science for a changing world

Prepared in cooperation with
Ouray County

Geochemistry of Red Mountain Creek, Colorado, Under Low-Flow Conditions, August 2002

Scientific Investigations Report 2005–5101

U.S. Department of the Interior
U.S. Geological Survey

Geochemistry of Red Mountain Creek, Colorado, Under Low-Flow Conditions, August 2002

By Robert L. Runkel, Briant A. Kimball, Katherine Walton-Day, and Philip L. Verplanck

Scientific Investigations Report 2005–5101

Prepared in cooperation with
Ouray County

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
Gale A. Norton, Secretary

U.S. Geological Survey
Charles G. Groat, Director

U.S. Geological Survey, Reston, Virginia: 2005

For more information about the USGS and its products:
Telephone: 1-888-ASK-USGS
World Wide Web: http://www.usgs.gov/

Suggested citation:
Runkel, Robert L., Kimball, Briant A., Walton-Day, Katherine, and Verplanck, Philip L., 2005, Geochemistry of Red Mountain Creek, Colorado, under low-flow conditions, August 2002: U.S. Geological Survey Scientific Investigations Report 2005–5101, 78 p.

Contents

Figures

Tables

Conversion Factors

Multiply	By	To obtain
	Length	
inch	2.54	centimeter
foot	0.3048	meter
mile	1.609	kilometer
	Volume	
ounce, fluid	0.02957	liter
gallon	3.785	liter
gallon	0.003785	cubic meter
	Flow rate	
cubic foot per second	0.02832	cubic meter per second
gallon per minute	0.06309	liter per second
	Mass	
ounce, avoirdupois	28.35	gram

Temperature in degrees Celsius (˚C) may be converted to degrees Fahrenheit (˚F) as follows:

$$˚F = (1.8 \times ˚C) + 32$$

Geochemistry of Red Mountain Creek, Colorado, Under Low-Flow Conditions, August 2002

By Robert L. Runkel, Briant A. Kimball, Katherine Walton-Day, and Philip L. Verplanck

Abstract

Red Mountain Creek, an acid mine drainage stream in southwestern Colorado, was the subject of a synoptic study conducted in August 2002. During the synoptic study, a solution containing lithium chloride was injected continuously to allow for the calculation of streamflow using the tracer-dilution method. Synoptic water-quality samples were collected from 48 stream sites and 29 inflow locations along a 5.4-kilometer study reach. Data from the study provide profiles of pH, concentration, and mass load with a high degree of spatial resolution. Despite the presence of 10 circumneutral inflows, pH remained below 3.4 at all stream sites. Concentration profiles indicate that dissolved concentrations of aluminum, cadmium, copper, lead, and zinc exceed chronic aquatic-life standards established by the State of Colorado along the entire study reach. Comparison of total recoverable and dissolved concentrations suggests that most constituents were transported conservatively. Exceptions to this pattern include arsenic, iron, molybdenum, and vanadium, four constituents that were subject to precipitation and(or) sorption reactions as the addition of a circumneutral tributary resulted in a slight increase in instream pH. Evaluation of data from the 29 inflow locations indicates a sharp contrast between the east and west sides of the watershed; inflows from the east side have high constituent concentrations and acidic pH, whereas inflows from the west side have lower concentrations and generally higher pH. Loading profiles, the product of streamflow and concentration, are used to rank potential sources of metals and acidity within the watershed. Four sources account for 83, 72, 70, 69, 64, and 61 percent of the aluminum, iron, arsenic, zinc, copper, and cadmium loading within the study reach, respectively. All four sources appear to be the result of surface inflows that have been affected by mining activities. The relatively small number of major sources and the fact that they are attributable to surface inflows are two factors that may facilitate effective remediation.

Introduction

Streams and rivers affected by acid mine drainage are complex systems in which hydrologic and geochemical processes interact to determine the fate and transport of trace metals. Many of the watersheds affected by mining activities are headwater systems that gain substantial amounts of water as they flow downvalley. The sources of additional water range from well-defined tributary inflows that appear on topographic maps, to diffuse ground-water inflows that are not visible to the naked eye. The water quality associated with these sources of water also can vary substantially, ranging from dilute mountain springs to metal-rich waters emanating from mineralized areas. The situation is further complicated in extensively mined watersheds where numerous adits, shafts, mine dumps, and prospect pits litter the landscape. The challenge facing those interested in improving water quality is thus one of source determination: in a given watershed, what sources of water are most detrimental to streamwater quality? In response to this question, synoptic sampling techniques have been developed within the U.S. Geological Survey's Toxic Substances Hydrology program that allow for the quantification of mass loads associated with various sources (Kimball and others, 2002, for example). Given this information, sources contributing the highest mass loads may be targeted for remediation.

In August 2002, the U.S. Geological Survey conducted a water-quality study on Red Mountain Creek using the synoptic sampling techniques described above. The study, conducted in cooperation with Ouray County, provides detailed spatial information on constituent concentrations, constituent loads, and streamflow along a 5.4-kilometer study reach.

Purpose and Scope

The purpose of this report is to characterize the geochemistry of Red Mountain Creek, an acid mine drainage stream in southwestern Colorado, under low-flow conditions. Samples collected from 48 stream sites and 29 inflow locations during August 2002 are thought to reflect streamwater quality under low-flow conditions. Potential sources of contamination identified in this report are therefore those sources that influence water quality throughout the hydrologic year. Additional sources that may be important at high flow, during snowmelt, or following heavy rain are not formally quantified; only a brief discussion of these additional sources is provided in this report.

Description of the Study Area

The San Juan Mountains of southwestern Colorado contain numerous headwater streams that are contaminated by acid mine drainage. Red Mountain Creek originates at the top of Red Mountain Pass south of Ouray, Colo. (fig. 1), and flows approximately 12 kilometers before merging with the Uncompahgre River. The study reach is the upper 5.4 kilometers of Red Mountain Creek, a free-flowing section of the stream that is within a steep canyon (stream slope approximately 220 meters/kilometer). Stream depth during low flow is generally less than 0.5 meter, and stream width ranges from 1 to 4 meters. Numerous inflows along the study reach introduce metals and acidic waters. These inflows consist of mine drainage and natural sources of water (Runnells and others, 1992). Elevated concentrations of iron, aluminum, copper, and zinc are observed, and pH remains below 3.4 throughout the study reach. Under these conditions, precipitated hydrous iron oxides coat the streambed and the stream is virtually devoid of typical montane aquatic life (Moran and Wentz, 1974; Mize and Deacon, 2002).

Red Mountain Creek drains water from Red Mountains #1, #2, and #3, which lie on the east side of the watershed (fig. 2). These mountains are hydrothermally altered and consist of acid-sulfate and quartz-sericite-pyrite assemblages. In these assemblages, original feldspar and other silicate minerals have been replaced by fine-grained minerals predominated by quartz, illite (sericite), alunite, other clay minerals, and 10 to 15 percent finely disseminated and fracture-filling pyrite (Dana Bove, U.S. Geological Survey, written commun., 2004). In contrast, bedrock along the west side of the watershed is primarily overprinted by propylitic alteration, which consists of calcite, chlorite, epidote, and in places, fine-grained disseminated pyrite. Nash (2002) notes that these different alteration assemblages have a striking effect on water quality. Waters draining the west side of the watershed tend to have circumneutral pH values and relatively low metal concentrations, whereas waters draining the east side tend to be acidic with high metal concentrations (Neubert, 2000).

The 5.4-kilometer study reach flows through the heart of the Red Mountain mining district, the United States' second largest silver producer during the 1880s. The most famous deposits are termed breccia pipe or chimney deposits that are associated with the acid sulfate alteration along the east side of the watershed. In general, these deposits were nearly vertical, cylindrical to elliptical ore bodies that ranged from 100 to 600 meters in width and length. In addition to silver, mined deposits were rich in copper, lead, and gold. Vein deposits lie along the west side of the watershed and were mined in the 1900s for lead, zinc, copper, and silver. Tunnels were driven on the west side of the watershed to reach ore deposits that had previously been accessed from the Telluride mining district. In addition, the Treasury tunnel was driven to access the Idarado mine workings and provide ore for the Idarado mill complex located along Red Mountain Creek (Nash, 2002).

Acknowledgments

Field assistance was provided by Don Batchelder, Sabre Duren, Kevin Johnson, Christopher Pikes, Walt Rule, Alan Staehle, Karin Stanley, Scott Verplanck, Cory Williams, and Marianne Zegers. Logistical support and additional information was provided by Carol Russell and Bill Schroeder of the U.S. Environmental Protection Agency, Bill Lyle of the Idarado Mining Company, Tom Nash, and Dana Bove. Inorganic analyses were performed at the University of Southern Mississippi under the direction of Alan Shiller; anion analyses were conducted by Judy Steiger. The authors appreciate the helpful review comments provided by Carol Russell, Bill Carey, and Brian Caruso. Additional support was provided by the U.S. Geological Survey's Toxic Substances Hydrology Program.

Methods

Tracer Injection and Synoptic Sampling

Quantification of metal sources and constituent loads requires estimates of streamflow and solute concentration. An approach used in acid mine drainage streams is to combine the tracer-dilution method with synoptic sampling (Bencala and McKnight, 1987; Kimball and others, 1994; Kimball and others, 2002; Runkel and Kimball, 2002). The tracer-dilution method provides estimates of streamflow (Kilpatrick and Cobb, 1985), and synoptic sampling provides a description of instream and inflow chemistry. Implementation of the tracer-dilution method typically involves the continuous injection of a conservative (nonreactive) tracer at a constant rate. Because the tracer is conservative, downstream decreases in tracer concentration are attributed solely to dilution. Potential tracers include lithium chloride, sodium bromide, and sodium chloride. Lithium chloride (LiCl) is typically the tracer used in acidic streams due to the conservative behavior of lithium at low pH and the low background concentration of lithium in most freshwaters. On August 25, 2002, a continuous injection of a concentrated LiCl solution was initiated at the upstream end of the study reach (near RM-100, fig. 2). The injection site was located on the east branch of Red Mountain Creek, just downstream from the confluence of two small streams (see sites RM-43 and RM-0, table 1) at the base of Red Mountain #3.[1] Synoptic samples were collected at 48 stream sites and 29 inflow locations (fig. 2)

[1]The west branch of Red Mountain Creek flows along Highway 550 and merges with the east branch approximately 570 meters downstream from the injection site (see RM-673, table 1).

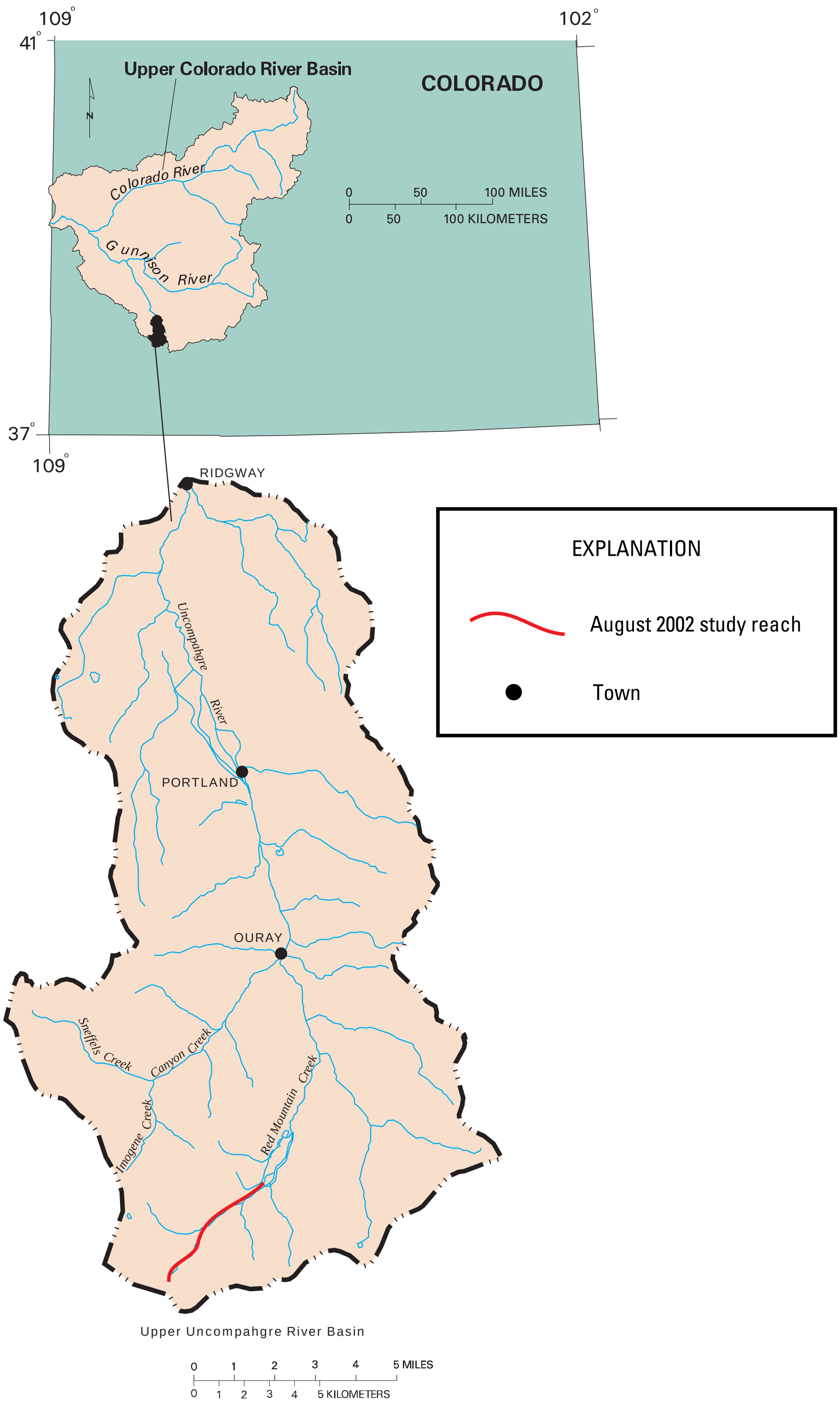

Figure 1. The Uncompahgre River Basin, including Red Mountain Creek, upstream from Ridgway, Colorado (after Mize and Deacon, 2002).

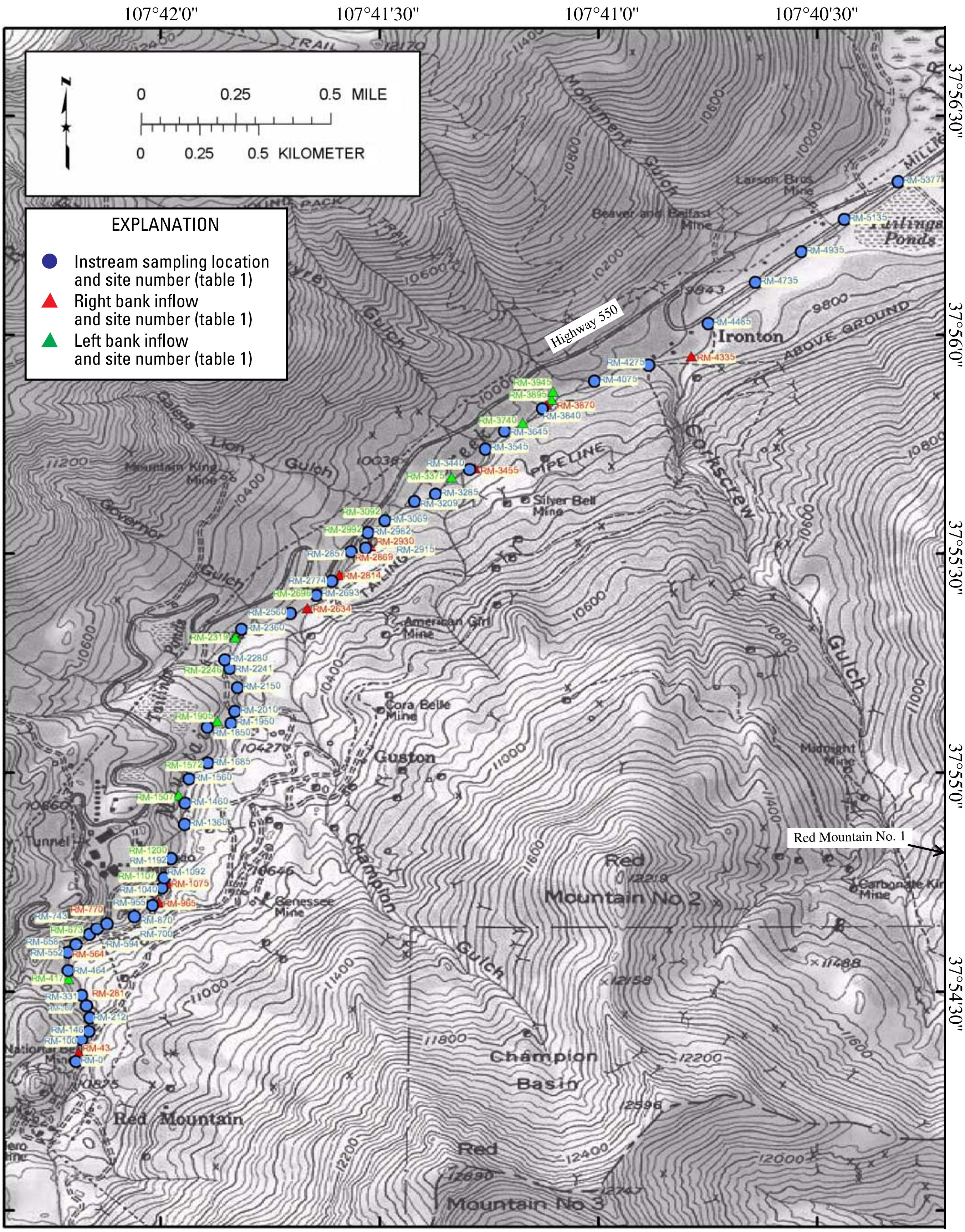

Figure 2. Instream sampling locations (blue), right bank inflows (red), and left bank inflows (green) on Red Mountain Creek, August 2002.

on the following 2 days; all stream samples were collected on August 27 after instream lithium concentrations had reached a steady-state plateau. Sampled inflows ranged from small springs to well-defined tributaries such as Champion Gulch. Inflow samples were collected close (0 to 3 meters) to where each inflow entered Red Mountain Creek.[2] A complete listing of sampling locations, sample information, and the associated data is provided in tables 1–9, following the main body of this report.

Samples were collected in 1.8-liter HPDE bottles by submersing the neck of each bottle into the water near the thalweg (shallow depths precluded the collection of samples using a width and depth integrated approach); sample bottles were triple rinsed with streamwater prior to sample collection. Stream temperature was measured in situ using an alcohol thermometer. Samples were transported to a central processing area where 125-milliliter aliquots were prepared for cation and anion analyses. Onsite processing included filtration, measurement of pH and specific conductance, and preservation of samples for iron speciation. Filtration was completed using tangential flow units equipped with 0.45-micrometer membranes. Aliquots for iron speciation were placed in amber bottles and preserved with concentrated HCl to fix the ratio of ferrous to ferric iron in filtered samples (To and others, 1999). Aliquots for cation analysis were acidified to pH <2.0 with ultrapure nitric acid (HNO_3). Total recoverable and dissolved cation concentrations were determined from unfiltered and filtered samples, respectively, using inductively coupled argon plasma-mass spectrometry (ICP–MS). ICP–MS analyses were performed at the University of Southern Mississippi, in a laboratory approved by the USGS Branch of Quality Assurance. Cation concentrations are reported for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn) (tables 3–8). Dissolved anion concentrations were determined from filtered, unacidified samples by ion chromatography (IC). IC analyses were performed at the USGS in Salt Lake City, Utah, using the quality-assurance procedures described by Kimball and others (1999). Anion concentrations are reported for chloride (Cl), fluoride (F), and sulfate (SO_4) (table 9). Ferrous and total dissolved iron were determined colorimetrically (Brown and others, 1970). Alkalinity was determined from filtered, unacidified samples. Concentrations of the lithium tracer were determined by atomic absorption spectroscopy. Estimates of streamflow were determined from lithium dilution (Kilpatrick and Cobb, 1985) as described in Appendix 1.

[2]"Left bank inflow" (LBI) and "right bank inflow" (RBI) as used throughout this report refer to the side of the stream from which a given inflow enters Red Mountain Creek (where "left" and "right" are from the point of view of an observer who is looking downstream).

Loading Analysis

The study reach is divided into 47 stream segments that are demarcated by the 48 stream samples. The change in mass load from one stream site to the next may be used to determine if a given segment is a source (increase in mass load with distance) or a sink (decrease in mass load with distance) for a given constituent. Mass load is generally defined as the product of streamflow and concentration. Three specific load calculations are used herein to quantify the sources of loading to Red Mountain Creek. The raw instream load is defined as the simple product of the estimated streamflow (Q) and the observed constituent concentration (C):

$$rawload = QC \quad (1)$$

where Q and C are in consistent units (Q in liters per second and C in milligrams per liter, for example). Spatial profiles of raw instream load show increases and decreases in load over the length of the study reach. Some of the raw load increases are easily explained as they appear in stream segments that bracket observed inflows that add a substantial amount of flow and(or) have elevated metal concentrations. Other load increases occur in segments without observed inflows, suggesting possible ground-water sources. Decreases in raw instream load, in contrast, are not expected in Red Mountain Creek for many constituents, as the depressed instream pH inhibits geochemical reactions that would result in decreased load. Further, decreases in load caused by loss of streamflow to the underlying ground-water system are unlikely to occur given the increases in streamflow along the entire study reach (Appendix 1). Most of the decreases in load are therefore attributable to errors in the estimation of streamflow and the observed constituent concentration. Three types of error are considered here: (1) error in the observed constituent concentration that arises due to uncertainty in laboratory analyses, (2) error in the observed lithium concentration that arises due to uncertainty in laboratory analyses (this type of error causes uncertainty in the streamflow estimate obtained using the tracer-dilution method; Appendix 1), and (3) sampling error due to variability in constituent and tracer concentrations over the channel cross section. Sampling error is of particular concern for Red Mountain Creek where shallow depths precluded the collection of a width and depth integrated sample.

