	40	22400		120	22100		120	21400		120	21700		120
Manganese	1	45		4	45.5		4	353		4	367		4
Potassium	100	741		300	720		300	2070		300	2050		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	593		10	623		10	144		10	156		10
Alkalinity mg/L	7				110		20				130		20
Bicarb Alk as Ca(	7				110		20				130		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				75		20				85		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample, metals ug/L	MDL	CO-SMC-SW10-01 (DISS)			CO-SMC-SW10-01			CO-SMC-SW09-01 (DISS)			CO-SMC-SW09-01		
Date Collected		**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**
Aluminum	30	< 30	uB	90	< 30	u	90	< 30	uB	90	< 30	uB	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	1.9	J	2.5	1.7	J	2.5	1.8	J	2.5	2	J	2.5
Calcium	100	31600		300	32400		300	31600		300	31800		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	3	J	10
Iron	40	< 40	u	120	79	J	120	< 40	u	120	87	J	120
Lead	2	2.3	J	10	< 2	u	10	< 2	u	10	2.7	J	10
Magnesium	40	22100		120	22300		120	21900		120	22200		120
Manganese	1	33		4	33.6		4	33.3		4	34.2		4
Potassium	100	695		300	716		300	743		300	743		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	586		10	636		10	602		10	628		10
Alkalinity mg/L	7				110		20				110		20
Bicarb Alk as Ca(	7				110		20				110		20
Carb Alk as CaCO:	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				76		20				77		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample, metals ug/L	MDL	CO-SMC-SW07-01 (DISS)			CO-SMC-SW07-01			CO-SMC-SW08-01 (DISS)			CO-SMC-SW08-01		
Date Collected		**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**
Aluminum	30	< 30	uB	90	< 30	uB	90	< 30	uB	90	< 30	uB	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	3.5		2.5	3.41		2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	30600		300	30900		300	31800		300	32200		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	3.7	J	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	95	J	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	15100		120	15200		120	27600		120	27900		120
Manganese	1	31.5		4	32.3		4	18.9		4	19.8		4
Potassium	100	707		300	697		300	614		300	634		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	914		10	939		10	376		10	390		10
Alkalinity mg/L	7				91		20				130		20
Bicarb Alk as Ca(	7				91		20				130		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				63		20				89		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW01-01 (DISS)			CO-SMC-SW01-01			CO-SMC-SW03-01 (DISS)			CO-SMC-SW03-01		
Date Collected		**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**	**08/20/02**	**Q**	**RL**
Aluminum	30	< 30	uB	90	< 30	uB	90	< 30	uB	90	81	JB	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	71.3		2.5	74.4		2.5
Calcium	100	28300		300	28200		300	76500		300	77100		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	2.7	J	10	39.5		10
Iron	40	88	J	120	162		120	< 40	u	120	1980		120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	2.2	J	10
Magnesium	40	14700		120	14700		120	63400		120	64000		120
Manganese	1	4.52		4	5.21		4	2390		4	2410		4
Potassium	100	534		300	551		300	1380		300	1420		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	8.2	J	10	5.6	J	10	20900		30	20900		30
Alkalinity mg/L	7				110		20				45		20
Bicarb Alk as Ca(	7				110		20				45		20
Carb Alk as CaCO:	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				27		20				470	D	120

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW04-01 (DISS)			CO-SMC-SW04-01			CO-SMC-SW04-02 (DISS)			CO-SMC-SW04-02		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	10.5		2.5	10.8		2.5	10.5		2.5	11		2.5
Calcium	100	40000		300	39400		300	39200		300	39400		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	2	J	10	5.5	J	10	2.9	J	10	5.8	J	10
Iron	40	< 40	u	120	192		120	< 40	u	120	194		120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	25000		120	24500		120	24500		120	24600		120
Manganese	1	202		4	199		4	197		4	199		4
Potassium	100	719		300	711		300	700		300	714		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	3160		10	3340		10	3160		10	3340		10
Alkalinity mg/L	7				100		20				100		20
Bicarb Alk as Ca(	7				100		20				100		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				140		20				130		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW06-01 (DISS)			CO-SMC-SW06-01			CO-SMC-SW13-01 (DISS)			CO-SMC-SW13-01		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	61	J	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	24000		300	24300		300	28300		300	28200		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	100	J	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	7970		120	8030		120	19700		120	19600		120
Manganese	1	10.1		4	14.7		4	9.62		4	10.3		4
Potassium	100	504		300	562		300	1510		300	1520		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	75.6		10	24.4		10	28.9		10	15.8		10
Alkalinity mg/L	7				86		20				130		20
Bicarb Alk as Ca(	7				86		20				130		20
Carb Alk as CaCO:	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				21		20				43		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-SMC-SW05-01 (DISS)			CO-SMC-SW05-01			CO-BC-SW11-01 (DISS)			CO-BC-SW11-01		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	22500		300	23200		300	26600		300	26600		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	51	J	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	5540		120	5680		120	9020		120	9020		120
Manganese	1	2.4	J	4	4.46		4	< 1	u	4	1.1	J	4
Potassium	100	346		300	357		300	796		300	786		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	5.1	J	10	< 3	u	10	98.3		10	100		10
Alkalinity mg/L	7				78		20				55		20
Bicarb Alk as Ca(	7				78		20				55		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				10	J	20				59		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW10-01 (DISS)			CO-BC-SW10-01			CO-BC-SW09-01 (DISS)			CO-BC-SW09-01		
Date Collected		**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**	**08/21/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	26100		300	26000		300	26300		300	26500		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	8140		120	8120		120	8030		120	8060		120
Manganese	1	< 1	u	4	< 1	u	4	< 1	u	4	< 1	u	4
Potassium	100	754		300	762		300	770		300	781		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	110		10	113		10	121		10	121		10
Alkalinity mg/l	7				45		20				48		20
Bicarb Alk as Ca(	7				45		20				48		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				61		20				64		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW03-01 (DISS)			CO-BC-SW03-01			CO-BC-SW02-01 (DISS)			CO-BC-SW02-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	39900		300	39700		300	79300		300	78500		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	14.3		10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	2.2	J	10	2.3	J	10	< 2	u	10	< 2	u	10
Magnesium	40	10200		120	10200		120	22800		120	22800		120
Manganese	1	1.2	J	4	4.35		4	< 1	u	4	< 1	u	4
Potassium	100	641		300	653		300	972		300	990		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	21.7		10	23.1		10	7.7	J	10	10.5		10
Alkalinity mg/L	7				45		20				63		20
Bicarb Alk as Ca(	7				45		20				63		20
Carb Alk as CaCO:	7				<7	u	20				<7		20
Chloride mg/L	1				<1	u	5				1	J	5
Sulfate mg/L	6				100		20				250	D	40