An estimate of the potential errors in raw load is obtained by considering the errors associated with replicate sampling. Sequential replicate samples (Wilde and others, 1999) were collected at two stream sites, located at 1,950 and 4,275 meters. At each of these stream sites, two samples were collected in sequence over a short time period (less than 2 minutes). Given the stable hydrologic conditions observed during sampling and the short time interval between sample collection, the replicate samples are treated as if they were collected concurrently. In the absence of error, load estimates based on concurrent replicate samples would be identical. Load estimates from replicate sampling differ in practice, however, due to the types of error discussed above. At a given replicate site, the percent relative error in load is given by:

$$\text{percent relative error} = 100\left(\frac{|Q_A C_A - Q_B C_B|}{maximum(Q_A C_A,\ Q_B C_B)}\right) \quad (2)$$

where the *A* and *B* subscripts refer to quantities based on the first and second replicate samples, respectively. The error estimate provided by equation 2 may be used to develop the corrected instream load as follows. First, the maximum percent relative error for each constituent is determined using data from the two stream sites at which replicate samples were collected (depending on the constituent, the maximum relative error may occur at either 1,950 or 4,275 meters). Starting at the top of the study reach, each decrease in the raw instream load is compared with the maximum relative error. If the decrease exceeds the maximum error, the decrease is considered valid and the corrected load is simply equal to the raw load. If the decrease is less than the maximum error, the decrease is assumed to result from laboratory and(or) field error. The corrected instream load in this case is set equal to the load at the previous stream site, such that the observed decrease in raw instream load is not included in the corrected instream load. This error testing procedure is done in a sequential manner such that two or more consecutive stream segments with decreases in raw instream load are considered in aggregate. For example, consider two consecutive stream segments with decreases in load that do not exceed the maximum error. When considered individually, the observed decreases would not be considered valid; when considered in aggregate, the decreases would be considered valid if their sum exceeds the maximum error.[3]

Finally, the cumulative instream load is developed by summing all the increases in corrected instream load. For a given stream segment, the cumulative instream load is increased if the corrected instream load exhibits an increase and is held constant if the corrected load exhibits a decrease. The cumulative instream load thus represents the total amount of loading within the study reach (whereas the corrected instream load represents the net amount of loading that results after both increases and decreases in load). Raw, corrected, and cumulative instream loads are calculated for most of the available constituents using the total recoverable concentrations in equations 1 and 2; sulfate loads are calculated using dissolved concentrations. Stream segments in which the corrected (and by definition, cumulative) instream load increases are considered sources of constituent mass. The percent contribution of each source is given by:

$$\text{percent contribution} = 100\left(\frac{\Delta load}{L_{5377}}\right) \quad (3)$$

[3]This objective means of determining corrected instream load was used for all 47 stream segments and all constituents. One exception to this general statement is the corrected instream load for sulfate at RM-2915; corrected instream load was held constant at this location even though the decrease in raw instream load exceeded the maximum error. This subjective determination of corrected instream load was made based on the judgment that the observed sulfate concentration at RM-2915 was in error.

where $\Delta load$ is the within-segment increase in corrected load and L_{5377} is the cumulative instream load at the end of the study reach (5,377 meters).

Each of the potential sources is ranked by considering the stream segment contribution to the corrected loads for aluminum, arsenic, cadmium, lead, copper, and zinc (the focus on loading from these constituents is appropriate given the ambient concentrations and aquatic-life standards shown later in this report). To qualify for ranking, a given stream segment must be a source of at least three of these constituents. The ranks of the top three constituents in each stream segment are summed to yield a score for the segment.[4] Stream segments are ranked according to their scores, with lower scores corresponding to higher rankings.

Geochemistry of Red Mountain Creek Under Low-Flow Conditions, August 2002

Constituent Concentration and pH

Spatial profiles of pH and constituent concentration (Fe, As, Al, Cd, Cu, Pb, SO_4, and Zn) are depicted in figures 3–5; concentration profiles for the remaining constituents are shown in Appendix 2. These spatial profiles are used to characterize the geochemical behavior of the constituents, to compare ambient concentrations with applicable water-quality standards, and to provide a preliminary look at source determination, as discussed below. In regard to geochemistry, spatial profiles of total recoverable and dissolved concentrations provide insight into the reactivity of a given constituent. As constituents are transported through the study reach, precipitation and(or) sorption reactions may result in the formation of solid phases and a corresponding decrease in dissolved concentration. Solid phases formed by these reactions are initially small and may remain in the water column for considerable distances before settling to the streambed. Total recoverable (dissolved plus solid) concentrations therefore exceed dissolved concentrations for reactive constituents such as arsenic (fig. 3*C*), iron (fig. 3*B*), molybdenum (Appendix 2), and vanadium (Appendix 2). Spatial profiles for these constituents exhibit a decrease in dissolved concentration downstream from 3,000 meters, as the addition of a circumneutral tributary (left bank inflow at 2,992 meters) results in a slight instream pH increase (fig. 3*A*). This pH increase promotes precipitation and sorption reactions that are not significant at the lower instream pH values observed farther upstream. In contrast, the observed pH increase at 3,000 meters does not affect many of the remaining constituents; total recoverable and dissolved concentrations for aluminum, cadmium, copper, lead, and zinc are approximately equal along the entire

[4]The stream segment ending at RM-2693, for example, has a score of 7 based on the fact that it is the second largest source of aluminum, the second largest source of cadmium, and the third largest source of zinc.

study reach (figs. 3–5; total recoverable concentrations not shown, see tables 3 and 4), suggesting conservative (non-reactive) transport. Values of pH along Red Mountain Creek are not high enough to initiate precipitation and(or) sorption reactions for these conservative constituents (aluminum, for example, remains highly soluble at the ambient pH; aluminum precipitation is usually not appreciable unless pH exceeds 4.5). Although instream lead concentrations in the first 1,000 meters of the study reach appear to be erratic, the observed concentrations are consistent with the observed inflow concentrations (fig. 5*A*).

The potential toxicity of the various constituents to aquatic life may be assessed by comparing observed concentrations with generic table value standards established by the State of Colorado (Colorado Department of Public Health and Environment, 2000). Chronic aquatic-life standards are shown along with dissolved concentration profiles in figures 3–5 and Appendix 2. Aquatic-life standards for dissolved silver, cadmium, copper, manganese, nickel, lead, and zinc are a function of water hardness, resulting in small changes in the standard over the length of the study reach (fig. 4*B*, for example). Dissolved concentrations of aluminum, cadmium, copper, lead, and zinc exceed the chronic standard along the entire study reach, whereas dissolved concentrations of arsenic, nickel, and manganese exceed the chronic standard along certain subreaches (fig. 3*C*, Appendix 2). Although the chronic aquatic-life standards are generic in nature (numeric water-quality standards have not been specifically established for Red Mountain Creek), the above comparison provides a possible explanation of why the study reach appears to be devoid of typical montane aquatic life.

In addition to the implications for geochemistry and aquatic life, the spatial profiles provide some preliminary information on the sources of acidic water and constituents to Red Mountain Creek. Profiles for each constituent include concentrations of instream sites and the sampled inflows (figs. 3–5). Concentrations of inflows entering on the right bank (east side of watershed) generally exceed concentrations of the left bank inflows (west side).[5] Similarly, all right bank inflows are acidic (pH <3.5), whereas most left bank inflows are circumneutral (fig. 3*A*). These differences between the eastern and western parts of the watershed are consistent with the observations of Nash (2002) and an alteration map of the area (Neubert and others, 2005) that shows a highly mineralized area on the eastern side. In addition to geological considerations, pH and metal concentrations associated with left bank inflows may be influenced by limestone and other amendments used in the revegetation of mine tailings (Hardy and others, 1999). Sources entering from the east side of the watershed appear to be the most detrimental to the water quality of Red Mountain Creek, an observation that is formally quantified in the loading analysis that follows.

[5]Exceptions to this general statement include left bank inflows entering at 1,200 and 2,246 meters (RM-1200, RM-2246); these inflows have high concentrations of iron, cadmium, lead, sulfate, and zinc.

Mass Loads

Load Profiles

Percent relative errors (eq. 2) used to develop the corrected instream load for each constituent are presented in table 10 and Appendix 3. Percent relative errors range from 0.2 percent (sulfate at RM-1950, table 10) to 12.8 percent (silver at RM-1950, Appendix 3), with a mean error of 6.2 percent.

Table 10. Percent relative errors (eq. 2) at replicate sites, Red Mountain Creek, Colo., August 2002.

Constituent	Percent relative error, at site:	
	RM-1950	RM-4275
Aluminum	7.2	2.2
Arsenic	7.9	8.4
Cadmium	0.9	6.4
Copper	8.3	0.7
Iron	3.3	2.9
Lead	3.6	10.9
Sulfate	0.2	1.7
Zinc	8.7	2.3

Spatial profiles of load are depicted in figures 6–13 (Al, As, Cd, Cu, Fe, Pb, SO_4, and Zn) and Appendix 3 (remaining constituents). Panel A of each figure shows the raw, corrected, and cumulative instream load for a specific constituent, and panel B depicts the percent contribution of each stream segment as given by equation 3. Corrected instream loads of aluminum, cadmium, copper, lead, and zinc exhibit a generally continuous increase throughout the study reach in response to loading from various sources and the acidic pH. As discussed in the previous section, these constituents do not form solid phases at the low pH values observed within the study reach, such that they are transported conservatively and any loss of instream load is negligible. Corrected and cumulative instream loads for these constituents are therefore similar. In contrast, corrected instream loads for iron and arsenic exhibit a gradual decrease over certain subreaches. This decrease is caused by the formation of solid phase material that settles to the streambed. The loss of mass is reflected in a divergence between cumulative and corrected instream loads (figs. 7*A* and 10*A*). Increases in corrected instream load result from sources of constituent mass; these sources are further quantified as the percent contribution (panel *B* in each figure). Although the location and magnitude of sources varies between constituents, some general loading

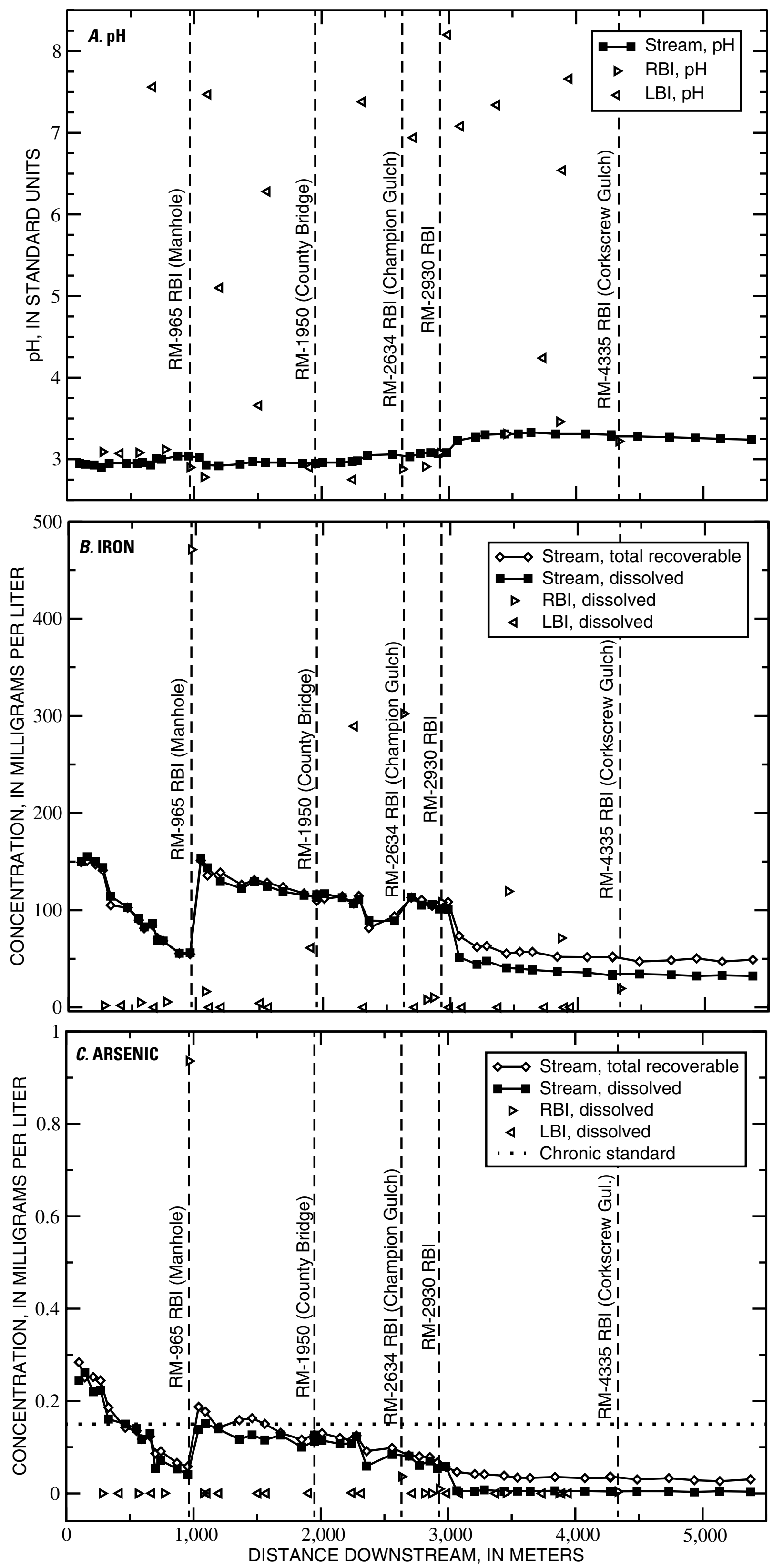

Figure 3. Spatial profiles of (*A*) pH, (*B*) iron concentrations, and (*C*) arsenic concentrations, August 2002 (RBI, right bank inflow; LBI, left bank inflow). Chronic standards are shown for comparison purposes only (numeric water-quality standards have not been established by the State of Colorado for Red Mountain Creek).

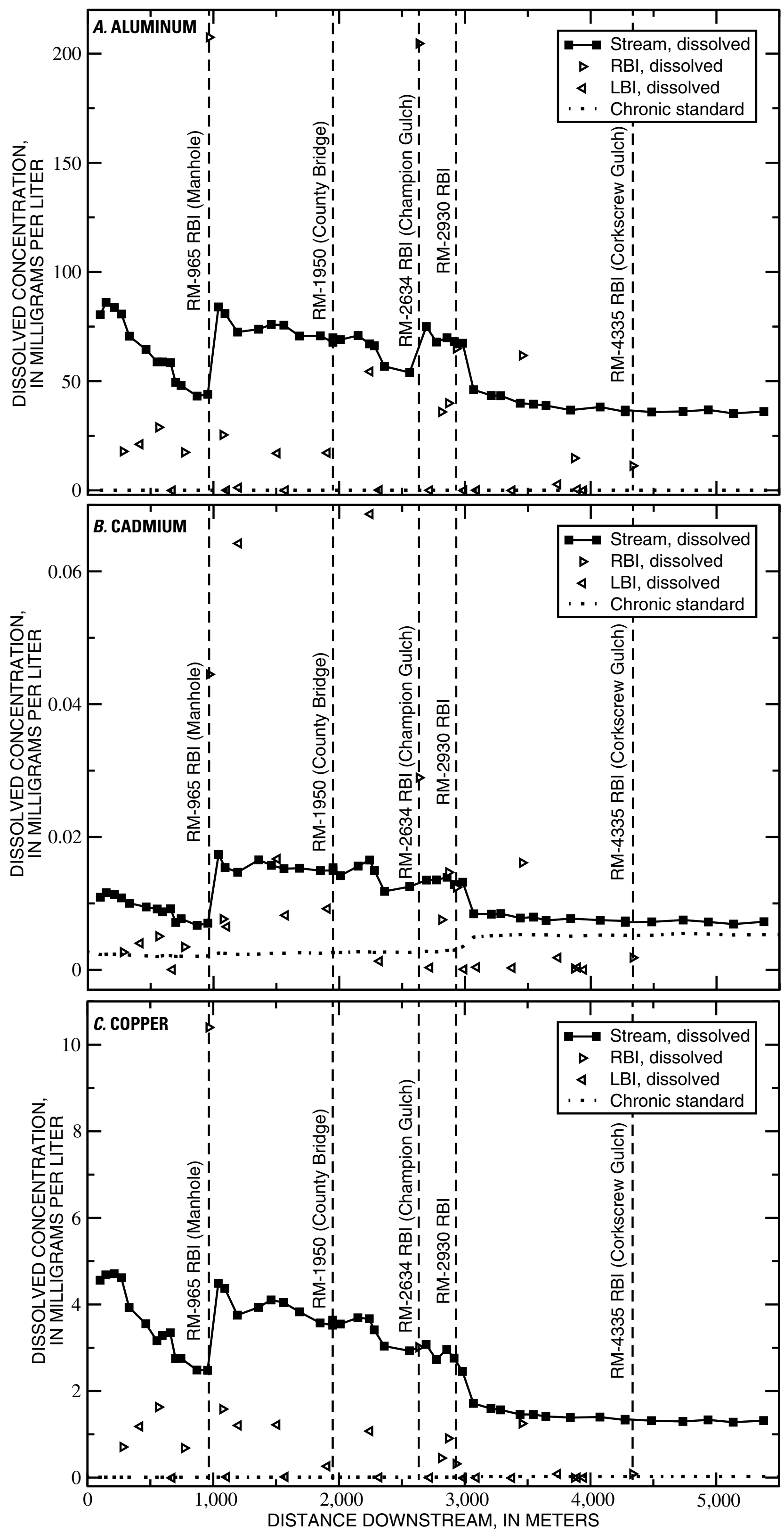

Figure 4. Spatial profiles of (*A*) aluminum concentrations, (*B*) cadmium concentrations, and (*C*) copper concentrations, August 2002 (RBI, right bank inflow; LBI, left bank inflow). Chronic standards are shown for comparison purposes only (numeric water-quality standards have not been established by the State of Colorado for Red Mountain Creek).

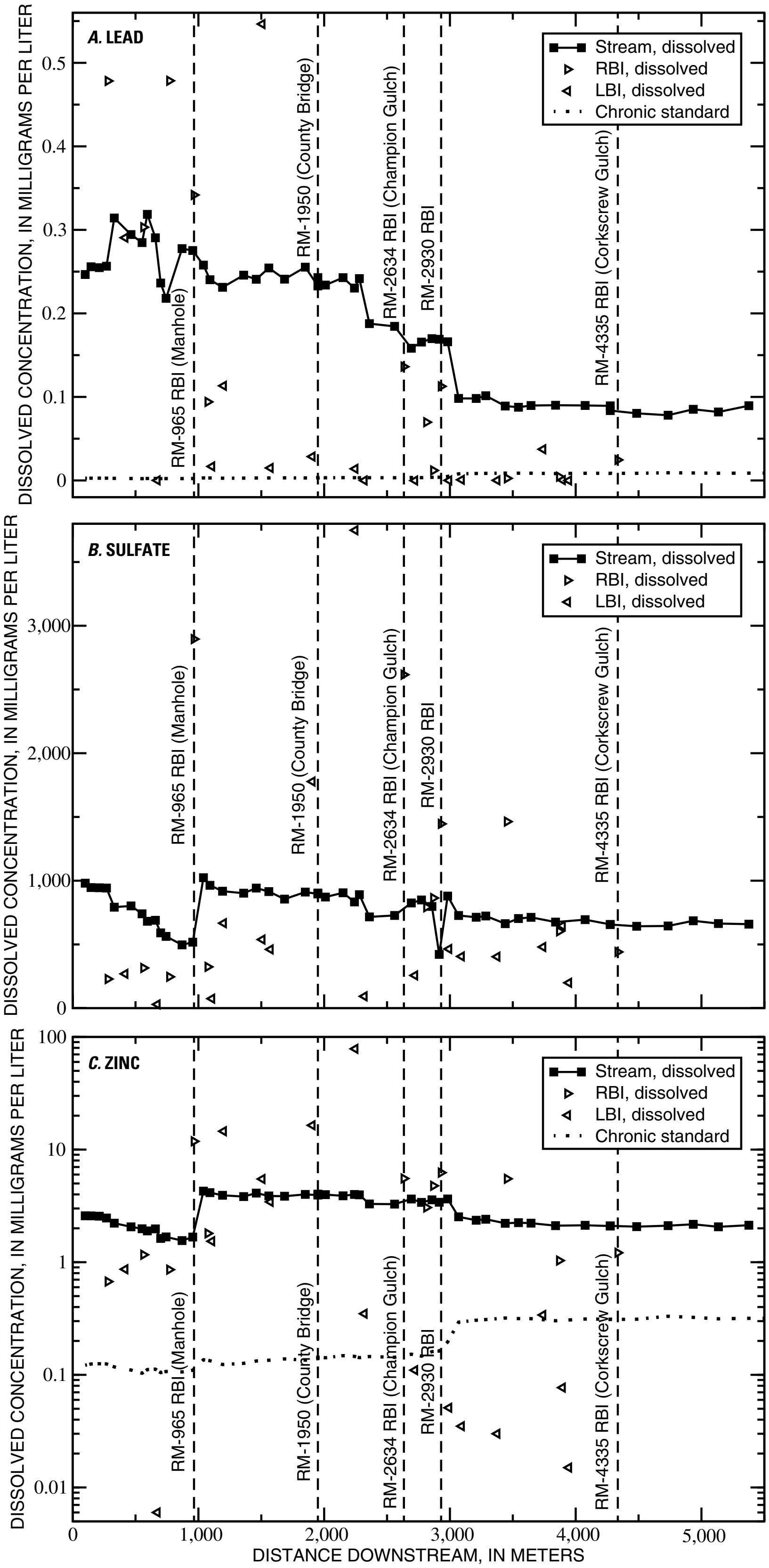

Figure 5. Spatial profiles of (*A*) lead concentrations, (*B*) sulfate concentrations, and *(C)* zinc concentrations, August 2002 (RBI, right bank inflow; LBI, left bank inflow). Chronic standards are shown for comparison purposes only (numeric water-quality standards have not been established by the State of Colorado for Red Mountain Creek).

patterns are clear. The stream segment ending at 1,040 meters, for example, has a high percent contribution for all of the constituents shown in figures 6–13 (ranging from 13 to 44.5 percent of the cumulative instream load). Additional characterization of individual sources is provided in the following subsection.

Major Sources of Metals

The top eight sources of constituent load to Red Mountain Creek are summarized in tables 11 and 12. Source number 1, RM-1040, is the largest contributor of aluminum, arsenic, cadmium, chromium, copper, iron, potassium, manganese, nickel, sulfate, vanadium, and zinc (table 11). The loading observed at RM-1040 is likely due to a right bank inflow at 965 meters (RM-965), an acidic inflow (pH=2.9) with high metal concentrations (figs. 3–5). Field reconnaissance in August 2002 revealed that RM-965 enters Red Mountain Creek after discharging from an overflowing manhole on a nearby county road. The manhole is part of a subterranean sewer system that drains the Genessee Mine.[6] Source number 2, RM-100, is located at the injection site and represents all of the constituent loading from sources upstream from the injection. This source is the largest contributor of lead and the second largest contributor of arsenic, copper, and silica (table 11). The observed loading is likely due to a pipe draining a mine adit (right bank inflow at 43 meters) and other sources in the headwaters of Red Mountain Creek. These other sources potentially include drainage from the Hero, National Belle, Hudson, and Enterprise mines and the Red Mountain adit (see fig. 2 in Hardy and others, 1999).

Source number 3, RM-2693, is the largest contributor of cobalt and the second largest contributor or aluminum, cadmium, chromium, iron, nickel, and vanadium (table 11). Observed loading at RM-2693 is likely due to Champion Gulch (right bank inflow at 2,634 meters), a tributary whose watershed includes numerous mine shafts and adits in the Guston area (fig. 2). Source number 4, RM-2982, is the second largest contributor of magnesium, manganese, sodium, and zinc (table 11). The loading observed at RM-2982 is likely due to a right bank inflow at 2,930 meters, an inflow that emanates from a concrete channel that is fed by the Joker Tunnel and two pipes (Carol Russell, U.S. Environmental Protection Agency, oral commun., 2004).

The correspondence between the previously noted sources and the inflows entering within the given stream segment is quantified by comparing the observed increase in load with the increase in load attributable to each inflow. This analysis is shown in figure 14 for sources 1, 3, and 4 (source number 2 is not included due to uncertainties in estimating the amount of streamflow associated with inflows upstream from the injection site). For each source and constituent, the change in corrected instream load is compared to the change in load based on the sampled inflow. The change in corrected instream load comes directly from the spatial profiles of instream load presented earlier (figs. 6–13), whereas the change in load based on the sampled inflow is equal to the product of the change in streamflow (Appendix 1) and the total recoverable inflow concentration. As shown in figure 14, the aluminum, iron, and zinc loads associated with the inflows are comparable to the observed change in instream load, an observation that supports the connections between the inflows and sources noted previously.

Sources 1–4 account for 83, 72, 70, 69, 64, and 61 percent of the aluminum, iron, arsenic, zinc, copper, and cadmium loading within the study reach, respectively. Sources 5–8 (table 12) account for a much smaller proportion of the observed loading and are much less important than the top four. One exception to this general statement is source number 5 (RM-870), a source that is the largest contributor to silver loading and the second largest contributor of lead.

Other Potential Sources

The foregoing subsection summarizes the major sources of loading to Red Mountain Creek in August of 2002. These sources are thought to be the primary determinants of streamwater quality under low-flow conditions. This is an appropriate starting point, as sources active at low flow are also likely to contribute to stream loading under higher flow regimes. In this subsection several secondary sources are discussed. Although these secondary sources had a relatively small effect on constituent loading in August 2002, they may have a greater effect on streamwater quality at high flow, during snowmelt, or following heavy rain. One potential source under these conditions is water emanating from the base of a revegetated tailings pond, upstream from the County Road 31 bridge (Red Mountain Tailings Pile 2, Hardy and others, 1999). A left bank inflow sampled at this location (1905 LBI) has the second highest dissolved zinc concentration of the 29 sampled inflows (fig. 5*C*). The effect of this inflow on stream loading was minimal under low-flow conditions, as very little water entered Red Mountain Creek within the corresponding stream segment (ending at RM-1950). Stream loading in this segment would be expected to increase, however, under hydrologic regimes in which additional water percolates through the revegetated area. A second potential source is a large deposit of mine tailings located on the right bank downstream from the County Road 31 bridge (downstream from RM-2010). As with the revegetated area, the effect at this location may be more pronounced when water is actively percolating through the tailings.

A third potential source, the Silver Bell Mine, is described in a U.S. Forest Service report (Gusey and Sutton, 2000). The effect of this source in August 2002 appears to be minimal, as there are no major sources in the proximate area (between RM-3209 and RM-3840). The stream segment ending at RM-3545 does, however, represent the sixth largest source of zinc (3 percent of the total load). The zinc loading observed at RM-3545

---

[6]The reason for the overflow from the subterranean system is unclear at this time. The site was revisited on September 28, 2004, and similar hydrologic conditions were observed.

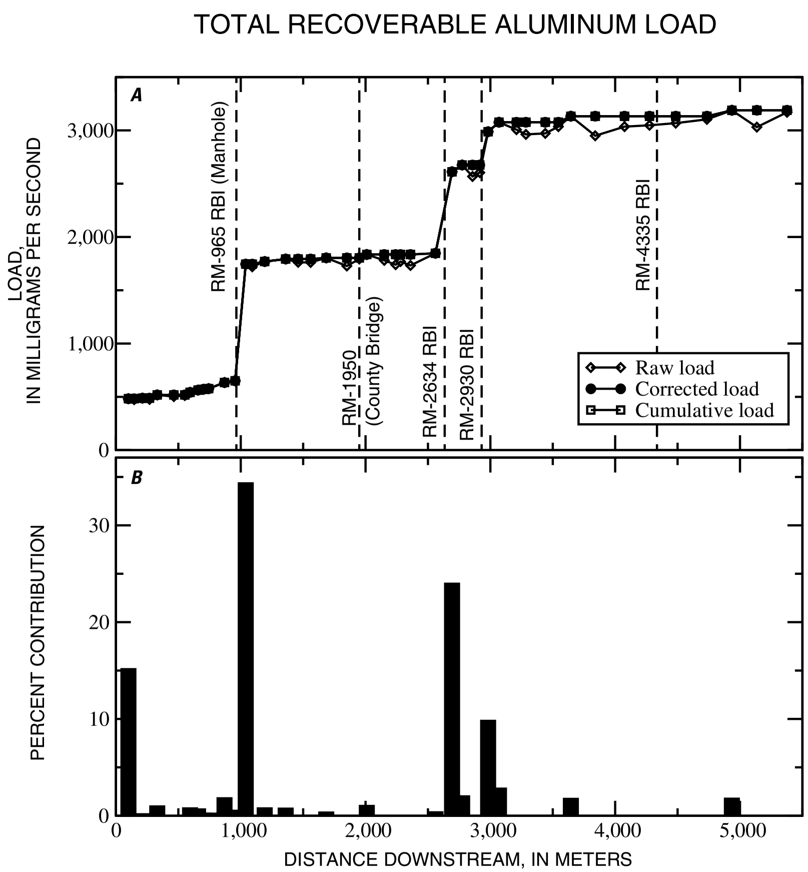

Figure 6. Total recoverable aluminum load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

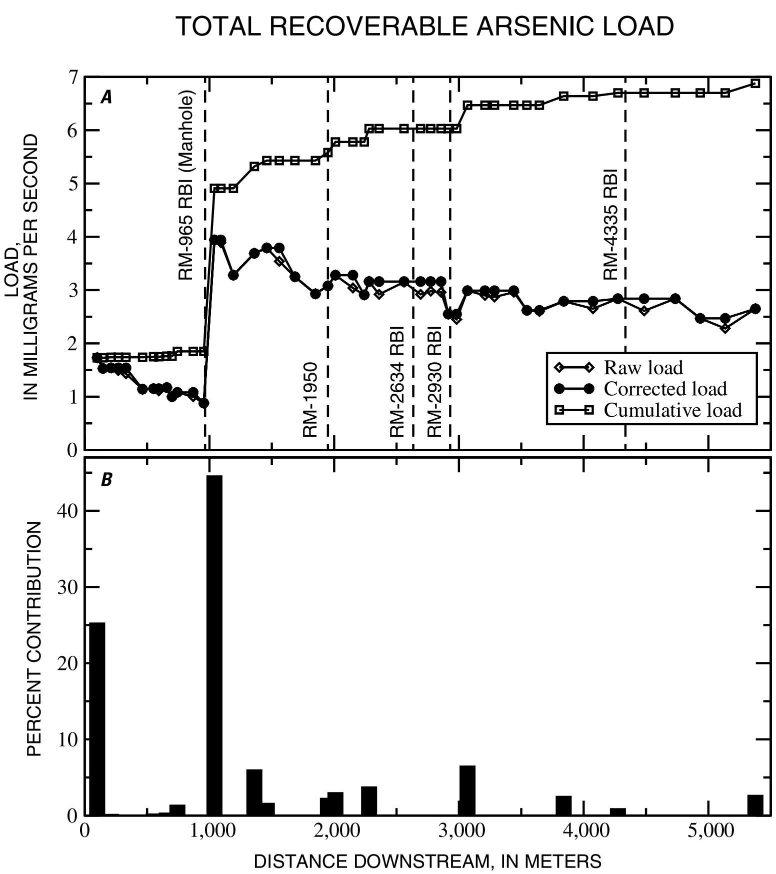

Figure 7. Total recoverable arsenic load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

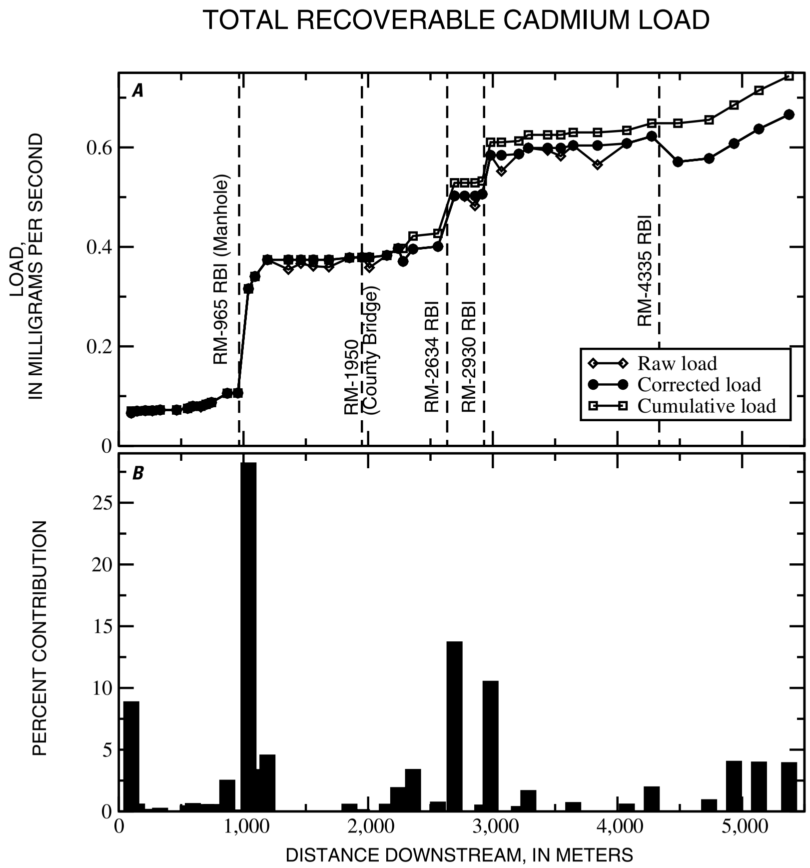

Figure 8. Total recoverable cadmium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

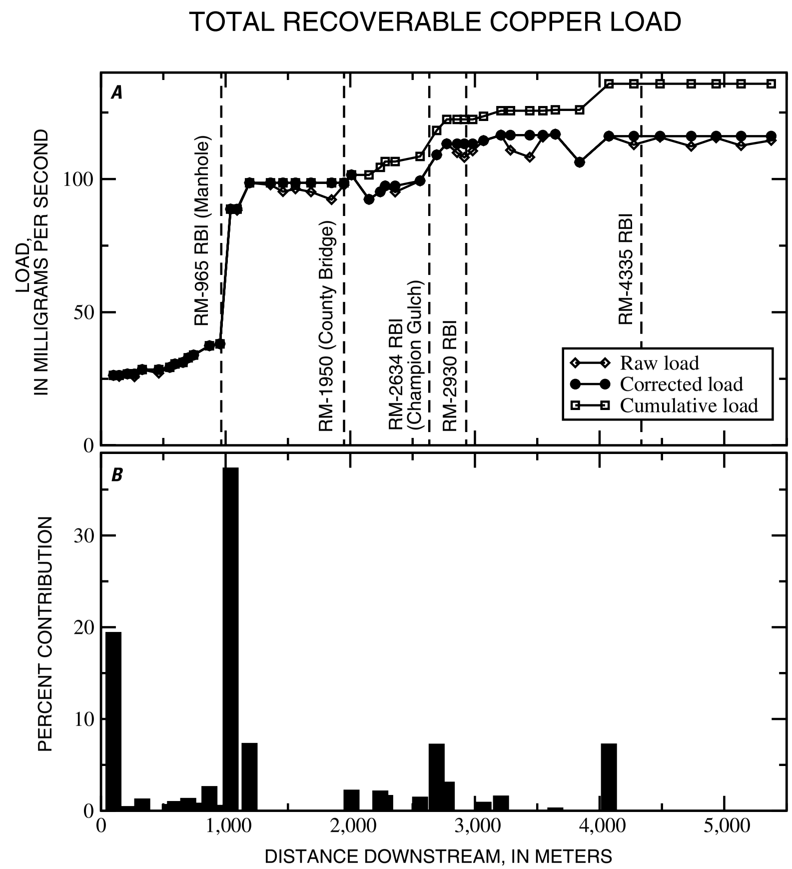

Figure 9. Total recoverable copper load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

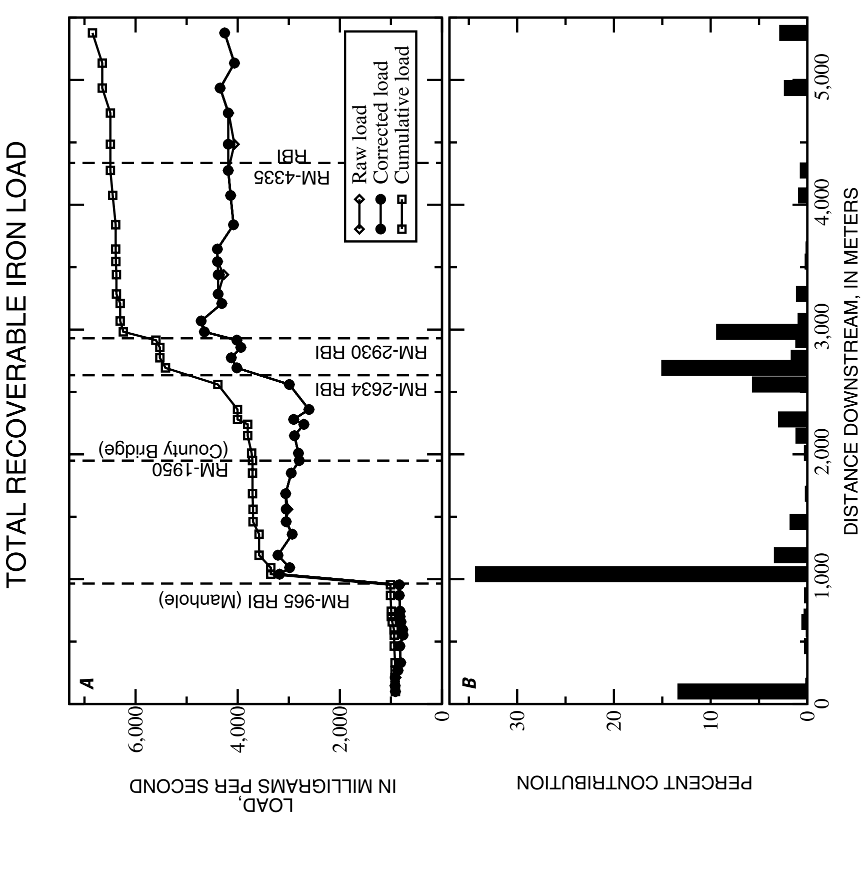

Figure 10. Total recoverable iron load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

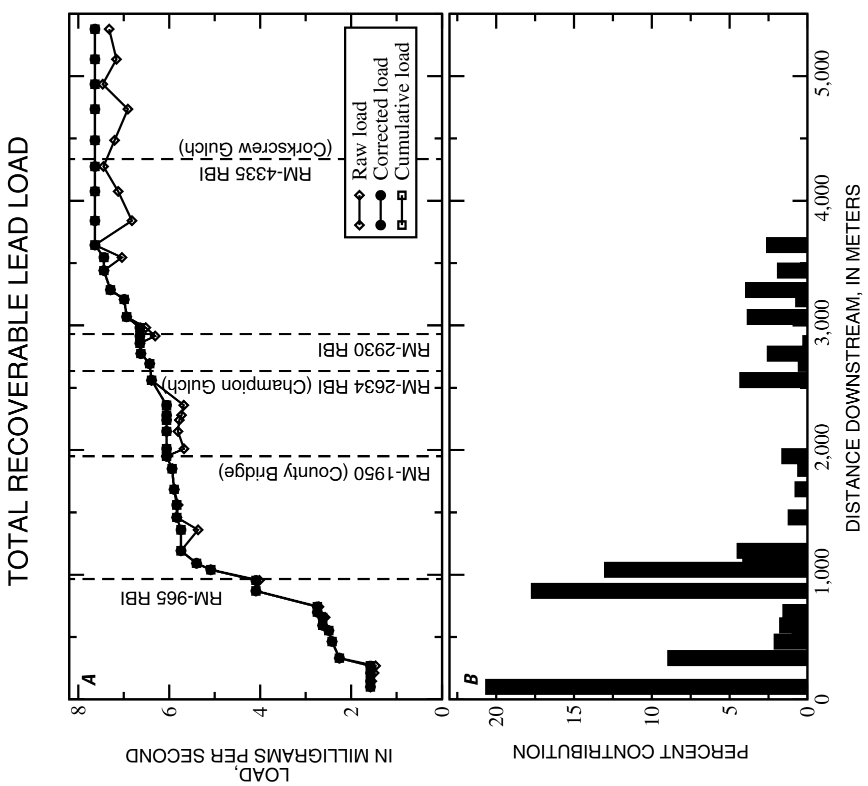

Figure 11. Total recoverable lead load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

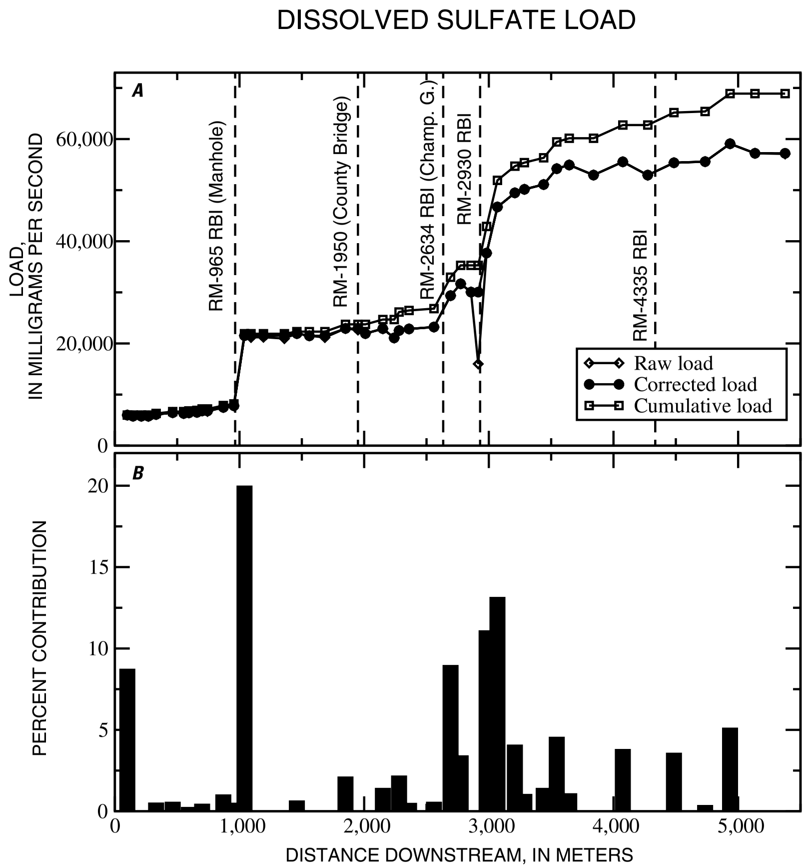

Figure 12. Dissolved sulfate load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

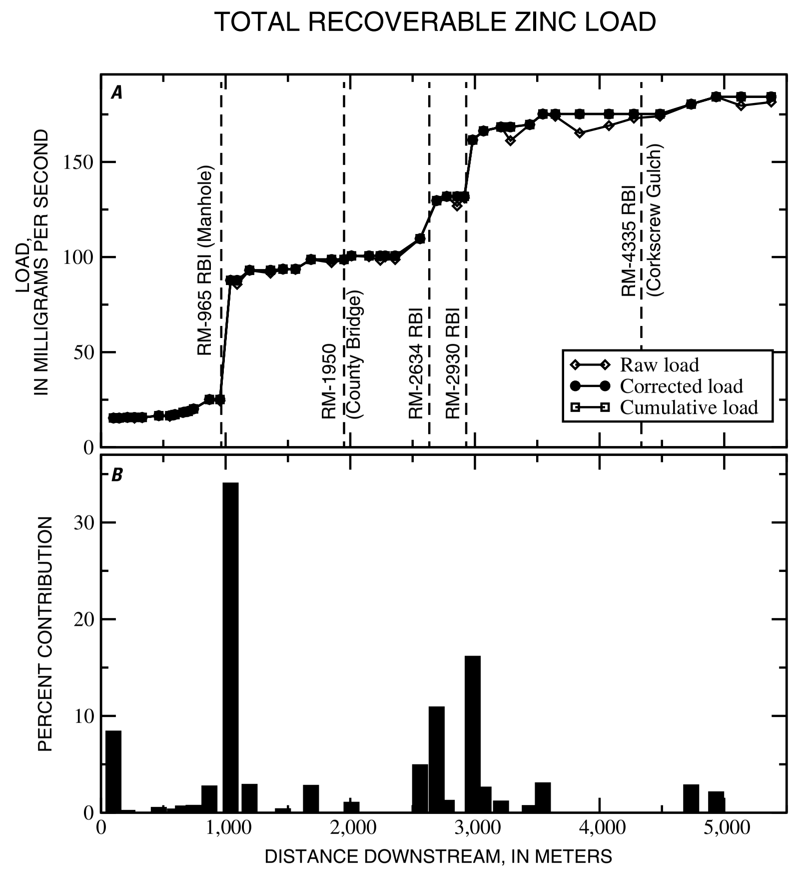

Figure 13. Total recoverable zinc load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

Table 11. Major sources of metals to Red Mountain Creek, ranked sources 1–4, August 2002.

[Source rank, rank of stream segment as a source of mass loading for suite of constituents. Stream segment ending at, distance at which stream segment ends, in meters. Upstream inflow, inflow within stream segment. Constituent source rank, rank of stream segment as a source of mass loading for a given constituent. Percentage of load, percentage of load for a given constituent contributed by stream segment. RBI, right bank inflow]

Source rank: 1 Stream segment ending at: RM-1040 Upstream inflow: 965 RBI			Source rank: 2 Stream segment ending at: RM-100 Upstream inflow: 43 RBI			Source rank: 3 Stream segment ending at: RM-2693 Upstream inflow: 2634 RBI			Source rank: 4 Stream segment ending at: RM-2982 Upstream inflow: 2930 RBI		
Constituent source rank	Constituent	Percentage of load	Constituent source rank	Constituent	Percentage of load	Constituent source rank	Constituent	Percentage of load	Constituent source rank	Constituent	Percentage of load
1	Al	34.3	1	Pb	20.6	1	Co	16.2	2	Mg	16.3
1	As	44.5	2	As	25.2	2	Al	24.0	2	Mn	17.4
1	Cd	28.2	2	Cu	19.4	2	Cd	13.7	2	Na	17.9
1	Cr	31.5	2	Si	13.0	2	Cr	17.6	2	Zn	16.1
1	Cu	37.3	3	Al	15.1	2	Fe	15.0	3	Cd	10.5
1	Fe	34.2	3	Cr	15.7	2	Ni	11.5	3	Co	9.3
1	K	14.4	3	Fe	13.3	2	V	20.0	3	SO_4	11.0
1	Mn	18.7	3	Ni	10.2	3	Mn	9.3	3	Sr	12.2
1	Ni	22.8	3	V	14.0	3	Zn	10.9	4	Al	9.8
1	V	40.2	4	Cd	8.8	4	SO_4	8.9	4	Ca	8.2
1	Zn	34.0	4	Co	7.9	5	Cu	7.2	4	Fe	9.3
1	SO_4	19.9	4	Zn	8.4	6	Si	8.0	4	Ni	9.1
2	Co	14.8	5	Mn	5.6	9	Mg	3.6	4	Si	9.5
3	Mg	11.6	5	SO_4	8.7	16	Ag	1.8	4	V	4.7
3	Mo	8.7	6	Mg	4.1	19	Ca	0.7	8	Mo	2.8
3	Pb	13.0	6	Sr	3.0	21	Sr	0.6	12	K	2.7
3	Si	11.5	7	K	4.2	22	Pb	0.6	13	Cr	1.1
8	Ca	2.5	8	Ba	5.0	25	K	0.6	17	Ba	2.2
15	Na	1.4	11	Na	2.0				21	Ag	0.7
24	Sr	0.3	12	Ca	1.8						
			15	Mo	1.5						
			18	Ag	1.3						

Table 12. Major sources of metals to Red Mountain Creek, ranked sources 5–8, August 2002.