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW01-01 (DISS)			CO-BC-SW01-01			CO-BC-SW05-01 (DISS)			CO-BC-SW05-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5	0.57	J	2.5	0.53	J	2.5
Calcium	100	30800		300	30700		300	13900		300	13900		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	3	J	10	3.7	J	10
Iron	40	< 40	u	120	50	J	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Magnesium	40	7500		120	7520		120	3180		120	3190		120
Manganese	1	< 1	u	4	6.42		4	1	J	4	1.1	J	4
Potassium	100	609		300	617		300	501		300	509		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	11.1		10	14.3		10	98.2		10	99.7		10
Alkalinity mg/L	7				43		20				26		20
Bicarb Alk as Ca(	7				43		20				26		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	20
Chloride mg/l	1				<1	u	5				<1	u	5
Sulfate mg/L	6				72		20				27		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW08-01 (DISS)			CO-BC-SW08-01			CO-BC-SW07-01 (DISS)			CO-BC-SW07-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	38	J	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	1.1	J	2.5	1	J	2.5	1.4	J	2.5	1.3	J	2.5
Calcium	100	30400		300	30400		300	78900		300	79600		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	2.2	J	10	< 2	u	10	2.5	J	10
Magnesium	40	7630		120	7610		120	32400		120	32500		120
Manganese	1	1.2	J	4	4.04		4	< 1	u	4	< 1	u	4
Potassium	100	628		300	632		300	1860		300	1890		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	406		10	418		10	208		10	213		10
Alkalinity mg/L	7				36		20				72		20
Bicarb Alk as Ca(	7				36		20				72		20
Carb Alk as CaCO3	7				<7	u	20				<7	u	2
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/L	6				74		20				280	D	60

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW07-02 (DISS)			CO-BC-SW07-02			CO-BC-SW06-01 (DISS)			CO-BC-SW06-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15	< 3	u	15	< 3	u	15
Cadmium	0.5	1.3	J	2.5	1.4	J	2.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	78800		300	79200		300	27000		300	27000		300
Chromium	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10	< 2	u	10	2.1	J	10
Magnesium	40	32200		120	32300		120	6440		120	6450		120
Manganese	1	< 1	u	4	< 1	u	4	< 1	u	4	2.1	J	4
Potassium	100	1820		300	1840		300	441		300	447		300
Silver	1	< 1	u	5	< 1	u	5	< 1	u	5	< 1	u	5
Zinc	3	207		10	212		10	20.5		10	18.3		10
Alkalinity mg/L	7				69		20				44		20
Bicarb Alk as Ca(	7				69		20				44		20
Carb Alk as CaCO:	7				<7	u	20				<7	u	20
Chloride mg/L	1				<1	u	5				<1	u	5
Sulfate mg/l	6				270	D	60				64		20

Table 5-1 (cont), South Mosquito Creek/Buckskin Creek Qualified Data

Sample metals ug/L	MDL	CO-BC-SW04-01 (DISS)			CO-BC-SW04-01		
Date Collected		**08/22/02**	**Q**	**RL**	**08/22/02**	**Q**	**RL**
Aluminum	30	< 30	u	90	< 30	u	90
Arsenic	3	< 3	u	15	< 3	u	15
Cadmium	0.5	< .5	u	2.5	< .5	u	2.5
Calcium	100	5380		300	5410		300
Chromium	2	< 2	u	10	< 2	u	10
Copper	2	< 2	u	10	< 2	u	10
Iron	40	< 40	u	120	< 40	u	120
Lead	2	< 2	u	10	< 2	u	10
Magnesium	40	991		120	998		120
Manganese	1	1.4	J	4	2.3	J	4
Potassium	100	170	J	300	170	J	300
Silver	1	< 1	u	5	< 1	u	5
Zinc	3	10.6		10	11		10
Alkalinity mg/L	7				21		20
Bicarb Alk as Ca(	7				21		20
Carb Alk as CaCO3	7				<7	u	20
Chloride mg/L	1				<1	u	5
Sulfate mg/L	6				8	J	20

J = estimate value due to analyte detected between MDI and RL or data qualification
u = non detect above MDL B = : Method blank detection
D = Analysis performed on diluted sample.