[Source rank, rank of stream segment as a source of mass loading for suite of constituents. Stream segment ending at, distance at which stream segment ends, in meters. Upstream inflow, inflow within stream segment. Constituent source rank, rank of stream segment as a source of mass loading for a given constituent. Percentage of load, percentage of load for a given constituent contributed by stream segment. RBI, right bank inflow. LBI, left bank inflow]

Source rank: 5 Stream segment ending at: 870 Upstream inflow: 770 RBI			Source rank: 6 Stream segment ending at: 1192 Upstream inflow: 1107 LBI			Source rank: 7 Stream segment ending at: 2560 Upstream inflow: none			Source rank: 8 Stream segment ending at: 2774 Upstream inflow: 2696 LBI		
Constituent source rank	**Constituent**	**Percentage of load**	**Constituent source rank**	**Constituent**	**Percentage of load**	**Constituent source rank**	**Constituent**	**Percentage of load**	**Constituent source rank**	**Constituent**	**Percentage of load**
1	Ag	16.4	3	Cu	7.3	5	Fe	5.6	6	Cu	3.1
2	Pb	17.7	5	Cd	4.5	5	Zn	4.9	6	Al	2.0
7	Cu	2.6	5	Cr	4.3	6	Pb	4.3	10	Ca	2.3
7	Si	4.7	5	Pb	4.5	9	Mo	2.7	10	Si	3.3
7	Al	1.8	6	Fe	3.4	10	Na	2.3	11	Fe	1.6
10	Zn	2.7	7	Zn	2.9	10	Ni	3.3	11	Mn	2.3
11	Cd	2.5	9	Na	2.3	12	Cu	1.4	11	Pb	2.5
13	Mn	2.2	9	Ni	3.5	12	Mg	2.8	11	SO_4	3.4
14	Ba	2.8	9	Si	3.7	12	Sr	1.2	13	Mg	2.6
15	Sr	0.8	9	V	2.1	13	Ca	1.7	13	Zn	1.2
16	K	2.4	10	Ba	4.9	14	Mn	2.0	14	Ag	2.4
16	Mg	2.0	11	Ag	3.3	15	Cr	1.0	15	K	2.5
17	Ca	0.8	11	Sr	1.8	16	Cd	0.7	16	Na	1.3
18	SO_4	1.0	12	Al	0.8	16	Si	1.3	18	Sr	0.7
19	Cr	0.2	12	Mo	2.2	17	Al	0.4	19	Ba	1.5
21	Na	0.7	15	Co	2.3	20	Ba	1.5			
22	Co	0.7	16	Ca	0.8	20	SO_4	0.5			
22	Fe	0.2	19	Mg	1.2	25	Co	0.5			
22	Ni	0.5	20	Mn	1.1						

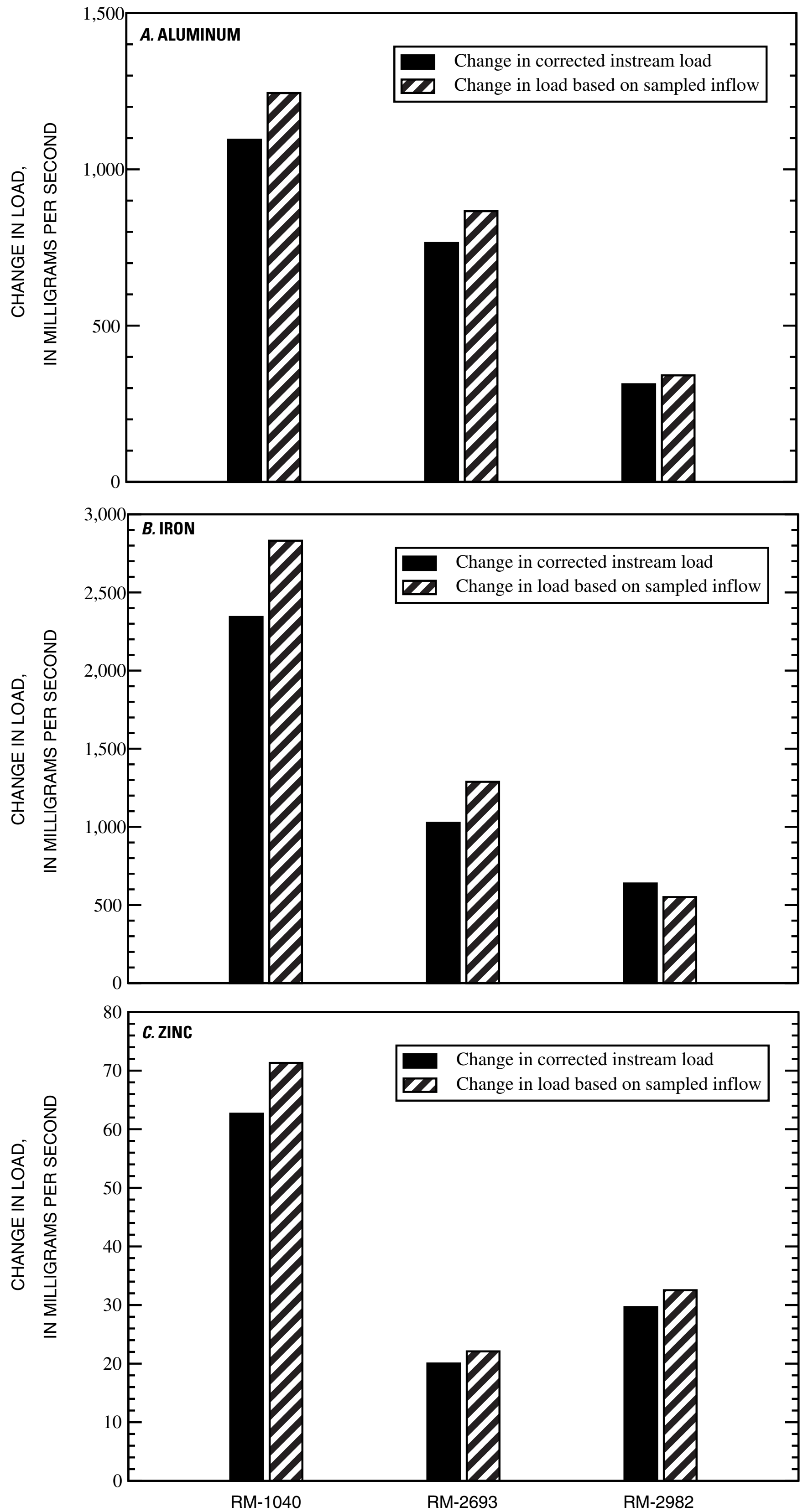

Figure 14. Comparison between change in corrected instream load and change in load attributable to observed inflows for (*A*) aluminum, (*B*) iron, and (*C*) zinc, Red Mountain Creek, Colo., August 2002.

is likely due to a right bank inflow at 3,455 meters, an inflow that appears to be directly downgradient from the Silver Bell Mine. A final source discussed here is the revegetated tailings ponds located at the end of the study reach (immediately upstream from County Road 20). The revegetated area is adjacent to three stream sites (RM-4935, RM-5135, RM-5377) that in aggregate account for 9.1 and 11.9 percent of the chromium and cadmium loads, respectively. Because no surface inflows were observed in this subreach, the observed loading is likely due to subsurface inflow. Additional loading from the subsurface may occur during snowmelt and rainfall events. The effect of these potential sources could be quantified by conducting additional synoptic studies at high flow, during snowmelt, and(or) following heavy rain.

Implications for Remediation

Given the magnitude by which aquatic-life standards are exceeded (figs. 3–5), extensive remedial efforts may be needed to substantially improve the water quality of Red Mountain Creek. The task is made somewhat more tractable, however, by two factors. First, most of the major sources (tables 11 and 12) appear to be surface inflows rather than diffuse ground-water inflow. Collection of source water prior to treatment therefore appears to be relatively straightforward. Second, the top four sources (table 11) account for the most of the loading; seven of eight constituents (Al, As, Cd, Cu, Mn, Ni, and Zn) that have concentrations exceeding the chronic aquatic-life standard have more than one-half of their loading attributed to the top four sources. The number of inflows requiring treatment may therefore be minimized. This second factor is further illustrated in table 13, where the number of sources comprising 80 percent of the load is tabulated for each constituent. As shown in the table, a relatively small number of sources contribute most of the load for those constituents that are toxic to aquatic life (Al, As, Cu, and Zn, for example). This is in contrast to those constituents commonly found in natural surface waters (K, Mg, and Si, for example) that have numerous sources within the study reach.

Additional Sources of Data

Additional sources of data on Red Mountain Creek include Moran and Wentz (1974), Nash (2002), and the U.S. Environmental Protection Agency (2003, 2004; Appendix 4). These sources of data are used in this section to investigate the four questions posed herein. Due to differences in data-collection and analysis techniques and the limited amount of overlap among the data sets, the interpretations that follow are rudimentary in nature.

Table 13. Number of sources for specific constituents, Red Mountain Creek, Colo., August 2002.

Constituent	Number of sources comprising 80 percent of load	Total number of sources
Aluminum	4	21
Arsenic	4	15
Vanadium	5	17
Copper	6	22
Iron	6	27
Chromium	7	24
Strontium	7	32
Zinc	7	23
Calcium	8	35
Cadmium	9	31
Lead	9	23
Molybdenum	9	25
Sodium	9	35
Sulfate	10	28
Silica	10	29
Silver	11	26
Manganese	11	30
Nickel	11	25
Cobalt	12	29
Magnesium	12	35
Barium	13	28
Potassium	14	29

Are the August 2002 data consistent with other data? Three sampling locations where there is overlap among the data sets include Red Mountain Creek near the County Road 31 bridge, Champion Gulch at mouth, and Red Mountain Creek at the end of the study reach (table 14). Dissolved concentrations from samples collected at these locations in August 2002 are generally higher than dissolved concentrations reported in the other data sources (fig. 15). These higher concentrations may be attributed to the lower pH values observed in August 2002 (fig. 15*A*; metal solubility generally increases with decreasing pH).

Another factor that may contribute to the higher concentrations is the extreme drought conditions during August 2002 that may have led to less dilution of the contaminant sources. Given these considerations, the August 2002 data appear to be consistent with other data available for Red Mountain Creek.

Table 14. Samples from additional data sources used in data comparison

[Streamflow, in cubic feet per second; USEPA, U.S. Environmental Protection Agency; NA, not available]

Sample	Data source	Date	Streamflow
	Samples near County Road 31 bridge		
RM-1950[1]	this study	08/27/2002	0.89
URRM-1B	USEPA (2003)	04/15/2003	1.04
URRM-1B	USEPA (2004)	09/27/2004	5.35
NGW841	Nash (2002)	09/07/1999	NA
	Samples of Champion Gulch at mouth		
RM-2634	this study	08/27/2002	NA
URRM-CG1	USEPA (2004)	09/28/2004	NA
	Samples near end of study reach		
RM-5377	this study	08/27/2002	3.06
UR-9	Moran and Wentz (1974)	12/15/1972	NA
URRM-2A	USEPA (2003)	04/15/2003	3.43
URRM-2A	USEPA (2004)	09/27/2004	15.70

[1]Sample concentrations used for the data comparison (fig. 15) are based on the average of concentrations from samples RM-1950A and RM-1950B (tables 5 and 6).

Have conditions in Red Mountain Creek changed over time? Moran and Wentz (1974) describe their sample location UR-9 as "Red Mountain Creek above Gray Copper Gulch" (table 14). The UR-9 sample is therefore comparable to RM-5377, the sample collected at the downstream end of the August 2002 study reach. Water-quality data for these two samples are remarkably similar (especially pH, Fe, and Cu; see fig. 15). This observation suggests very little change in ambient water quality over a 30-year time period. Although this apparent lack of temporal change may be true, firm conclusions on the issue cannot be made using a single set of data points at a single overlapping stream site.

Does water quality change seasonally? A simple look at seasonality may be obtained by comparing the three August–September sampling events (Nash, 2002; USEPA, 2004; this study) with the April 2003 sampling event (USEPA, 2003) (table 14). Samples from Red Mountain Creek in April 2003 have higher pH and lower dissolved copper, iron, lead concentrations than the corresponding samples for August–September (fig. 15). This comparison suggests a small amount of dilution due to snowmelt that may be more pronounced later in the spring. Dissolved cadmium and zinc concentrations do not support this observation, however, and additional data would be needed to arrive at a firm conclusion.

What are the water-quality conditions downstream from the study reach? Sampling efforts by the U.S. Environmental Protection Agency (2003, 2004) included several sites downstream from the August 2002 study reach. These downstream sites include two additional sites on Red Mountain Creek and five additional sites on the Uncompahgre River downstream from the confluence with Red Mountain Creek. These additional data provide an opportunity to look at how water quality changes as Red Mountain Creek flows down-valley and merges with the Uncompahgre River.

Instream constituent concentrations decrease downstream from the August 2002 study reach as relatively dilute waters from Crystal Lake (8,100 meters), the Uncompahgre River (11,700 meters), Bear Creek (13,100 meters), and other tributaries mix with water from Red Mountain Creek. In addition to providing for dilution, these tributaries act to buffer the acidic water of Red Mountain Creek, causing an increase in pH with distance (fig. 16*A*). The increase in pH promotes precipitation and sorption reactions that result in the formation of solid phases and a corresponding decrease in concentrations of dissolved aluminum, cadmium, copper, lead, and zinc. Dissolved copper and zinc concentrations from April 2003, for example, decrease downstream from 15,000 meters where the formation of a solid phase is evident (fig. 16*B* and *C*; total recoverable concentrations exceed dissolved concentrations). The formation of a solid phase is likely due to the sorption of copper and zinc onto hydrous iron oxides, a process that becomes important as pH increases (Runkel and others, 1999). The reactive behavior of aluminum, copper, cadmium, lead, and zinc downstream from 5,000 meters is in contrast to the data from the August 2002 study reach that suggest conservative transport of these constituents (pH in the August 2002 study reach remains low such that solid phase formation is negligible). The increase in reactivity with pH shown here has important implications for potential toxicity, as dissolved concentrations for most metals fall below State of Colorado aquatic-life standards before the Uncompahgre River reaches Ouray (copper and zinc, for example; fig. 16*B* and *C*).

Spatial profiles of raw instream load based on total recoverable aluminum, copper, iron, and zinc concentrations are shown in figure 17. Behavior of these constituents downstream from the August 2002 study reach may be examined by considering three subreaches. The first subreach extends from the end of the August 2002 study reach to the confluence of Red

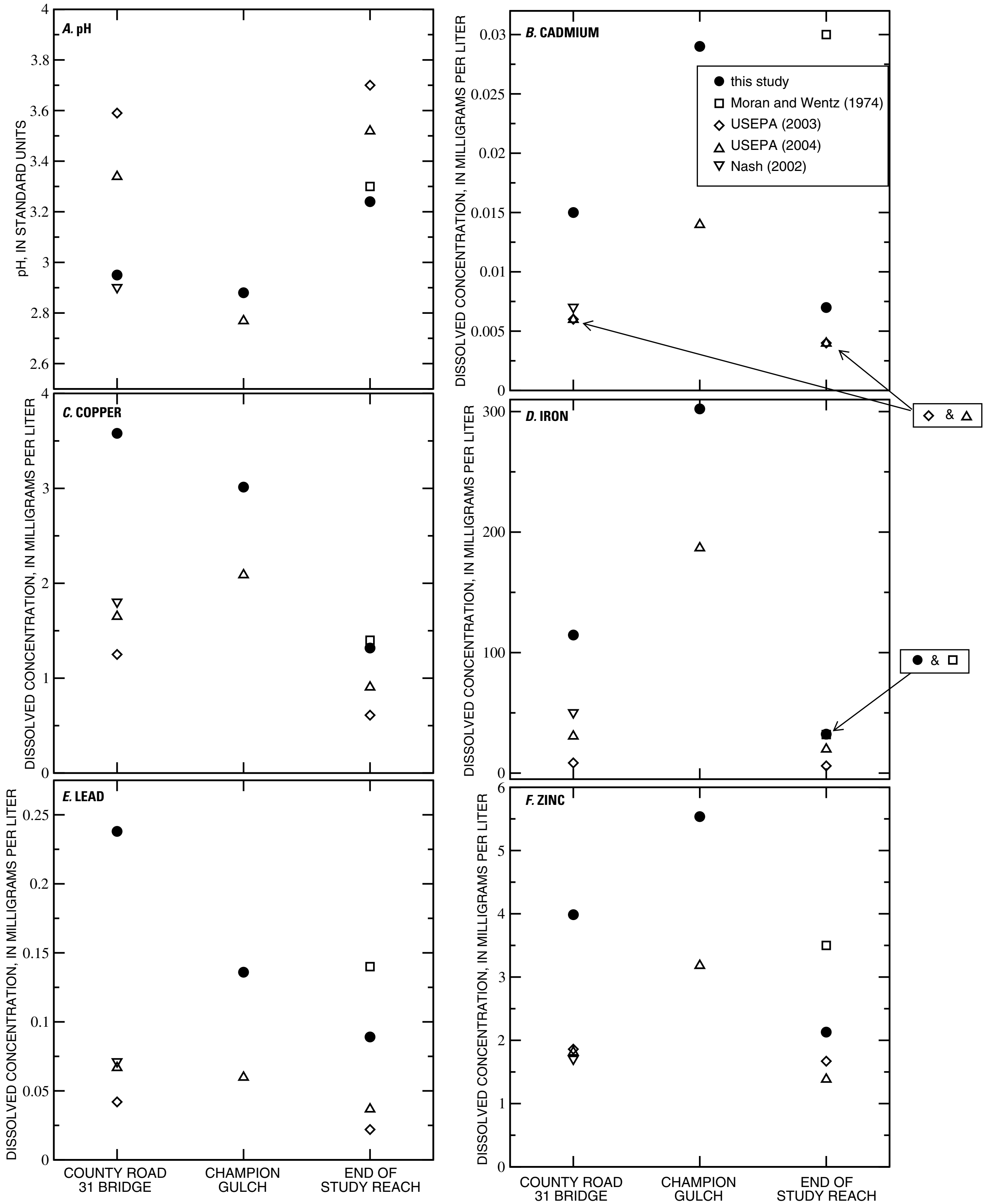

Figure 15. Data comparison at three sampling locations for (*A*) pH, (*B*) cadmium concentrations, (*C*) copper concentrations, (*D*) iron concentrations, (*E*) lead concentrations, and (*F*) zinc concentrations. Dissolved concentrations are from samples filtered through a 0.45-micrometer membrane.

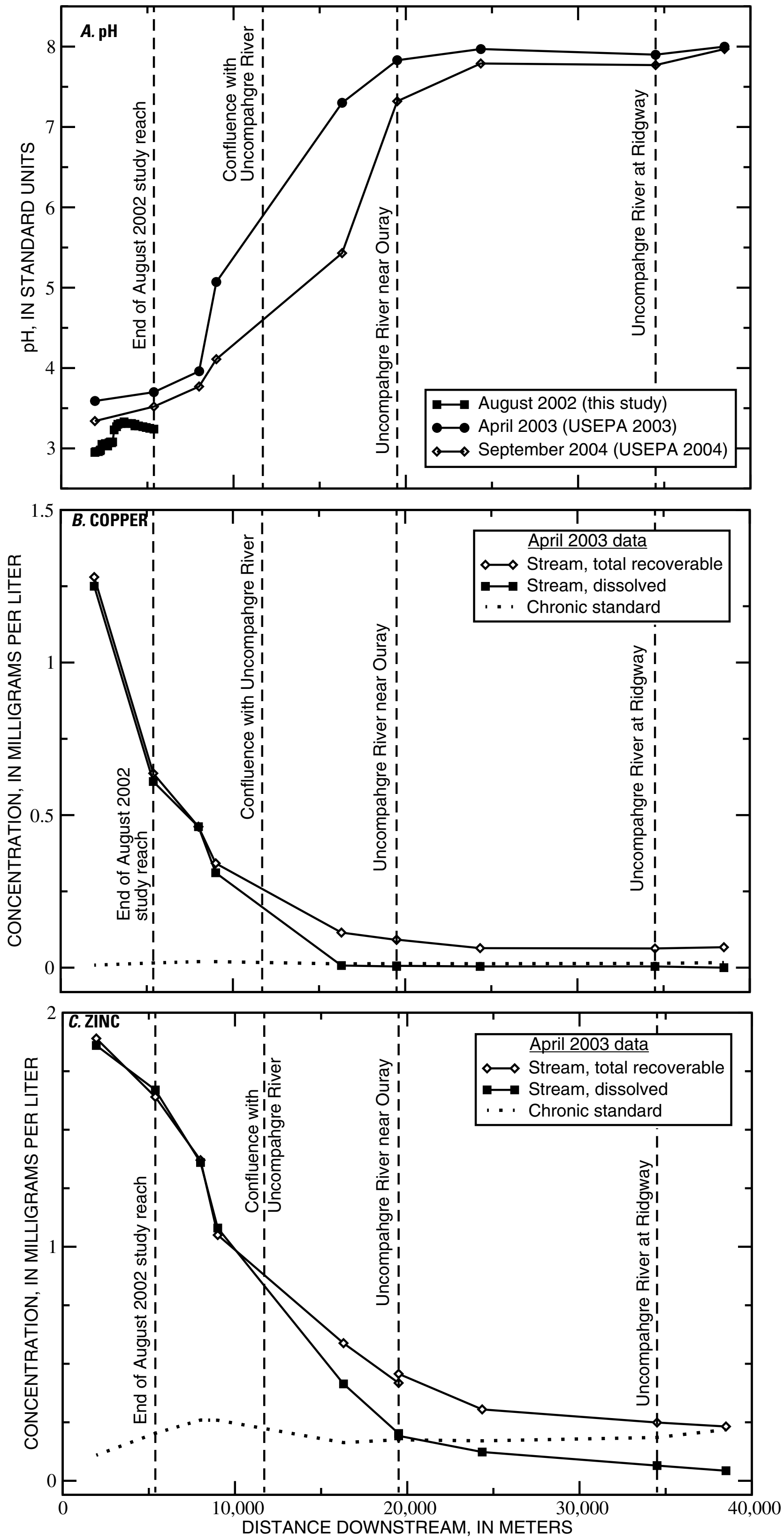

Figure 16. Spatial profiles of (*A*) pH, (*B*) copper concentrations, and (*C*) zinc concentrations for Red Mountain Creek and the Uncompahgre River downstream from the confluence with Red Mountain Creek.

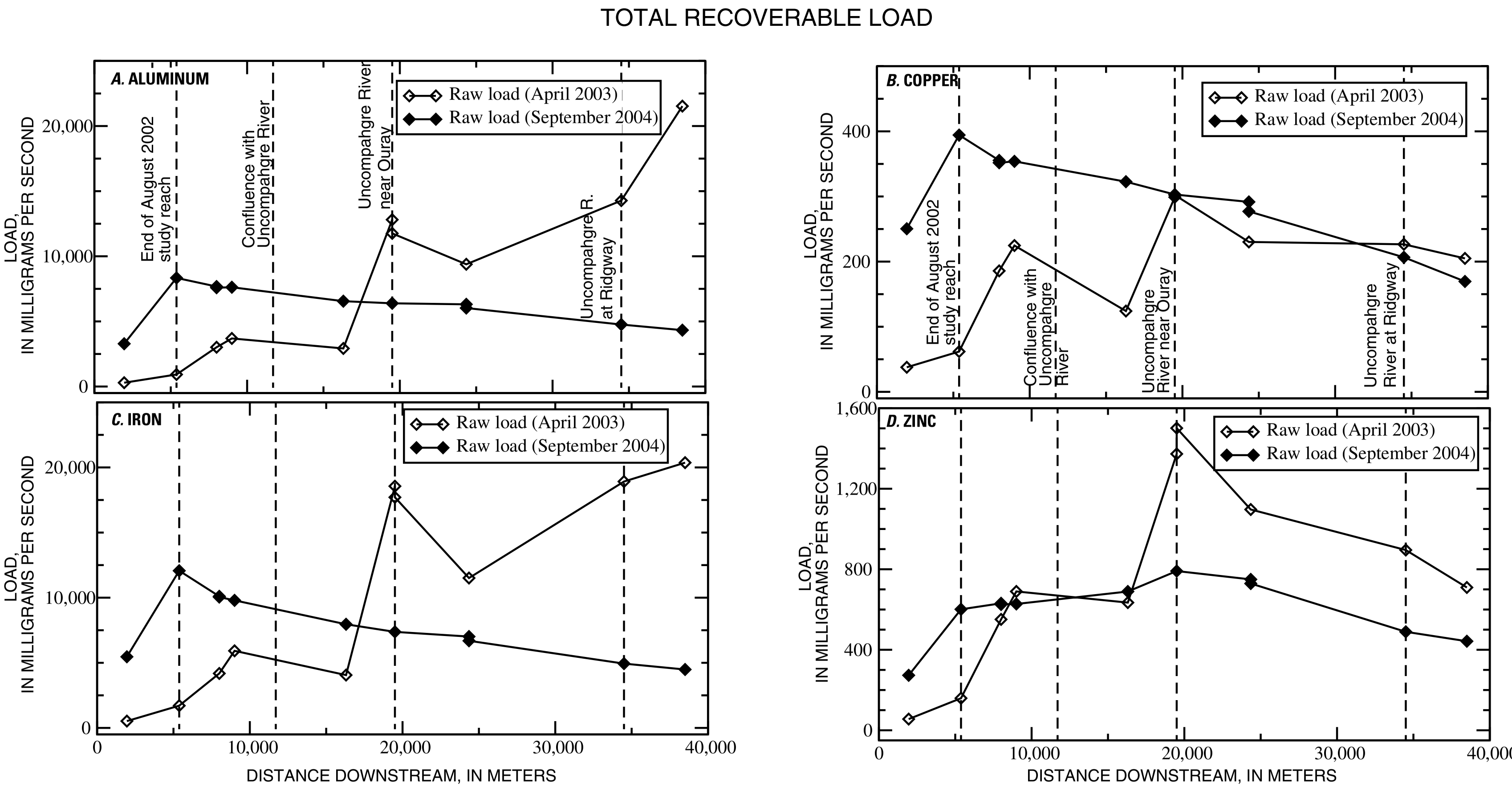

Figure 17. Total recoverable loads from April 2003 and September 2004 for Red Mountain Creek and the Uncompahgre River downstream from the confluence with Red Mountain Creek: (*A*) raw aluminum load, (*B*) raw copper load, (*C*) raw iron load, and (*D*) raw zinc load.

Mountain Creek with the Uncompahgre River (5,377–11,700 meters, Appendix 4). This subreach includes the Ironton Park wetland area and drainage from several tributaries. Constituent loads for aluminum (April 2003), iron (April 2003), copper (April 2003), and zinc (April 2003 and September 2004) increase in the subreach (fig. 17), suggesting the presence of constituent sources. Potential sources in this subreach include Gray Copper, Brooklyn, and Full Moon Gulches, drainage from the Ironton Park wetland, and mined areas within the subwatershed. Aluminum, copper, and iron loads for September 2004, in contrast, show a decrease in load. This decrease in load represents a decrease in constituent mass that is attributable to the formation of solid phases that are removed from the water column as they settle to the streambed.

The second subreach extends from the confluence of Red Mountain Creek and the Uncompahgre River to USGS gaging station 09146020 downstream from Ouray (11,700–19,500 meters, Appendix 4). Constituent loading in this subreach follows a similar pattern to that of the first subreach: Aluminum, iron, and copper loads increase in the April 2003 data set and decrease in the September 2004 data set, whereas zinc loads increase in both April 2003 and September 2004. Increases in load are primarily in the downstream half of the subreach, an area that includes the Silvershield Mill, a potential source area (Nash, 2002). The final subreach extends from Ouray to USGS gaging station 09146200 downstream from Ridgway (19,500–38,500 meters, Appendix 4). Despite the potential for loading from the Banner Mill (Nash, 2002), constituent loads generally decrease within this subreach (exceptions include increased aluminum and iron loading for April 2003).

In summary, constituent concentrations downstream from the August 2002 study reach decrease due to dilution from several tributaries and reactions that become important as pH increases. The decrease in concentrations results in water-quality conditions that are more hospitable to aquatic life. Constituent loads from September 2004 generally decrease, suggesting a lack of major constituent sources downstream from the August 2002 study reach (with the exception of increased zinc loading in the top two subreaches). In contrast, constituent loads from April 2003 generally increase, suggesting the presence of sources. The different loading patterns determined from April and September data may be partially explained by a rainfall event that occurred during sampling on April 14, 2003. Rainfall received during this time may have flushed constituent mass out of source areas, leading to the observed increases in load. Further data collection and analysis, including synoptic studies that provide more spatial resolution, may be needed to fully characterize constituent sources downstream from the August 2002 study reach.

Summary and Conclusions

In August 2002, the U.S. Geological Survey conducted a water-quality study on Red Mountain Creek using synoptic sampling techniques and the tracer-dilution method. The study, conducted in cooperation with Ouray County, provides detailed spatial information on constituent concentrations, constituent loads, and streamflow along a 5.4-kilometer study reach. Samples collected from various locations along the study reach are thought to reflect streamwater quality under low-flow conditions. Despite the presence of 10 circumneutral inflows, pH remained below 3.4 at all stream sites. Spatial profiles of constituent concentration indicate that dissolved concentrations of aluminum, arsenic, cadmium, copper, lead, manganese, nickel, and zinc exceed chronic aquatic-life standards along all or part of the study reach. Comparison of total recoverable and dissolved concentrations suggests that most constituents were transported conservatively. Exceptions to this pattern include arsenic, iron, molybdenum, and vanadium, four constituents that were subject to precipitation and(or) sorption reactions as the addition of a circumneutral tributary resulted in a slight increase in instream pH. Evaluation of data from the 29 inflow locations indicates a sharp contrast between the east and west sides of the watershed; inflows from the east side have high constituent concentrations and acidic pH, whereas inflows from the west side have lower concentrations and generally higher pH. Spatial profiles of constituent load are used to identify the primary sources of acidity and metals within the study reach. Analysis of the identified sources indicates that four major sources account for more than one-half of the aluminum, arsenic, cadmium, copper, iron, nickel, manganese, and zinc loading. These four major sources appear to be the result of surface inflows that have been affected by mining activities. The relatively small number of major sources and the fact that they are attributable to surface inflows are two factors that may make remediation more tractable.

Data from the August 2002 study are generally consistent with other sources of data on Red Mountain Creek (see section entitled “Additional Sources of Data”). The data and analyses presented herein therefore provide a good description of streamwater quality within the 5.4-kilometer study reach under low-flow conditions. Despite this contribution, several outstanding issues remain. First, the focus of this report is the identification of constituent sources that influence water quality under low-flow conditions. This is an appropriate starting point, as sources active at low flow are also likely to contribute to stream loading under higher flow regimes. Additional sources, active only during high flow, snowmelt, and heavy rain, may also be factors in determining the overall water quality of Red Mountain Creek (see subsection entitled “Other Potential Sources”). These additional sources may be quantified by conducting synoptic studies that focus on constituent loading during periods of elevated streamflow. Second, a review of other data available for Red Mountain Creek suggests the possibility of constituent sources downstream from the 5.4-kilometer study reach. Of particular interest is the subreach extending from the end of the study reach to the confluence of Red Mountain Creek with the Uncompahgre River. Potential sources in this subreach include Gray Copper, Brooklyn, and Full Moon Gulches, drainage from the Ironton Park wetland, and mined areas within the subwatershed. An additional low-flow synoptic study (such as the one described here) would provide the spatial resolution needed to quantify and rank these potential sources.

Third, the approach taken herein is to quantify all sources of constituent load, without regard to the nature of the contributing source areas (mined or unmined source areas). With the exception of the top four sources, relatively little effort has been put forth to determine whether individual sources are affected by mine drainage or whether the sources arise from natural processes. Additional field reconnaissance and sampling could help identify the origin of individual sources and provide the data needed to evaluate pre-mining conditions in Red Mountain Creek. Finally, the presence of substantial constituent sources that are active at low flow may necessitate further remedial actions. Evaluation of remedial options may be facilitated through the use of reactive solute transport models that are calibrated using synoptic data sets (Runkel and Kimball, 2002, for example).

References Cited

Bencala, K.E., and McKnight, D.M., 1987, Identifying in-stream variability—Sampling iron in an acidic stream, *in* Averett, R.C. and McKnight, D.M., eds., Chemical quality of water and the hydrologic cycle: Chelsea, Mich., Lewis Publishers, Inc., p. 255–269.

Brown, E., Skougstad, M.W., and Fishman, M.J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques of Water-Resource Investigations, book 5, chap. A1, 103 p.

Colorado Department of Public Health and Environment, 2000, Regulation no. 31—The basic standards and methodologies for surface water (5 *CCR* 1002–31), as amended on October 30, 2001: State of Colorado, Denver, Colorado, 58 p.

Gusey, D.L., and Sutton, T., 2000, The Red Mountain project—Phase 1, Ouray County Hazardous Materials Report: United States Forest Service, 48 p.

Hardy, A.J., Redmond, J.V., River, R.A., and Davis, C.S., 1999, High altitude mine waste remediation—implementation of the Idarado remedial action plan, *in* Bengson, S.A., and Bland, D.M., eds., Proceedings of the 16th Annual National Meeting of the American Society for Surface Mining and Reclamation, Scottsdale, Arizona, August 13–19, 1999: American Society for Surface Mining and Reclamation, p. 120–131.

Kilpatrick, F.A., and Cobb, E.D., 1985, Measurement of discharge using tracers: U.S. Geological Survey Techniques of Water-Resource Investigations, book 3, chap. A16, 52 p.

Kimball, B.A., Broshears, R.E., Bencala, K.E., and McKnight, D.M., 1994, Coupling of hydrologic transport and chemical reactions in a stream affected by acid mine drainage: Environmental Science and Technology, v. 28, no. 12, p. 2065–2073.

Kimball, B.A., Nimick, D.A., Gerner, L.J., and Runkel, R.L., 1999, Quantification of metal loading in Fisher Creek by tracer injection and synoptic sampling, Park County, Montana, August 1997: U.S. Geological Survey Water-Resources Investigations Report 99–4119, 40 p.

Kimball, B.A., Runkel, R.L., Walton-Day, Katherine, and Bencala, K.E., 2002, Assessment of metal loads in watersheds affected by acid mine drainage by using tracer injection synoptic sampling—Cement Creek, Colorado, USA: Applied Geochemistry, v. 17, no. 9, p. 1183–1207.

Mize, S.V., and Deacon, J.R., 2002, Relations of benthic macroinvertebrates to concentrations of trace elements in water, streambed sediments, and transplanted bryophytes and stream habitat conditions in nonmining and mining areas of the Upper Colorado River Basin, Colorado, 1995–98: U.S. Geological Survey Water-Resources Investigations Report 02–4139, 54 p.

Moran, R.E., and Wentz, D.A., 1974, Effects of metal-mine drainage on water quality in selected areas of Colorado, 1972–73: Colorado Water Conservation Board Water Resources Circular 25, 250 p.

Nash, J.T., 2002, Hydrogeochemical investigations of historic mining districts, Central Western Slope of Colorado, including influence on surface-water quality: U.S. Geological Survey Digital Data Series 73, 168 p.

Neubert, J.T., 2000, Naturally degraded surface waters associated with hydrothermally altered terrane in Colorado: Colorado Geological Survey Open-File Report 00–16, 158 p.

Neubert, J.T., Kurtz, J.P., Bove, D.J., and Sares, M.A., 2005, Natural acid rock drainage associated with hydrothermally altered terrane in Colorado: Colorado Geological Survey Bulletin 54, 182 p.

Runkel, R.L., Kimball, B.A., McKnight, D.M., and Bencala, K.E., 1999, Reactive solute transport in streams—A surface complexation approach for trace metal sorption: Water Resources Research, v. 35, no. 12, p. 3829–3840.

Runkel, R.L., and Kimball, B.A., 2002, Evaluating remedial alternatives for an acid mine drainage stream—Application of a reactive transport model: Environmental Science and Technology, v. 36, no. 5, p. 1093–1101.

Runnells, D.D., Shepherd, T.A., and Angino, E.E., 1992, Metals in water—Determining natural background concentrations in mineralized areas: Environmental Science and Technology, v. 26, p. 2316–2323.

Sauer, V.B., and Meyer, R.W., 1992, Determination of error in individual discharge measurements: U.S. Geological Survey Open-File Report 92–144, 21 p.

To, T.B., Nordstrom, D.K., Cunningham, K.M., Ball, J.W., and McCleskey, R.B., 1999, A new method for the direct determination of dissolved Fe(III) concentration in acid mine waters: Environmental Science and Technology, v. 33, no. 5, p. 807–813.

U.S. Environmental Protection Agency, 2003, Analytical data package for samples collected April 14–18, 2003, LSR R8030053: USEPA Lab 8TMS–L, 141 p.

U.S. Environmental Protection Agency, 2004, Analytical data package for samples collected September 27–28, 2004, LSR R8040156: USEPA Lab 8TMS–L, 152 p.

Wilde, F.D., Radtke, D.B., Gibs, J., and Iwatsubo, R.T., 1999, National field manual for the collection of water-quality data—Collection of water samples: Techniques of Water-Resources Investigations of the U.S. Geological Survey, book 9, chap. A4, 156 p.

Tables 1–9

The following tables include all of the relevant data from the Red Mountain Creek synoptic, conducted August 25–27, 2002.

Table 1. Site descriptions and locations for all sites sampled on August 26 and August 27, 2002, Red Mountain Creek, Colo.

[Distance, distance downstream, in meters. Source, type of sample collected where S denotes stream sample from Red Mountain Creek, LBI denotes left bank inflow, and RBI denotes right bank inflow. Easting and Northing, Universal Transverse Mercator (UTM) coordinates in zone 13 S using the North American Datum of 1927 (NAD27). Altitude, elevation provided by GPS unit, in feet, referenced to the North American Vertical Datum of 1927 (NAVD 27)]

Site (fig. 2)	Distance	Source	Description	Easting	Northing	Altitude
RM-0	0	S	Near National Bell Mine	262387	4198588	10,877
RM-43	43	RBI	Drainage from mine adit	262399	4198628	10,871
RM-100	100	S	Upstream from injection site (Transport Site #0)	262410	4198680	10,869
RM-146	146	S	Upstream from break in gradient	262434	4198713	10,850
RM-212	212	S	Upstream from right bank mine dump	262441	4198772	10,795
RM-269	269	S	Downstream from dump; upstream from right bank springs	262429	4198822	10,745
RM-281	281	RBI	Spring draining mine dump	262437	4198832	10,735
RM-331	331	S	Downstream from springs from mine dump	262415	4198867	10,717
RM-417	417	LBI	Moss inflow with pool	262375	4198939	10,710
RM-464	464	S	Downstream from inflow at log cascade	262373	4198972	10,699
RM-552	552	S	Upstream from right bank fen inflow	262374	4199049	10,656
RM-564	564	RBI	Iron fen drainage	262379	4199063	10,654
RM-594	594	S	Downstream from fen inflow	262402	4199081	10,639
RM-658	658	S	Upstream from West branch, Red Mountain Creek; at Idarado property line (Transport Site #1)	262449	4199125	10,609
RM-673	673	LBI	West branch, Red Mountain Creek	262451	4199131	10,606
RM-700	700	S	Downstream from West branch, Red Mountain Creek; downstream from weir	262474	4199148	10,598
RM-743	743	S	Upstream from right bank inflow	262509	4199167	10,589
RM-770	770	RBI	Clear inflow	262506	4199182	10,597
RM-870	870	S	Downstream from inflow with more biofilm precipitation	262601	4199196	10,592
RM-955	955	S	Upstream from collapsed structure on right bank	262663	4199241	10,558
RM-965	965	RBI	At collapsed structure; manhole discharge	262686	4199255	10,554
RM-1040	1,040	S	Downstream from collapsed structure	262697	4199313	10,508
RM-1075	1,075	RBI	Drainage down from area of Genessee Mine	262716	4199334	10,475
RM-1092	1,092	S	Downstream from wasted area from Genessee Mine	262705	4199355	10,477
RM-1107	1,107	LBI	From disturbed area toward Idarado Mine	262698	4199365	10,470
RM-1192	1,192	S	Downstream from dilute inflow; up from flat area	262732	4199438	10,442
RM-1200	1,200	LBI	From Idarado Mine area	262741	4199441	10,445
RM-1360	1,360	S	At weir at end of flat area, diversion	262780	4199580	10,436

Table 1. Site descriptions and locations for all sites sampled on August 26 and August 27, 2002, Red Mountain Creek, Colo.—Continued

[Distance, distance downstream, in meters. Source, type of sample collected where S denotes stream sample from Red Mountain Creek, LBI denotes left bank inflow, and RBI denotes right bank inflow. Easting and Northing, Universal Transverse Mercator (UTM) coordinates in zone 13 S using the North American Datum of 1927 (NAD27). Altitude, elevation provided by GPS unit, in feet, referenced to the North American Vertical Datum of 1927 (NAVD 27)]

Site (fig. 2)	Distance	Source	Description	Easting	Northing	Altitude
RM-1460	1,460	S	Among tailings piles; upstream from stream return	262785	4199669	10,425
RM-1507	1,507	LBI	Real channel returning	262766	4199705	10,404
RM-1560	1,560	S	Downstream from main channel inflow	262801	4199772	10,389
RM-1572	1,572	LBI	Small flow, a trickle with pit; marsh area	262866	4199836	10,390
RM-1685	1,685	S	At washed out weir downstream from left bank marsh	262866	4199836	10,398
RM-1850	1,850	S	Upstream from revegetated tailings	262869	4199987	10,359
RM-1905	1,905	LBI	Seep from toe of revegetated tailings	262905	4200015	10,343
RM-1950	1,950	S	Downstream from revegetated tailings, at County Road 31 bridge	262949	4200003	10,322
RM-2010	2,010	S	Upstream from right bank tailings	262963	4200052	10,319
RM-2150	2,150	S	Upstream from bedrock chute and narrow canyon	262975	4200153	10,295
RM-2241	2,241	S	Upstream from left bank seep	262951	4200234	10,264
RM-2246	2,246	LBI	Seep near revegetated tailings	262944	4200237	10,260
RM-2280	2,280	S	At end of bedrock canyon	262935	4200271	10,260
RM-2319	2,319	LBI	Commodore and Spirit Gulches	262974	4200365	10,188
RM-2360	2,360	S	Downstream from Commodore and Spirit Gulches	262995	4200397	10,191
RM-2560	2,560	S	After steady gradient, no inflows	263161	4200460	10,137
RM-2634	2,634	RBI	Champion Gulch	263219	4200482	10,128
RM-2693	2,693	S	Downstream from Champion Gulch	263250	4200533	10,137
RM-2696	2,721	LBI	Spring from willows and watercress	263252	4200537	10,137
RM-2774	2,774	S	Upstream from Joker tailings	263303	4200593	10,110
RM-2814	2,814	RBI	Seep at Joker tailings	263330	4200619	10,088
RM-2857	2,857	S	Downstream from Joker tailings (Transport Site #2)	263370	4200714	10,055
RM-2869	2,869	RBI	Seep from Joker tailings	263381	4200719	10,052
RM-2915	2,915	S	Upstream from large right bank inflow	263421	4200729	10,059
RM-2930	2,930	RBI	Joker Tunnel and two inflow pipes that discharge into cement channel up on hillside	263438	4200737	10,060
RM-2982	2,982	S	Downstream from large right bank inflow	263430	4200793	10,068
RM-2992	2,992	LBI	Gulch draining under highway	263428	4200800	10,071
RM-3069	3,069	S	Stream between left bank inflows from alluvial fan	263488	4200842	10,047
RM-3092	3,092	LBI	Inflow at downstream end of alluvial fan	263493	4200863	10,047
RM-3209	3,209	S	Downstream from left bank fan inflows	263590	4200920	10,004

Table 1. Site descriptions and locations for all sites sampled on August 26 and August 27, 2002, Red Mountain Creek, Colo.—Continued

[Distance, distance downstream, in meters. Source, type of sample collected where S denotes stream sample from Red Mountain Creek, LBI denotes left bank inflow, and RBI denotes right bank inflow. Easting and Northing, Universal Transverse Mercator (UTM) coordinates in zone 13 S using the North American Datum of 1927 (NAD27). Altitude, elevation provided by GPS unit, in feet, referenced to the North American Vertical Datum of 1927 (NAVD 27)]

Site (fig. 2)	Distance	Source	Description	Easting	Northing	Altitude
RM-3285	3,285	S	At weir	263661	4200950	9,954
RM-3375	3,375	LBI	More flow from fan	263719	4201022	9,962
RM-3440	3,440	S	Downstream from Galena Lion Gulch	263777	4201051	9,951
RM-3455	3,455	RBI	Draining from workings up right bank	263798	4201058	9,943
RM-3545	3,545	S	Upstream from debris/alluvial flow from McIntyre Gulch	263833	4201136	9,905
RM-3645	3,645	S	Downstream from debris/alluvial flow	263900	4201210	9,915
RM-3740	3,740	LBI	Inflow with red liverwort (Jungermannia rubra)	263963	4201244	9,893
RM-3840	3,840	S	Downstream from inflow with red liverwort	264030	4201300	9,886
RM-3870	3,870	RBI	Black moss seep over ferricrete ledge	264046	4201319	9,878
RM-3895	3,895	LBI		264062	4201339	9,876
RM-3945	3,945	LBI		264068	4201375	9,868
RM-4075	4,075	S	At good mixing chute on bedrock	264207	4201413	9,862
RM-4275	4,275	S	Upstream from Corkscrew Gulch (Transport Site #3)	264390	4201474	9,811
RM-4335	4,335	RBI	Corkscrew Gulch	264536	4201510	9,802
RM-4485	4,485	S	Downstream from Corkscrew Gulch	264594	4201644	9,771
RM-4735	4,735	S	Downstream from Ironton bridge	264757	4201814	9,753
RM-4935	4,935	S	Near upstream end of tailings ponds	264915	4201939	9,761
RM-5135	5,135	S	Along Ironton tailings pond	265062	4202072	9,730
RM-5377	5,377	S	Bridge at County Road 20 (Transport Site #4)	265247	4202226	9,714

Table 2. Sample data including pH, specific conductance, temperature, and alkalinity, Red Mountain Creek, Colo.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; pH, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature measured onsite, in degrees Celsius; Alkalinity, in milligrams per liter as calcium carbonate; --, no data]

Sample	Date	Time	pH	Specific conductance	Temperature	Alkalinity
RM-0	08/27/02	09:20	3.14	631	4.5	--
RM-43	08/27/02	09:25	2.84	1,940	4.0	--
RM-100	08/27/02	15:30	2.95	1,659	17.0	--
RM-146	08/27/02	15:25	2.94	1,884	16.0	--
RM-212	08/27/02	15:20	2.93	1,877	15.0	--
RM-269	08/27/02	15:15	2.90	1,894	14.0	--
RM-281	08/26/02	15:05	3.09	621	3.0	--
RM-331	08/27/02	15:10	2.95	1,644	12.0	--
RM-417	08/26/02	15:00	3.07	696	8.0	--
RM-464	08/27/02	15:05	2.95	1,570	13.0	--
RM-552	08/27/02	15:00	2.95	1,544	13.0	--
RM-564	08/26/02	14:50	3.08	765	12.0	--
RM-594	08/27/02	14:50	2.96	1,462	13.5	--
RM-658	08/27/02	14:40	2.93	1,435	14.0	--
RM-673	08/26/02	14:35	7.56	141	--	31.9
RM-700	08/27/02	14:35	3.01	1,272	14.0	--
RM-743	08/27/02	14:30	3.00	1,238	13.0	--
RM-770	08/26/02	14:25	3.12	628	12.0	--
RM-870	08/27/02	14:25	3.04	1,141	13.0	--
RM-955	08/27/02	14:20	3.04	1,135	12.0	--
RM-965	08/26/02	09:55	2.90	3,220	4.5	--
RM-1040	08/27/02	14:15	3.02	1,679	11.0	--
RM-1075	08/26/02	14:10	2.78	1,018	12.0	--
RM-1092	08/27/02	14:10	2.93	1,436	11.0	--
RM-1107	08/26/02	14:05	7.47	250	14.0	32.6
RM-1192	08/27/02	14:05	2.92	1,559	13.0	--
RM-1200	08/26/02	13:55	5.10	1,237	19.0	0.2
RM-1360	08/27/02	14:00	2.94	1,575	13.5	--
RM-1460	08/27/02	13:55	2.97	1,578	13.5	--

Table 2. Sample data including pH, specific conductance, temperature, and alkalinity, Red Mountain Creek, Colo.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; pH, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature measured onsite, in degrees Celsius; Alkalinity, in milligrams per liter as calcium carbonate; --, no data]

Sample	Date	Time	pH	Specific conductance	Temperature	Alkalinity
RM-1507	08/26/02	13:50	3.66	1,026	19.5	--
RM-1560	08/27/02	13:40	2.96	1,565	14.5	--
RM-1572	08/26/02	13:30	6.28	952	8.0	32.0
RM-1685	08/27/02	13:35	2.96	816	14.0	--
RM-1850	08/27/02	13:35	2.95	1,553	13.0	--
RM-1905	08/27/02	13:15	2.90	2,920	15.0	--
RM-1950A	08/27/02	13:20	2.95	1,546	13.0	--
RM-1950B	08/27/02	13:25	2.95	1,552	13.0	--
RM-2010	08/27/02	13:10	2.96	1,490	--	--
RM-2150	08/27/02	13:00	2.96	1,474	13.0	--
RM-2241	08/27/02	12:45	2.97	1,397	11.5	--
RM-2246	08/27/02	12:40	2.75	5,120	18.0	--
RM-2280	08/27/02	12:40	2.98	1,498	11.0	--
RM-2319	08/26/02	12:50	7.38	236	11.0	23.0
RM-2360	08/27/02	12:30	3.05	1,265	11.0	--
RM-2560	08/27/02	12:15	3.06	1,260	11.0	--
RM-2634	08/27/02	12:00	2.88	2,870	11.0	--
RM-2693	08/27/02	12:00	3.03	1,459	11.0	--
RM-2696	08/26/02	12:35	6.94	600	6.0	--
RM-2774	08/27/02	11:45	3.07	1,398	10.5	--
RM-2814	08/26/02	11:55	2.91	1,353	9.0	--
RM-2857	08/27/02	11:40	3.08	1,363	10.0	--
RM-2869	08/26/02	11:45	--	--	11.5	--
RM-2915	08/27/02	11:35	3.07	1,416	10.0	--
RM-2930	08/27/02	11:30	3.08	2,100	16.0	--
RM-2982	08/27/02	11:20	3.08	1,436	9.5	--
RM-2992	08/26/02	11:40	8.20	984	11.0	102.2
RM-3069	08/27/02	11:15	3.23	1,244	10.0	--
RM-3092	08/26/02	11:30	7.08	865	6.0	82.6
RM-3209	08/27/02	11:05	3.27	516	9.0	--

Table 2. Sample data including pH, specific conductance, temperature, and alkalinity, Red Mountain Creek, Colo.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; pH, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature measured onsite, in degrees Celsius; Alkalinity, in milligrams per liter as calcium carbonate; --, no data]

Sample	Date	Time	pH	Specific conductance	Temperature	Alkalinity
RM-3285	08/27/02	10:55	3.30	1,249	7.0	--
RM-3375	08/26/02	11:10	7.34	852	7.0	80.1
RM-3440	08/27/02	10:40	3.31	1,205	7.5	--
RM-3455	08/27/02	10:35	3.31	1,207	8.5	--
RM-3545	08/27/02	10:30	3.31	1,207	10.0	--
RM-3645	08/27/02	10:25	3.33	1,222	7.0	--
RM-3740	08/26/02	10:55	4.24	816	9.5	--
RM-3840	08/27/02	10:10	3.31	1,221	6.5	--
RM-3870	08/26/02	09:45	3.46	985	5.5	--
RM-3895	08/26/02	09:35	6.54	1,123	8.5	21.5
RM-3945	08/26/02	09:30	7.66	550	7.5	77.8
RM-4075	08/27/02	10:00	3.31	1,217	6.0	--
RM-4275A	08/27/02	09:40	3.30	1,196	6.5	--
RM-4275B	08/27/02	09:45	3.28	1,225	6.5	--
RM-4335	08/26/02	09:05	3.22	968	3.5	--
RM-4485	08/27/02	09:30	3.28	1,211	6.5	--
RM-4735	08/27/02	09:20	3.27	1,212	6.0	--
RM-4935	08/27/02	09:10	3.26	1,188	6.0	--
RM-5135	08/27/02	09:00	3.25	1,229	6.0	--
RM-5377	08/27/02	08:50	3.24	1,220	5.0	--

Table 3. Total recoverable concentrations from unfiltered samples for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-0	<0.05	7.63	106.7	30.	41.83	7.18	25.8	1.8	1.260	17.23	0.729
RM-43	<0.05	108.28	364.8	6.	27.69	12.50	147.3	33.7	5.710	204.8	1.189
RM-100	0.05	79.08	283.8	16.	30.16	10.76	126.7	26.2	4.307	149.3	0.986
RM-146	<0.05	77.64	251.2	14.	31.71	11.43	121.1	25.1	4.239	150.6	1.098
RM-212	0.05	79.86	252.0	14.	32.27	11.58	128.3	26.2	4.394	147.3	0.933
RM-269	0.05	78.00	244.4	14.	30.52	11.51	123.6	26.5	4.218	141.1	0.985
RM-281	1.94	17.78	<1.3	17.	16.69	2.66	28.5	2.4	0.711	2.09	0.879
RM-331	0.39	67.32	186.0	14.	27.44	9.39	102.6	21.4	3.699	105.1	0.929
RM-417	1.06	20.32	<1.3	16.	20.04	3.98	37.0	3.6	1.180	1.96	0.814
RM-464	0.46	62.48	142.2	16.	27.26	8.91	107.2	20.7	3.369	102.5	0.904
RM-552	0.43	60.28	135.6	15.	27.00	8.86	93.4	18.8	3.450	89.83	0.935
RM-564	0.73	27.71	2.9	14.	19.77	5.10	41.6	6.9	1.660	5.12	0.721
RM-594	0.46	57.51	117.5	15.	26.66	8.45	97.2	18.1	3.243	81.39	1.093
RM-658	0.50	59.46	123.5	14.	27.01	8.21	87.3	17.0	3.288	84.71	0.811
RM-673	<0.05	<0.41	<1.3	47.	19.40	<0.10	<1.0	0.1	<0.024	<0.55	0.486
RM-700	0.41	49.48	86.4	21.	27.04	7.24	72.6	13.5	2.852	71.25	0.805
RM-743	0.41	48.43	91.0	20.	26.86	7.32	76.0	13.9	2.845	68.49	1.011
RM-770	1.85	16.48	<1.3	20.	19.87	3.35	29.8	2.0	0.669	5.41	0.957
RM-870	0.59	42.12	66.2	20.	26.66	7.02	64.4	11.1	2.482	55.56	1.026
RM-955	0.60	43.19	58.2	21.	28.35	7.05	68.4	11.2	2.530	54.75	0.831
RM-965	0.35	208.42	917.6	2.	49.44	45.38	274.8	72.6	10.449	474.3	5.273
RM-1040	0.41	82.98	187.3	15.	32.37	15.01	117.7	23.3	4.218	151.2	1.576
RM-1075	0.10	26.17	<1.3	9.	8.78	8.21	37.1	7.3	1.637	17.13	0.519
RM-1092	0.36	78.24	177.2	15.	30.96	15.49	112.7	23.5	4.015	135.7	1.651
RM-1107	0.07	<0.41	<1.3	86.	31.58	6.62	3.2	0.1	0.044	<0.55	1.007
RM-1192	0.37	76.48	141.8	18.	33.02	16.17	116.7	24.2	4.261	138.8	1.360
RM-1200	0.15	1.38	<1.3	26.	203.1	64.23	6.7	0.2	1.257	<0.55	4.081
RM-1360	0.32	77.17	158.7	17.	32.82	15.26	109.9	23.1	4.210	126.2	1.668

Table 3. Total recoverable concentrations from unfiltered samples for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-1460	0.27	75.65	162.8	17.	33.55	15.74	109.7	22.5	4.091	131.0	1.560
RM-1507	0.14	17.46	<1.3	19.	119.8	17.14	56.7	3.1	1.279	5.16	2.249
RM-1560	0.27	74.92	150.5	17.	34.02	15.36	104.8	21.4	4.096	128.3	1.714
RM-1572	0.12	<0.41	<1.3	74.	143.4	8.35	<1.0	0.1	<0.024	<0.55	1.462
RM-1685	0.25	72.89	131.2	17.	36.55	14.52	100.9	20.5	3.847	123.8	1.519
RM-1850	0.27	68.64	116.4	18.	34.07	15.03	109.3	22.3	3.667	117.3	1.403
RM-1905	0.08	17.74	<1.3	5.	407.8	8.93	590.6	2.0	0.277	65.55	5.102
RM-1950A	0.25	73.56	126.8	18.	39.94	14.91	106.0	21.0	4.031	112.4	1.600
RM-1950B	0.22	68.93	117.9	17.	36.77	15.19	100.8	20.1	3.735	109.7	1.671
RM-2010	0.24	72.93	130.4	17.	40.45	14.24	97.3	20.4	4.035	111.7	1.508
RM-2150	0.21	70.41	120.2	18.	38.25	15.14	107.1	20.5	3.654	114.2	1.569
RM-2241	0.21	68.81	115.1	20.	38.68	15.70	124.0	21.4	3.766	107.0	1.566
RM-2246	0.45	52.62	8.7	17.	602.0	64.87	2002.7	3.1	1.157	308.3	12.968
RM-2280	0.21	69.88	125.0	17.	39.63	14.64	102.5	21.0	3.848	114.7	1.467
RM-2319	<0.05	0.47	<1.3	28.	34.82	1.29	6.0	0.2	0.028	<0.55	0.412
RM-2360	0.23	54.30	91.6	21.	36.58	12.40	88.5	16.9	2.981	81.65	1.383
RM-2560	0.14	57.88	98.6	22.	42.09	12.56	90.0	17.2	3.113	93.70	1.340
RM-2634	0.09	236.86	38.8	6.	40.17	26.66	293.4	44.7	3.509	352.3	1.681
RM-2693	0.14	73.42	82.2	20.	39.68	14.13	125.3	20.5	3.068	112.9	1.266
RM-2696	<0.05	<0.41	<1.3	14.	96.06	0.39	<1.0	0.1	<0.024	<0.55	0.643
RM-2774	0.15	71.69	80.0	20.	44.25	13.43	110.8	18.9	3.035	110.6	1.302
RM-2814	0.75	37.86	5.4	6.	102.7	7.44	71.4	3.3	0.464	9.41	0.779
RM-2857	0.12	68.16	78.5	19.	43.19	12.81	109.0	18.2	2.918	104.5	1.385
RM-2869	1.01	40.61	3.4	10.	119.2	14.99	89.1	4.0	0.945	12.10	0.329
RM-2915	0.13	68.66	67.2	19.	44.98	13.34	113.0	18.5	2.852	105.9	1.232
RM-2930	<0.05	69.28	10.1	4.	164.0	12.59	105.9	6.3	0.336	112.0	1.986
RM-2982	0.12	69.73	57.2	18.	59.45	13.63	121.2	17.3	2.581	108.6	1.180
RM-2992	<0.05	<0.41	<1.3	9.	198.7	0.15	2.0	0.1	<0.024	<0.55	0.591
RM-3069	0.09	47.90	46.5	15.	98.21	8.59	67.5	11.3	1.781	73.40	1.059
RM-3092	<0.05	<0.41	<1.3	27.	176.0	0.37	<1.0	0.1	<0.024	<0.55	0.659

Table 3. Total recoverable concentrations from unfiltered samples for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-3209	0.08	43.34	41.8	15.	103.2	8.46	67.9	10.5	1.680	62.13	0.935
RM-3285	0.06	42.70	41.4	16.	106.8	8.63	76.3	11.1	1.598	63.19	1.044
RM-3375	<0.05	<0.41	<1.3	22.	170.5	0.31	<1.0	0.1	<0.024	<0.55	0.544
RM-3440	0.07	38.54	38.5	16.	114.4	7.70	63.1	9.7	1.404	55.42	1.175
RM-3455	0.86	60.84	4.0	8.	208.0	16.18	161.6	4.3	1.250	121.3	2.116
RM-3545	0.06	39.37	34.0	19.	112.3	7.56	66.2	9.7	1.501	57.00	1.009
RM-3645	0.07	40.63	33.7	17.	119.1	7.83	68.4	9.9	1.515	57.05	1.091
RM-3740	0.06	2.80	<1.3	19.	156.7	1.80	4.3	0.1	0.089	<0.55	1.221
RM-3840	0.06	37.61	35.6	15.	114.2	7.21	58.3	8.6	1.356	52.05	1.123
RM-3870	<0.05	14.46	6.1	7.	116.2	0.19	36.9	0.9	<0.024	78.38	3.791
RM-3895	<0.05	<0.41	<1.3	54.	224.4	0.25	11.3	0.1	<0.024	<0.55	0.883
RM-3945	<0.05	1.07	1.5	82.	89.30	<0.10	1.1	0.6	<0.024	2.05	0.917
RM-4075	0.07	37.94	33.1	16.	115.7	7.60	61.4	9.1	1.452	51.75	1.136
RM-4275A	<0.05	37.74	34.1	16.	115.3	7.53	62.6	8.9	1.408	51.61	1.080
RM-4275B	0.06	37.88	36.5	18.	119.1	7.91	64.2	9.4	1.392	52.20	1.147
RM-4335	<0.05	11.36	6.8	14.	96.62	1.58	24.9	1.2	0.088	19.62	1.005
RM-4485	0.07	35.60	30.3	16.	113.3	6.63	52.5	8.0	1.343	47.17	1.188
RM-4735	<0.05	36.01	33.0	17.	113.3	6.70	60.1	7.7	1.303	48.45	1.154
RM-4935	0.06	36.99	28.6	16.	118.9	7.05	57.6	8.2	1.340	50.40	1.144
RM-5135	0.10	35.16	26.5	18.	109.0	7.39	64.1	8.7	1.306	47.16	1.105
RM-5377	0.11	36.59	30.6	19.	116.0	7.69	67.7	9.0	1.322	49.13	1.223

Table 4. Total recoverable concentrations from unfiltered samples for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-0	5.48	0.94	<0.07	2.95	22.4	44.9	7.91	1.46	1.1	1.84
RM-43	5.76	2.11	0.25	0.73	130.7	333.4	26.72	0.25	61.8	2.65
RM-100	5.60	1.80	0.22	1.41	105.2	258.2	21.91	0.61	43.2	2.53
RM-146	5.78	1.76	0.42	1.44	98.3	253.2	21.69	0.66	41.2	2.52
RM-212	5.80	1.72	0.61	1.51	106.1	244.9	22.76	0.65	41.0	2.58
RM-269	5.71	1.77	0.42	1.50	102.5	239.6	21.68	0.66	40.1	2.51
RM-281	4.16	1.24	<0.07	0.72	23.8	495.2	14.36	0.13	<0.3	0.69
RM-331	5.13	1.62	0.30	1.30	85.3	293.4	19.47	0.54	28.4	2.03
RM-417	4.22	1.21	<0.07	1.65	29.2	289.3	13.83	0.43	<0.3	0.85
RM-464	5.32	1.63	0.37	1.39	91.1	300.6	20.06	0.55	25.2	2.06
RM-552	5.11	1.60	0.21	1.35	78.8	293.1	19.10	0.50	20.2	1.92
RM-564	4.73	1.38	<0.07	1.52	40.4	276.9	17.84	0.34	<0.3	1.18
RM-594	5.07	1.57	0.20	1.44	82.1	278.3	19.33	0.51	19.0	1.82
RM-658	5.27	1.62	0.18	1.45	79.9	271.6	19.67	0.52	17.0	1.94
RM-673	1.30	<0.02	0.09	3.09	<0.9	<1.7	1.48	0.60	<0.3	<0.014
RM-700	4.86	1.36	0.20	1.76	59.9	237.9	16.98	0.50	12.4	1.64
RM-743	4.76	1.42	0.18	1.81	70.0	227.2	16.59	0.55	12.9	1.69
RM-770	4.49	1.33	<0.07	0.79	24.9	485.0	15.18	0.19	0.8	0.83
RM-870	4.84	1.40	0.11	1.64	57.4	271.7	16.31	0.50	9.6	1.67
RM-955	4.93	1.42	0.10	1.79	54.9	266.7	17.24	0.59	9.1	1.62
RM-965	18.01	6.84	2.32	1.17	291.9	336.0	21.49	0.36	203.1	11.95
RM-1040	8.08	2.75	0.46	1.57	109.5	241.8	17.99	0.44	42.5	4.17
RM-1075	2.38	0.75	0.11	0.47	39.2	94.3	20.11	0.09	0.3	1.92
RM-1092	7.49	2.60	0.39	1.51	99.6	245.7	17.24	0.43	39.2	3.90
RM-1107	3.12	0.24	1.79	6.41	1.7	152.3	2.47	0.95	<0.3	1.61
RM-1192	7.79	2.60	0.50	1.86	109.0	248.2	18.00	0.50	40.4	4.02
RM-1200	20.19	6.24	0.26	19.81	17.5	136.1	9.05	3.35	<0.3	14.87
RM-1360	7.71	2.56	0.44	1.87	105.1	230.9	17.76	0.47	36.2	3.94
RM-1460	7.68	2.63	0.42	1.93	100.4	250.5	17.73	0.50	34.1	4.02

Table 4. Total recoverable concentrations from unfiltered samples for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-1507	17.27	4.29	1.11	10.49	47.1	548.2	13.96	3.30	<0.3	5.60
RM-1560	7.97	2.57	0.33	2.05	92.7	246.9	17.51	0.51	29.7	3.98
RM-1572	10.79	<0.02	0.15	37.46	2.9	25.0	3.42	4.27	<0.3	3.34
RM-1685	8.05	2.57	0.37	3.02	101.5	238.1	17.12	0.63	30.5	3.99
RM-1850	7.53	2.54	0.40	3.01	101.1	235.9	16.17	0.65	29.3	3.86
RM-1905	108.5	62.14	0.31	5.20	69.0	34.9	21.04	3.10	0.4	16.54
RM-1950A	8.51	2.93	0.32	3.02	95.7	235.2	17.27	0.65	27.4	4.07
RM-1950B	7.72	2.74	0.30	2.74	104.8	246.3	15.62	0.60	25.9	3.76
RM-2010	8.44	3.01	0.32	3.16	92.7	225.5	17.28	0.63	26.7	4.00
RM-2150	8.14	2.92	0.33	2.92	96.1	229.7	16.57	0.68	27.0	3.96
RM-2241	8.11	2.94	0.34	2.96	106.2	228.5	15.87	0.70	28.7	3.89
RM-2246	238.6	201.9	6.63	12.95	221.5	54.0	29.35	6.17	1.3	80.14
RM-2280	8.55	3.12	0.32	3.05	90.9	226.3	16.63	0.65	27.1	3.95
RM-2319	2.61	0.68	0.47	1.72	1.1	<1.7	2.55	0.59	<0.3	0.42
RM-2360	7.05	2.56	0.36	2.74	75.6	178.1	13.43	0.65	20.5	3.09
RM-2560	7.78	2.68	0.44	3.04	82.0	200.2	14.04	0.70	19.7	3.44
RM-2634	11.85	5.26	0.18	0.99	196.3	132.7	27.86	0.25	97.9	6.04
RM-2693	7.81	2.91	0.33	2.65	94.0	180.8	14.90	0.65	29.0	3.65
RM-2696	9.12	<0.02	0.11	3.91	1.2	<1.7	5.92	1.21	<0.3	0.10
RM-2774	8.01	2.90	0.31	2.75	88.9	177.5	15.11	0.64	26.3	3.54
RM-2814	21.84	3.85	0.52	6.50	52.5	84.3	23.01	1.25	0.7	3.12
RM-2857	7.94	2.75	0.29	2.72	85.1	176.4	14.22	0.62	24.8	3.37
RM-2869	28.95	4.85	1.03	7.63	61.9	54.6	30.55	1.27	0.8	4.62
RM-2915	8.33	2.83	0.27	2.84	89.3	166.4	14.95	0.67	25.1	3.46
RM-2930	24.28	5.61	0.10	15.59	76.5	109.7	18.81	2.66	10.8	6.61
RM-2982	10.52	3.31	0.30	4.28	92.4	152.1	15.51	0.95	24.3	3.77
RM-2992	6.89	0.52	1.19	3.93	<0.9	<1.7	6.05	2.46	<0.3	0.08
RM-3069	9.40	2.35	0.53	4.30	56.5	108.0	12.94	1.21	15.8	2.59
RM-3092	7.59	<0.02	1.39	3.94	<0.9	1.7	5.35	1.87	<0.3	0.03
RM-3209	9.28	2.23	0.55	4.27	54.3	100.8	12.07	1.36	14.2	2.43

Table 4. Total recoverable concentrations from unfiltered samples for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-3285	9.19	2.23	0.61	4.17	57.0	105.1	11.79	1.35	14.9	2.32
RM-3375	6.25	<0.02	1.46	3.91	<0.9	<1.7	5.48	2.17	<0.3	0.04
RM-3440	8.83	1.99	0.57	4.17	51.4	96.5	11.05	1.39	12.7	2.20
RM-3455	26.84	4.65	0.33	3.50	94.2	19.2	30.36	1.15	1.5	5.40
RM-3545	9.15	2.10	0.65	4.13	50.9	91.3	11.65	1.35	12.4	2.27
RM-3645	9.51	2.20	0.94	4.56	52.9	99.0	11.86	1.39	13.1	2.26
RM-3740	9.39	0.60	<0.07	6.36	8.4	35.7	11.33	2.40	<0.3	0.34
RM-3840	8.65	1.99	0.53	3.96	46.4	87.0	11.12	1.32	11.7	2.11
RM-3870	17.41	3.14	0.07	2.59	23.0	5.4	12.95	0.72	6.0	1.04
RM-3895	9.68	2.06	0.19	5.50	5.9	<1.7	9.41	3.90	<0.3	0.08
RM-3945	7.11	0.84	0.67	7.02	0.9	7.3	9.25	1.09	2.7	<0.014
RM-4075	9.39	2.07	0.51	4.38	48.6	89.0	11.36	1.39	11.8	2.11
RM-4275A	9.41	2.07	0.50	4.31	47.0	87.9	11.46	1.38	11.7	2.14
RM-4275B	9.51	2.09	0.56	4.59	49.1	96.8	11.39	1.44	12.4	2.15
RM-4335	9.75	2.08	<0.07	2.44	15.4	25.3	15.54	0.88	1.5	1.16
RM-4485	9.21	2.11	0.47	4.21	43.5	83.6	11.71	1.33	10.3	2.02
RM-4735	9.14	2.06	0.53	4.02	42.4	80.2	11.38	1.32	10.7	2.09
RM-4935	9.59	2.10	0.51	4.41	43.9	86.6	11.97	1.32	10.6	2.14
RM-5135	9.03	2.11	0.49	4.04	49.7	83.1	11.32	1.46	11.5	2.08
RM-5377	9.28	2.07	0.55	4.20	51.3	84.5	11.07	1.44	12.1	2.10

Table 5. Dissolved concentrations from filtered samples for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-0	<0.05	7.65	100.4	32.	42.69	8.00	26.1	1.9	1.262	17.85	0.667
RM-43	<0.05	112.93	356.9	5.	29.55	12.64	151.7	33.2	5.673	207.7	1.063
RM-100	<0.05	80.38	244.4	12.	32.15	10.94	117.8	25.8	4.560	150.0	0.968
RM-146	0.20	86.09	261.3	14.	32.99	11.62	128.7	28.2	4.683	155.1	1.143
RM-212	<0.05	83.82	220.0	14.	33.39	11.34	122.6	25.6	4.711	150.0	0.987
RM-269	<0.05	80.75	222.8	13.	33.25	10.83	120.8	25.0	4.617	143.8	1.124
RM-281	1.92	17.85	<1.3	16.	16.81	2.66	29.5	2.5	0.708	1.93	0.913
RM-331	0.34	70.60	161.1	15.	30.67	10.03	104.5	20.7	3.932	114.5	0.943
RM-417	0.78	21.11	<1.3	16.	20.76	4.00	38.0	3.7	1.181	1.97	0.787
RM-464	0.42	64.51	150.0	15.	28.18	9.47	100.8	19.8	3.553	103.0	0.896
RM-552	0.42	58.80	140.3	15.	25.93	9.16	101.7	19.1	3.161	91.57	0.911
RM-564	0.63	28.88	<1.3	16.	21.25	5.05	46.8	4.1	1.629	5.01	0.815
RM-594	0.39	58.79	116.7	15.	28.61	8.73	97.0	17.6	3.282	82.89	0.933
RM-658	0.49	58.51	129.6	15.	29.01	9.19	88.6	18.8	3.345	86.13	0.909
RM-673	<0.05	<0.41	<1.3	45.	20.56	<0.10	<1.0	0.1	<0.024	<0.55	0.456
RM-700	0.40	49.40	54.5	20.	27.05	7.13	75.8	13.3	2.750	69.23	0.904
RM-743	0.38	48.05	71.8	21.	27.91	7.69	68.7	12.7	2.756	68.33	1.019
RM-770	1.58	17.41	<1.3	20.	21.49	3.45	30.2	2.1	0.683	5.65	1.171
RM-870	0.55	43.17	53.1	21.	27.31	6.70	68.6	11.6	2.486	55.74	0.944
RM-955	0.50	43.99	40.8	20.	28.58	7.02	69.3	11.8	2.479	56.13	0.730
RM-965	<0.05	207.45	936.0	2.	49.50	44.49	298.3	71.3	10.400	471.2	5.267
RM-1040	0.31	83.99	138.7	16.	33.74	17.37	122.1	25.0	4.489	153.8	1.381
RM-1075	0.10	25.40	<1.3	9.	8.46	7.65	36.5	7.4	1.583	16.32	0.478
RM-1092	0.28	80.98	150.8	15.	33.11	15.41	114.0	24.4	4.370	143.7	1.520
RM-1107	<0.05	<0.41	<1.3	84.	30.13	6.49	3.2	0.1	<0.024	<0.55	0.995
RM-1192	0.30	72.50	139.9	17.	29.78	14.70	109.0	22.6	3.753	129.8	1.387
RM-1200	<0.05	1.24	<1.3	26.	206.0	64.20	5.9	0.1	1.205	<0.55	3.572
RM-1360	0.22	73.80	117.0	18.	31.68	16.55	109.8	22.4	3.933	122.4	1.505
RM-1460	0.22	75.94	126.6	18.	33.02	15.74	110.8	22.1	4.104	129.6	1.479

Table 5. Dissolved concentrations from filtered samples for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-1507	0.06	16.99	<1.3	17.	117.0	16.69	54.3	0.9	1.220	4.20	2.005
RM-1560	0.23	75.68	115.6	18.	33.81	15.23	105.4	21.9	4.044	124.7	1.492
RM-1572	<0.05	<0.41	<1.3	72.	144.4	8.21	<1.0	0.1	<0.024	<0.55	1.208
RM-1685	0.20	70.67	126.4	20.	35.73	15.30	114.8	22.4	3.830	119.2	1.599
RM-1850	0.20	70.77	100.3	20.	34.41	14.93	114.0	22.2	3.573	115.5	1.610
RM-1905	<0.05	17.18	<1.3	3.	400.2	9.20	575.1	2.1	0.262	61.30	4.456
RM-1950A	0.23	67.78	112.8	17.	35.22	14.98	104.4	21.6	3.523	113.3	1.494
RM-1950B	0.20	69.86	126.3	18.	36.66	15.37	110.9	20.9	3.638	115.9	1.455
RM-2010	0.19	68.98	114.7	18.	35.97	14.19	105.1	20.3	3.548	116.9	1.336
RM-2150	0.14	70.91	107.3	18.	38.78	15.62	106.7	20.7	3.691	112.9	1.541
RM-2241	0.14	67.08	108.0	18.	38.00	16.53	101.4	19.8	3.670	106.9	1.416
RM-2246	0.14	54.41	1.4	7.	588.1	68.62	1859.8	2.7	1.075	289.3	11.779
RM-2280	0.19	66.21	122.7	18.	36.31	14.93	116.8	21.6	3.415	111.2	1.308
RM-2319	<0.05	<0.41	<1.3	29.	34.40	1.31	6.6	0.1	<0.024	<0.55	0.352
RM-2360	0.11	56.79	59.1	20.	39.16	11.82	86.0	16.5	3.037	89.23	1.481
RM-2560	0.13	53.98	84.6	20.	38.28	12.52	88.3	17.5	2.929	88.90	1.407
RM-2634	0.06	204.61	36.5	6.	34.83	28.93	301.3	45.5	3.013	302.3	1.679
RM-2693	0.08	75.01	80.8	17.	40.98	13.52	99.5	18.1	3.076	113.5	1.389
RM-2696	<0.05	<0.41	<1.3	13.	90.88	0.34	<1.0	0.1	<0.024	<0.55	0.593
RM-2774	0.11	67.93	60.8	18.	38.85	13.54	108.1	17.9	2.728	105.3	0.995
RM-2814	0.42	35.92	<1.3	3.	98.07	7.54	72.6	3.5	0.452	7.84	0.773
RM-2857	0.11	69.87	70.4	19.	44.29	13.95	113.7	19.4	2.961	106.0	1.522
RM-2869	0.17	39.92	<1.3	5.	114.1	14.68	83.6	3.7	0.907	10.06	0.244
RM-2915	0.12	68.10	53.8	18.	44.75	12.85	105.4	18.5	2.760	101.3	1.249
RM-2930	0.05	64.95	9.8	4.	149.4	12.39	111.1	6.4	0.318	108.3	1.770
RM-2982	0.08	67.38	58.1	17.	56.20	13.19	108.5	16.9	2.453	101.0	1.272
RM-2992	<0.05	<0.41	<1.3	8.	201.1	<0.10	1.4	0.1	<0.024	<0.55	0.677
RM-3069	<0.05	46.07	5.8	14.	101.8	8.44	65.7	9.2	1.715	51.58	0.942
RM-3092	<0.05	<0.41	<1.3	28.	177.1	0.39	<1.0	0.2	<0.024	<0.55	0.658
RM-3209	<0.05	43.46	4.8	15.	107.8	8.38	65.3	9.0	1.593	44.42	0.934

Table 5. Dissolved concentrations from filtered samples for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-3285	<0.05	43.35	7.6	15.	109.7	8.46	70.0	9.4	1.565	47.58	1.105
RM-3375	<0.05	<0.41	<1.3	23.	176.0	0.29	<1.0	0.1	<0.024	<0.55	0.621
RM-3440	<0.05	39.91	4.5	15.	114.8	7.80	61.7	8.3	1.459	40.67	1.122
RM-3455	0.11	61.76	<1.3	2.	211.3	16.12	154.6	4.3	1.250	119.5	2.255
RM-3545	<0.05	39.48	5.1	15.	112.5	7.94	61.9	8.2	1.459	39.78	0.964
RM-3645	0.06	38.83	4.9	16.	112.3	7.43	64.5	8.2	1.414	38.53	0.945
RM-3740	0.06	2.76	<1.3	18.	152.4	1.83	4.4	0.1	0.083	<0.55	1.316
RM-3840	0.06	36.76	5.7	16.	106.7	7.72	62.1	8.5	1.386	36.85	1.098
RM-3870	<0.05	14.76	<1.3	7.	116.8	0.20	34.2	0.7	<0.024	71.34	3.457
RM-3895	<0.05	0.43	<1.3	50.	218.8	0.34	10.3	1.3	<0.024	<0.55	0.875
RM-3945	<0.05	<0.41	<1.3	49.	90.06	<0.10	<1.0	0.2	<0.024	<0.55	0.892
RM-4075	<0.05	38.18	5.1	16.	111.0	7.48	65.3	8.3	1.399	35.87	0.825
RM-4275A	<0.05	35.99	4.1	16.	110.8	7.36	60.4	7.5	1.331	32.83	1.007
RM-4275B	<0.05	36.76	4.3	16.	110.4	7.15	59.6	7.4	1.348	34.13	0.905
RM-4335	<0.05	11.22	4.0	11.	98.60	1.83	27.3	1.2	0.085	19.42	1.600
RM-4485	<0.05	35.880	4.7	15.	110.4	7.22	61.2	7.8	1.315	34.33	1.257
RM-4735	<0.05	36.15	4.7	16.	119.6	7.50	53.3	7.0	1.297	33.49	1.268
RM-4935	0.05	36.87	3.2	16.	116.4	7.21	58.8	7.8	1.333	32.34	1.264
RM-5135	0.05	35.23	4.7	15.	112.0	6.89	58.4	7.0	1.280	33.05	1.057
RM-5377	<0.05	36.11	3.8	18.	113.5	7.24	65.8	8.0	1.317	32.33	1.122

Table 6. Dissolved concentrations from filtered samples for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-0	5.48	0.96	0.12	3.10	22.5	44.0	7.92	1.49	1.3	1.90
RM-43	5.83	2.16	0.30	0.73	131.7	318.3	27.77	0.23	62.3	2.71
RM-100	5.72	1.85	0.17	1.38	103.1	246.6	21.90	0.55	42.0	2.58
RM-146	5.92	1.88	0.45	1.56	105.4	255.8	23.43	0.68	43.2	2.58
RM-212	5.81	1.86	0.43	1.52	105.1	254.8	22.71	0.63	38.7	2.56
RM-269	5.81	1.80	0.36	1.52	104.4	256.5	22.57	0.65	37.5	2.47
RM-281	4.03	1.25	<0.07	0.70	24.9	478.3	14.55	0.15	<0.3	0.67
RM-331	5.55	1.76	0.34	1.39	88.2	314.2	21.96	0.50	29.0	2.22
RM-417	4.34	1.30	<0.07	1.73	30.1	290.6	14.77	0.48	<0.3	0.87
RM-464	5.32	1.66	0.25	1.38	87.2	294.4	20.38	0.56	24.2	2.06
RM-552	5.03	1.60	0.21	1.33	82.6	284.8	18.46	0.53	21.8	1.98
RM-564	4.69	1.39	<0.07	1.51	41.1	303.2	18.14	0.33	<0.3	1.17
RM-594	5.30	1.63	0.22	1.44	76.8	318.6	20.31	0.49	18.3	1.90
RM-658	5.30	1.67	0.24	1.50	77.4	290.5	19.56	0.52	17.6	1.98
RM-673	1.27	<0.02	0.13	3.09	<0.9	<1.7	1.45	0.54	<0.3	<0.01
RM-700	4.65	1.40	0.14	1.78	69.3	236.4	16.94	0.57	8.0	1.63
RM-743	4.70	1.40	0.09	1.82	60.7	218.0	17.15	0.53	8.9	1.68
RM-770	4.58	1.39	<0.07	0.79	24.2	478.6	15.52	0.18	0.7	0.86
RM-870	4.82	1.43	0.09	1.70	59.8	277.6	16.64	0.50	7.7	1.56
RM-955	4.94	1.48	0.09	1.83	57.5	275.3	17.13	0.49	6.6	1.67
RM-965	17.95	6.75	2.41	1.17	297.3	341.8	21.63	0.36	207.2	11.84
RM-1040	8.26	2.82	0.37	1.64	108.5	257.8	18.53	0.43	41.9	4.28
RM-1075	2.32	0.73	<0.07	0.45	36.4	94.1	20.04	0.10	0.3	1.80
RM-1092	7.98	2.73	0.37	1.66	104.2	240.3	18.34	0.41	37.8	4.15
RM-1107	3.26	0.25	1.61	6.75	1.6	16.8	2.57	1.05	<0.3	1.54
RM-1192	7.54	2.55	0.38	1.78	112.3	231.3	16.50	0.48	32.8	3.93
RM-1200	20.15	6.15	0.13	19.75	16.2	113.3	8.49	3.23	<0.3	14.55
RM-1360	7.12	2.45	0.36	1.73	103.3	245.8	16.47	0.43	30.8	3.83
RM-1460	7.85	2.63	0.33	1.87	97.3	240.9	17.52	0.45	30.8	4.11

Table 6. Dissolved concentrations from filtered samples for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-1507	16.50	4.23	<0.07	10.14	47.6	546.4	13.83	3.46	<0.3	5.48
RM-1560	7.88	2.56	0.30	2.07	105.5	254.4	17.54	0.56	27.7	3.88
RM-1572	11.16	<0.02	0.07	38.35	2.8	14.9	3.47	4.62	<0.3	3.43
RM-1685	7.63	2.45	0.34	2.80	106.9	241.0	16.38	0.65	27.3	3.85
RM-1850	7.58	2.51	0.29	2.98	100.1	255.4	16.74	0.65	25.8	4.00
RM-1905	107.4	60.81	0.48	5.04	64.0	28.5	20.43	3.16	0.3	16.44
RM-1950A	8.14	2.93	0.28	2.93	101.1	232.8	15.98	0.66	25.7	3.95
RM-1950B	8.29	2.91	0.28	3.11	99.7	242.9	16.81	0.69	26.8	4.03
RM-2010	8.32	2.87	0.24	3.01	96.5	233.9	16.53	0.65	24.1	3.98
RM-2150	8.19	2.90	0.30	3.04	97.8	242.8	16.76	0.61	24.0	3.89
RM-2241	8.12	2.80	0.27	2.90	97.7	230.3	15.87	0.60	25.3	4.00
RM-2246	234.2	198.0	0.52	12.85	211.9	13.9	29.66	6.21	<0.3	78.47
RM-2280	8.18	3.00	0.26	3.03	96.7	241.7	15.77	0.75	26.5	3.96
RM-2319	2.64	0.70	0.45	1.81	1.4	<1.7	2.49	0.63	<0.3	0.35
RM-2360	7.29	2.63	0.20	2.83	77.5	187.7	13.97	0.67	10.7	3.29
RM-2560	7.24	2.58	0.26	2.78	79.7	184.5	13.35	0.63	16.4	3.28
RM-2634	10.49	4.78	0.14	0.92	213.3	136.2	25.95	0.30	103.4	5.54
RM-2693	7.98	3.03	0.24	2.67	87.0	158.3	15.37	0.54	22.4	3.64
RM-2696	8.97	<0.02	<0.07	4.04	1.5	<1.7	5.72	1.29	<0.3	0.11
RM-2774	7.76	2.83	0.16	2.68	84.2	165.7	14.04	0.71	17.9	3.40
RM-2814	21.76	3.75	<0.07	6.25	53.6	69.7	21.50	1.36	<0.3	3.06
RM-2857	8.08	2.91	0.32	2.82	84.1	169.8	15.34	0.65	23.0	3.58
RM-2869	28.08	4.62	0.15	7.43	59.9	12.0	31.09	1.20	<0.3	4.77
RM-2915	8.28	2.86	0.23	2.84	88.3	169.0	14.69	0.66	16.1	3.41
RM-2930	22.16	5.53	<0.07	14.66	85.5	112.7	18.94	3.01	10.7	6.24
RM-2982	10.02	3.25	0.21	4.21	84.1	166.0	15.34	0.92	21.1	3.64
RM-2992	6.91	0.49	1.02	3.95	<0.9	<1.7	5.99	2.20	<0.3	0.05
RM-3069	9.30	2.33	0.07	4.24	55.6	98.2	12.48	1.18	1.3	2.53
RM-3092	7.58	<0.02	1.44	4.11	<0.9	<1.7	5.47	1.89	<0.3	0.04
RM-3209	9.14	2.08	0.07	4.32	52.7	98.2	11.99	1.39	0.9	2.36

Table 6. Dissolved concentrations from filtered samples for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-3285	9.12	2.13	0.39	4.18	55.6	101.4	11.14	1.42	1.7	2.41
RM-3375	6.24	<0.02	1.43	3.89	<0.9	<1.7	5.47	2.14	<0.3	0.03
RM-3440	8.94	2.10	0.07	4.26	49.9	89.1	11.48	1.36	0.8	2.22
RM-3455	27.35	4.70	0.09	3.46	91.1	2.5	31.14	1.13	1.0	5.50
RM-3545	9.19	2.07	<0.07	4.25	50.6	87.7	11.29	1.36	0.9	2.244
RM-3645	9.19	2.07	<0.07	4.26	50.7	89.7	11.27	1.45	0.8	2.22
RM-3740	9.41	0.60	<0.07	6.15	8.8	37.3	11.10	2.32	<0.3	0.34
RM-3840	8.84	2.03	0.09	4.34	51.1	90.0	10.90	1.38	1.0	2.11
RM-3870	16.97	3.24	<0.07	2.65	23.7	4.5	12.51	0.66	1.7	1.03
RM-3895	9.37	2.05	0.48	5.50	6.0	<1.7	8.84	3.73	<0.3	0.08
RM-3945	6.69	0.66	0.48	6.43	<0.9	<1.7	6.89	1.03	<0.3	0.02
RM-4075	9.37	2.05	0.10	4.27	48.2	89.8	11.14	1.51	0.8	2.13
RM-4275A	9.10	2.02	0.10	4.17	47.6	89.3	10.67	1.52	0.6	2.10
RM-4275B	9.00	2.05	<0.07	4.25	47.5	83.7	10.95	1.48	0.7	2.10
RM-4335	10.10	2.15	<0.07	2.53	15.4	24.6	15.49	0.97	0.7	1.21
RM-4485	9.32	2.08	<0.07	4.29	47.4	80.3	11.63	1.48	0.9	2.07
RM-4735	9.39	2.06	<0.07	4.18	51.5	78.1	11.38	1.47	0.7	2.11
RM-4935	9.19	2.10	<0.07	4.28	47.4	85.2	11.75	1.32	0.5	2.17
RM-5135	9.13	2.05	0.07	4.15	46.0	82.0	11.29	1.50	0.8	2.06
RM-5377	9.19	2.07	0.07	4.31	50.8	89.5	11.64	1.30	0.7	2.13

Table 7. Ultrafiltrate concentrations from samples passed through 10,000 Dalton molecular mass membranes for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-0	<0.05	7.32	103.4	32.	39.13	7.15	28.1	2.0	1.204	16.52	0.710
RM-100	<0.05	78.49	259.5	13.	30.29	11.30	117.3	25.2	4.272	148.2	1.063
RM-146	<0.05	77.70	246.1	13.	30.93	11.23	123.1	25.6	4.169	145.0	1.046
RM-212	0.05	77.02	238.7	13.	30.64	11.86	117.6	25.3	4.172	142.3	0.804
RM-269	<0.05	80.64	214.2	15.	32.12	11.33	132.2	27.3	4.384	146.3	1.002
RM-331	0.35	69.60	182.0	15.	29.37	10.31	107.5	22.6	3.797	116.4	0.910
RM-464	0.29	63.45	130.0	15.	27.53	9.27	102.4	20.8	3.562	99.55	0.942
RM-552	0.41	61.70	130.1	13.	27.47	9.18	94.2	18.0	3.412	95.39	0.973
RM-594	0.40	55.61	116.7	14.	26.36	8.78	91.2	16.3	3.212	82.22	1.029
RM-700	0.37	46.70	49.0	20.	25.80	7.01	71.9	13.3	2.616	67.17	0.937
RM-743	0.37	50.05	51.8	22.	27.08	7.48	78.4	14.2	2.793	68.84	0.871
RM-870	0.50	41.36	39.6	20.	25.25	7.10	69.1	11.7	2.381	54.19	0.902
RM-955	0.51	41.44	37.4	20.	26.77	7.22	71.1	11.8	2.360	51.71	0.854
RM-1040	0.32	80.45	161.5	14.	30.74	16.19	116.2	25.4	4.145	144.6	1.482
RM-1092	0.28	78.25	140.6	15.	31.11	15.73	117.7	23.9	4.134	137.0	1.368
RM-1192	0.27	76.69	123.1	17.	32.39	15.96	119.7	24.6	3.937	136.8	1.389
RM-1360	0.30	74.43	129.3	19.	30.91	15.95	124.4	25.2	3.813	126.4	1.734
RM-1460	0.23	73.88	134.6	15.	31.48	15.73	113.1	22.2	3.735	126.3	1.558
RM-1560	0.22	77.47	106.9	17.	34.96	15.96	110.2	22.3	4.033	127.5	1.594
RM-1685	0.19	71.84	94.4	19.	34.67	15.23	107.7	22.8	3.853	117.2	1.462
RM-1850	0.19	72.48	118.6	20.	36.00	15.70	115.9	23.1	3.947	121.2	1.529
RM-1950A	0.17	72.50	120.5	20.	37.91	16.31	121.5	23.4	3.824	118.3	1.524
RM-1950B	0.18	67.82	128.7	18.	36.80	16.49	116.3	21.8	3.446	113.8	1.599
RM-2010	0.16	72.95	102.9	19.	39.17	15.07	118.2	22.9	3.920	121.2	1.443
RM-2150	0.15	71.13	119.9	18.	37.78	15.10	110.4	21.8	3.570	112.5	1.525
RM-2241	0.19	70.31	125.4	19.	37.91	14.88	115.0	22.1	3.514	114.5	1.498
RM-2280	0.15	71.85	118.6	18.	39.33	15.71	116.0	23.0	3.532	113.7	1.483
RM-2360	0.12	54.54	59.0	21.	38.07	12.77	90.5	17.6	2.970	84.24	1.303

Table 7. Ultrafiltrate concentrations from samples passed through 10,000 Dalton molecular mass membranes for silver (Ag), aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), and potassium (K), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Ag (µg/L)	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)
RM-2560	0.10	58.73	68.8	21.	40.49	12.65	97.2	17.6	3.187	86.98	1.258
RM-2693	0.08	68.84	75.7	18.	40.49	13.27	107.5	19.0	2.880	103.4	1.244
RM-2774	0.08	65.32	54.4	18.	39.57	13.11	103.1	18.0	2.668	101.2	1.262
RM-2857	0.07	68.60	69.7	19.	43.27	13.32	104.3	18.8	2.824	103.1	1.436
RM-2915	0.08	65.80	53.8	20.	40.64	13.62	117.3	19.9	2.747	95.14	1.277
RM-2982	0.07	66.35	54.1	18.	56.26	13.30	102.8	18.1	2.486	98.73	1.316
RM-3069	<0.05	46.85	4.8	15.	105.9	9.26	81.8	11.0	1.755	50.70	1.053
RM-3209	<0.05	41.14	3.9	15.	101.4	8.27	69.6	9.5	1.550	42.17	0.893
RM-3285	<0.05	46.08	5.2	14.	112.1	8.72	68.7	9.6	1.702	46.66	1.094
RM-3440	0.05	38.97	3.8	17.	118.5	8.04	63.1	8.4	1.458	37.78	1.232
RM-3545	<0.05	39.31	4.7	16.	111.8	7.86	65.6	8.3	1.426	37.53	0.984
RM-3645	<0.05	38.79	4.7	17.	111.9	8.21	66.4	9.2	1.467	36.59	1.080
RM-3840	<0.05	38.16	5.4	17.	113.2	7.81	61.6	8.8	1.421	36.37	1.175
RM-4075	<0.05	36.96	4.3	17.	114.2	7.64	67.8	8.3	1.364	35.05	0.920
RM-4275A	<0.05	37.79	3.7	17.	120.9	7.68	66.0	8.3	1.392	33.82	1.011
RM-4275B	<0.05	36.52	3.5	18.	112.2	7.33	67.0	8.9	1.348	32.19	1.029
RM-4485	<0.05	34.70	4.3	18.	111.9	7.30	61.5	7.7	1.257	31.57	1.269
RM-4735	<0.05	35.38	3.7	17.	117.4	7.61	62.8	8.1	1.297	31.47	1.222
RM-4935	<0.05	36.21	3.4	17.	115.1	7.20	57.4	8.3	1.303	30.54	1.161
RM-5135	0.05	37.61	3.8	17.	120.5	7.55	60.7	7.8	1.363	33.45	1.130
RM-5377	0.05	36.23	3.6	16.	114.3	7.44	59.9	7.2	1.321	32.10	1.138

Table 8. Ultrafiltrate concentrations from samples passed through 10,000-Dalton molecular mass membranes for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-0	5.25	0.91	<0.07	2.87	23.6	46.6	7.31	1.51	1.0	1.82
RM-100	5.54	1.76	0.22	1.38	103.2	245.8	21.30	0.61	41.3	2.40
RM-146	5.47	1.75	0.39	1.47	105.6	253.7	20.90	0.62	42.1	2.55
RM-212	5.50	1.74	0.44	1.49	109.7	242.8	21.20	0.66	38.4	2.51
RM-269	5.79	1.78	0.42	1.55	106.6	265.9	22.52	0.63	39.3	2.58
RM-331	5.49	1.74	0.37	1.41	95.5	318.8	21.05	0.56	29.7	2.22
RM-464	5.24	1.64	0.23	1.39	90.4	299.7	19.90	0.53	23.9	2.02
RM-552	5.22	1.65	0.20	1.39	83.5	272.4	19.24	0.52	20.0	2.03
RM-594	5.11	1.59	0.20	1.45	80.4	266.0	18.33	0.52	16.5	1.92
RM-700	4.48	1.33	0.13	1.75	66.3	227.4	15.83	0.61	6.9	1.59
RM-743	4.82	1.43	0.18	1.90	65.4	249.1	17.14	0.56	8.1	1.69
RM-870	4.56	1.38	0.11	1.69	60.4	272.8	15.90	0.50	7.0	1.57
RM-955	4.75	1.42	0.13	1.76	56.7	272.7	16.09	0.54	6.0	1.54
RM-1040	7.73	2.71	0.36	1.57	111.5	250.7	17.06	0.47	38.4	4.01
RM-1092	7.63	2.66	0.41	1.55	114.0	240.3	17.27	0.45	35.8	3.96
RM-1192	7.91	2.58	0.38	1.84	105.8	256.5	17.49	0.46	31.1	4.00
RM-1360	7.40	2.55	0.43	1.81	107.7	264.4	16.88	0.49	31.1	3.94
RM-1460	7.62	2.61	0.36	1.82	106.6	222.2	16.86	0.48	29.0	4.03
RM-1560	8.17	2.75	0.29	2.17	101.3	250.9	18.33	0.56	26.8	4.10
RM-1685	7.62	2.49	0.29	2.91	98.1	252.4	16.47	0.60	25.0	3.82
RM-1850	7.91	2.63	0.27	3.03	96.6	265.7	17.25	0.62	24.9	4.02
RM-1950A	8.26	3.01	0.35	3.11	102.5	265.3	16.43	0.65	25.4	3.98
RM-1950B	7.94	2.87	0.28	2.98	105.7	239.3	15.89	0.66	26.1	3.93
RM-2010	8.47	2.99	0.30	3.15	96.9	255.6	17.26	0.65	25.8	4.040
RM-2150	8.58	2.98	0.26	3.31	100.5	236.3	17.22	0.65	22.9	4.05
RM-2241	8.22	3.03	0.27	3.09	101.7	249.5	16.84	0.68	24.7	4.04
RM-2280	8.51	3.12	0.43	3.15	103.8	242.8	17.00	0.70	25.3	4.05
RM-2360	7.17	2.59	0.32	2.92	83.3	177.2	13.09	0.70	9.1	3.34

Table 8. Ultrafiltrate concentrations from samples passed through 10,000-Dalton molecular mass membranes for magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), silica (Si), strontium (Sr), vanadium (V), and zinc (Zn), Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mg (mg/L)	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	Si (mg/L)	Sr (mg/L)	V (µg/L)	Zn (mg/L)
RM-2560	7.79	2.83	0.22	2.98	78.7	204.3	14.79	0.68	13.5	3.45
RM-2693	7.64	2.80	0.21	2.67	87.1	171.8	14.13	0.59	21.1	3.30
RM-2774	7.44	2.69	0.18	2.53	94.1	164.8	13.25	0.65	16.1	3.38
RM-2857	8.21	2.85	0.17	2.97	87.5	165.1	14.75	0.63	18.6	3.44
RM-2915	7.75	2.82	0.21	2.73	91.6	184.8	13.68	0.71	16.0	3.38
RM-2982	10.46	3.21	0.44	4.30	87.8	154.3	15.22	0.89	18.9	3.74
RM-3069	9.47	2.37	<0.07	4.29	60.8	116.0	12.63	1.30	1.1	2.58
RM-3209	9.00	2.15	0.07	4.20	54.7	101.2	11.10	1.31	0.8	2.38
RM-3285	9.76	2.37	0.12	4.49	53.3	102.1	13.31	1.30	1.2	2.49
RM-3440	9.23	2.07	0.09	4.34	52.7	90.8	11.42	1.39	0.7	2.26
RM-3545	9.32	2.08	<0.07	4.46	49.9	90.8	11.63	1.39	0.8	2.28
RM-3645	9.24	2.08	<0.07	4.38	51.4	94.8	11.37	1.54	0.7	2.24
RM-3840	9.38	2.09	<0.07	4.37	51.0	89.8	11.35	1.40	0.9	2.19
RM-4075	9.11	2.06	0.09	4.33	51.3	94.1	11.75	1.49	0.7	2.11
RM-4275A	9.41	2.05	<0.07	4.41	50.3	90.3	11.50	1.47	0.6	2.19
RM-4275B	8.74	1.98	0.07	4.22	50.8	94.2	11.02	1.42	0.6	2.15
RM-4485	8.98	1.96	<0.07	4.07	50.5	84.4	11.13	1.31	0.7	2.04
RM-4735	9.17	2.05	0.13	4.29	53.2	87.9	11.56	1.41	0.6	2.10
RM-4935	9.43	2.08	0.07	4.39	48.5	84.6	11.67	1.47	0.5	2.12
RM-5135	9.51	2.12	<0.07	4.40	47.5	84.3	12.17	1.38	0.7	2.15
RM-5377	9.55	2.08	<0.07	4.44	47.1	83.0	11.86	1.41	0.6	2.15

Table 9. Dissolved concentrations from filtered samples for chloride (Cl), fluoride (F), sulfate (SO4), ferrous iron [Fe(II)], and ferrous plus ferric iron [Fe(II+III)], Red Mountain Creek, Colo., August 2002.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; --, no data]

Sample	Cl (mg/L)	F (µg/L)	SO_4 (mg/L)	Fe(II) (mg/L)	Fe(II+III) (mg/L)
RM-0	1.13	52.	274.7	7.35	18.36
RM-43	0.91	384.	1,305.	194.47	232.0
RM-100	0.41	378.	980.4	121.10	168.4
RM-146	81.24	324.	946.0	112.58	167.5
RM-212	82.52	273.	944.5	112.52	164.5
RM-269	80.71	116.	942.1	113.81	161.9
RM-281	1.15	102.	228.7	0.53	2.24
RM-331	61.40	315.	792.3	--	--
RM-417	1.34	103.	269.4	1.46	2.33
RM-464	57.57	260.	802.1	78.50	113.6
RM-552	56.42	264.	740.2	52.95	106.2
RM-564	0.93	277.	315.4	1.13	5.65
RM-594	48.28	299.	681.5	79.01	94.68
RM-658	48.92	243.	689.5	--	--
RM-673	3.27	--	29.65	0.10	0.07
RM-700	41.75	379.	590.8	46.24	73.71
RM-743	40.44	350.	563.1	71.66	86.31
RM-770	1.18	101.	246.1	1.67	6.01
RM-870	32.12	271.	496.6	44.91	59.61
RM-955	31.76	520.	517.5	60.33	102.6
RM-965	0.14	1,317.	2,895.	425.11	620.9
RM-1040	23.86	413.	1,024.	114.44	172.5
RM-1075	--	127.	324.0	2.35	18.34
RM-1092	23.19	431.	963.7	106.73	160.7
RM-1107	6.65	73.	74.64	0.12	0.08
RM-1192	22.91	442.	917.4	85.38	153.5
RM-1200	26.05	569.	666.8	0.15	0.11
RM-1360	22.79	456.	901.9	97.55	151.3
RM-1460	22.87	394.	942.0	87.62	149.7

Table 9. Dissolved concentrations from filtered samples for chloride (Cl), fluoride (F), sulfate (SO4), ferrous iron [Fe(II)], and ferrous plus ferric iron [Fe(II+III)], Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; --, no data]

Sample	Cl (mg/L)	F (µg/L)	SO_4 (mg/L)	Fe(II) (mg/L)	Fe(II+III) (mg/L)
RM-1507	5.35	316.	538.2	3.41	4.62
RM-1560	22.52	436.	914.6	82.84	145.9
RM-1572	5.19	256.	460.9	0.05	0.04
RM-1685	21.85	433.	855.7	77.16	139.8
RM-1850	21.61	367.	910.9	72.70	137.7
RM-1905	11.06	3,083.	1,778.	29.39	63.44
RM-1950A	21.69	413.	895.9	89.18	135.4
RM-1950B	21.87	361.	903.2	78.82	135.0
RM-2010	21.82	428.	871.7	78.84	132.2
RM-2150	21.94	398.	905.1	74.27	131.6
RM-2241	21.62	472.	833.3	70.32	130.8
RM-2246	16.50	6,154.	3,749.	152.67	288.2
RM-2280	21.63	436.	890.3	87.38	131.5
RM-2319	0.65	462.	92.93	0.13	0.11
RM-2360	18.10	350.	716.1	59.94	99.95
RM-2560	18.03	330.	727.3	59.99	100.8
RM-2634	0.22	901.	2,616.	266.05	430.1
RM-2693	16.26	465.	825.3	82.36	126.9
RM-2696	7.02	293.	256.8	0.15	0.10
RM-2774	15.56	466.	848.9	61.58	121.0
RM-2814	1.20	415.	792.0	0.70	9.18
RM-2857	15.78	442.	798.0	71.51	120.4
RM-2869	1.80	498.	864.0	2.66	12.15
RM-2915	15.69	377.	421.9	68.94	118.4
RM-2930	0.52	579.	1,446.	104.94	136.4
RM-2982	14.01	497.	879.4	65.63	118.3
RM-2992	0.66	393.	464.3	0.08	0.09
RM-3069	10.47	468.	727.0	44.01	54.81
RM-3092	1.80	370.	406.0	0.10	0.11
RM-3209	9.55	471.	713.1	46.77	49.13

Table 9. Dissolved concentrations from filtered samples for chloride (Cl), fluoride (F), sulfate (SO4), ferrous iron [Fe(II)], and ferrous plus ferric iron [Fe(II+III)], Red Mountain Creek, Colo., August 2002.—Continued

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote sample that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; --, no data]

Sample	Cl (mg/L)	F (µg/L)	SO_4 (mg/L)	Fe(II) (mg/L)	Fe(II+III) (mg/L)
RM-3285	9.65	464.	723.1	46.36	50.60
RM-3375	1.10	309.	403.7	0.09	0.04
RM-3440	8.78	403.	662.9	35.10	42.05
RM-3455	0.16	1,087.	1,463.	7.09	131.8
RM-3545	8.98	336.	703.1	36.16	41.77
RM-3645	8.83	434.	712.5	28.85	41.25
RM-3740	3.82	521.	479.8	0.20	0.14
RM-3840	8.43	405.	675.3	26.08	41.75
RM-3870	0.61	350.	602.8	69.59	73.43
RM-3895	1.29	430.	645.9	0.13	0.11
RM-3945	4.12	222.	199.1	0.17	0.11
RM-4075	8.55	338.	694.3	27.22	38.91
RM-4275A	8.08	406.	657.0	31.43	37.17
RM-4275B	8.72	377.	656.1	31.73	37.54
RM-4335	1.60	213.	441.0	7.31	20.25
RM-4485	7.95	343.	642.4	21.82	36.93
RM-4735	8.14	307.	644.9	22.43	35.48
RM-4935	7.67	373.	685.5	22.01	34.22
RM-5135	8.30	322.	663.9	33.93	36.85
RM-5377	8.07	382.	659.0	16.34	35.33

Appendix 1. Estimating Streamflow Using the Tracer-Dilution Method

Estimates of streamflow used to construct constituent loading profiles were obtained using the tracer-dilution method (Kilpatrick and Cobb, 1985) and observed lithium concentrations. Under the tracer-dilution method, a conservative tracer (lithium chloride, in this case) is continuously injected at a constant rate and concentration. Given sufficient time, all portions of the stream become saturated with tracer, and concentrations at a given instream site reach a plateau. Decreases in plateau concentration with stream length reflect dilution of the tracer by additional water entering the channel (surface and(or) groundwater inflow). Consideration of this dilution allows for the calculation of discharge at each site:

$$Q = \frac{Q_{INJ} C_{INJ}}{C_P - C_B} \qquad (4)$$

where C_B is the background lithium concentration, C_P is the lithium concentration at plateau, C_{INJ} is the injectate concentration, Q_{INJ} is the injection rate, and Q is the streamflow estimate.

Lithium concentrations and other quantities used in equation 4 are shown in table 15. Although use of equation 4 is theoretically straightforward, practical application is often confounded by laboratory and field sampling errors that affect the plateau concentrations. For the case considered here, streamflow estimates at most stream sites were obtained using the observed plateau lithium concentration (from the synoptic sample) and equation 4 (with C_B equal to 0.0, C_{INJ} equal to 34,882 milligrams per liter, and Q_{INJ} equal to 2.935×10^{-3} liters per second). Alternate calculations were needed at several sites, however, due to anomalous lithium concentrations. Lithium concentrations used for estimating streamflow at RM-146 and RM-212, for example, were set equal to the observed lithium value at RM-269 (see "Alternate Li concentration," table 15). Use of the observed lithium values from RM-146 and RM-212 would have resulted in a decrease in streamflow with distance, a theoretical impossibility when using the tracer-dilution method. Alternative concentrations were used in a similar manner at RM-870, RM-1950, RM-2010, RM-2241, RM-2360, RM-3209, RM-3285, RM-3440, RM-3545, RM-4935, and RM-5135. A linear increase in flow was assumed at three additional sites (RM-1360, RM-2857, RM-3840) where observed lithium concentrations appeared to be too low; streamflow estimates at these three sites were determined by interpolation.

Streamflow estimates obtained using the tracer-dilution method are compared with several velocity discharge measurements in figure 18. Velocity discharge measurements were conducted on the same day as the synoptic sampling and were rated either "poor" or "fair" (Kevin Johnson, U.S. Geological Survey, written commun., 2002). Streamflow estimates used to assess potential errors in raw load are provided in table 16.

Table 15. Data used to estimate streamflow using the tracer-dilution method, Red Mountain Creek, Colo., August 2002.

[Plateau Li concentration, lithium concentration from synoptic sample, in milligrams per liter. Alternate Li concentration, lithium concentration used in equation 4 in lieu of plateau values, in milligrams per liter. Method used, method used to estimate streamflow, where E denotes that the estimate was obtained using equation 4 and I denotes that the estimate is by interpolation. Streamflow estimate, estimate of streamflow, in cubic feet per second. --, not applicable]

Site	Plateau Li concentration	Alternate Li concentration	Method used	Streamflow estimate
RM-146	16.30	16.77	E	0.216
RM-212	16.77	16.77	E	0.216
RM-269	16.77	--	E	0.216
RM-331	13.30	--	E	0.272
RM-464	12.73	--	E	0.284
RM-552	12.05	--	E	0.300
RM-594	10.86	--	E	0.333
RM-658	10.81	--	E	0.335
RM-700	8.88	--	E	0.407
RM-743	8.59	--	E	0.421
RM-870	6.74	6.80	E	0.532
RM-955	6.80	--	E	0.532
RM-1040	4.87	--	E	0.743
RM-1092	4.66	--	E	0.776
RM-1192	4.43	--	E	0.817
RM-1360	4.37	--	I	0.821
RM-1460	4.40	--	E	0.823
RM-1560	4.36	--	E	0.830
RM-1685	4.14	--	E	0.874
RM-1850	4.07	--	E	0.889
RM-1950	4.04[1]	4.07	E	0.889
RM-2010	4.07	4.07	E	0.889
RM-2150	4.05	--	E	0.893
RM-2241	4.05	4.05	E	0.893
RM-2280	4.04	--	E	0.894
RM-2360	3.17	3.21	E	1.127
RM-2560	3.21	--	E	1.127
RM-2693	2.88	--	E	1.256

Table 15. Data used to estimate streamflow using the tracer-dilution method, Red Mountain Creek, Colo., August 2002.—Continued

[Plateau Li concentration, lithium concentration from synoptic sample, in milligrams per liter. Alternate Li concentration, lithium concentration used in equation 4 in lieu of plateau values, in milligrams per liter. Method used, method used to estimate streamflow, where E denotes that the estimate was obtained using equation 4 and I denotes that the estimate is by interpolation. Streamflow estimate, estimate of streamflow, in cubic feet per second. --, not applicable]

Site	Plateau Li concentration	Alternate Li concentration	Method used	Streamflow estimate
RM-2774	2.74	--	E	1.318
RM-2857	2.69	--	I	1.330
RM-2915	2.70	--	E	1.339
RM-2982	2.39	--	E	1.513
RM-3069	1.59	--	E	2.268
RM-3209	1.47	1.48	E	2.450
RM-3285	1.48	1.48	E	2.450
RM-3440	1.32	1.33	E	2.723
RM-3545	1.33	1.33	E	2.723
RM-3645	1.33	--	E	2.723
RM-3840	1.23	--	I	2.769
RM-4075	1.28	--	E	2.825
RM-4275	1.27[1]	--	E	2.847
RM-4485	1.19	--	E	3.044
RM-4735	1.19	--	E	3.044
RM-4935	1.19	1.19	E	3.044
RM-5135	1.20	1.19	E	3.044
RM-5377	1.18	--	E	3.059

[1]Average of two samples (replicate location).

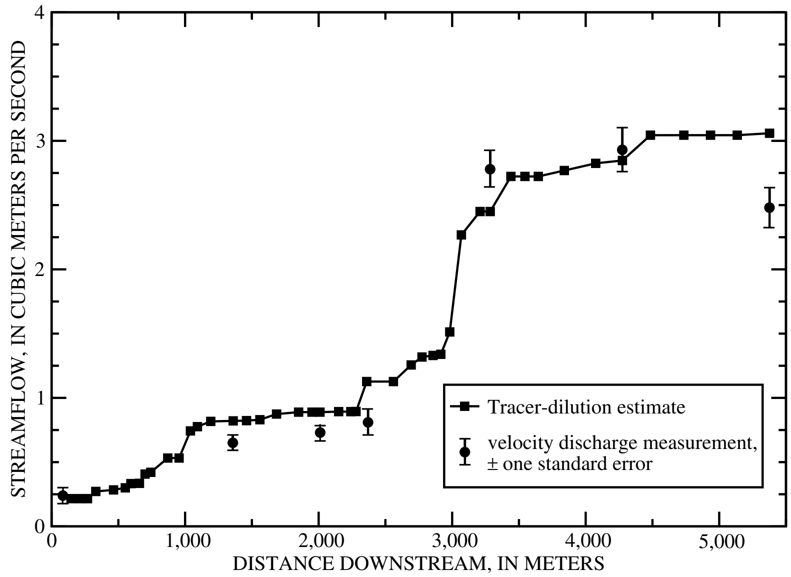

Figure 18. Spatial profile of streamflow estimates from tracer-dilution method and velocity discharge measurements, Red Mountain Creek, Colo., August 2002. Standard errors were calculated following Sauer and Meyer (1992).

Table 16. Streamflow estimates for replicate samples used to assess potential errors in raw load.

[Plateau Li concentration, lithium concentration from synoptic sample, in milligrams per liter. Method used, method used to estimate streamflow, where E denotes that the estimate was obtained using equation 4 and I denotes that the estimate is by interpolation. Streamflow estimate, estimate of streamflow, in cubic feet per second]

Sample	Plateau Li concentration	Method used	Streamflow estimate
RM-1950A	4.02	E	0.899
RM-1950B	4.06	E	0.891
RM-4275A	1.28	E	2.870
RM-4275B	1.26	E	2.818

Appendix 2. Spatial Profiles of Concentration—Additional Constituents

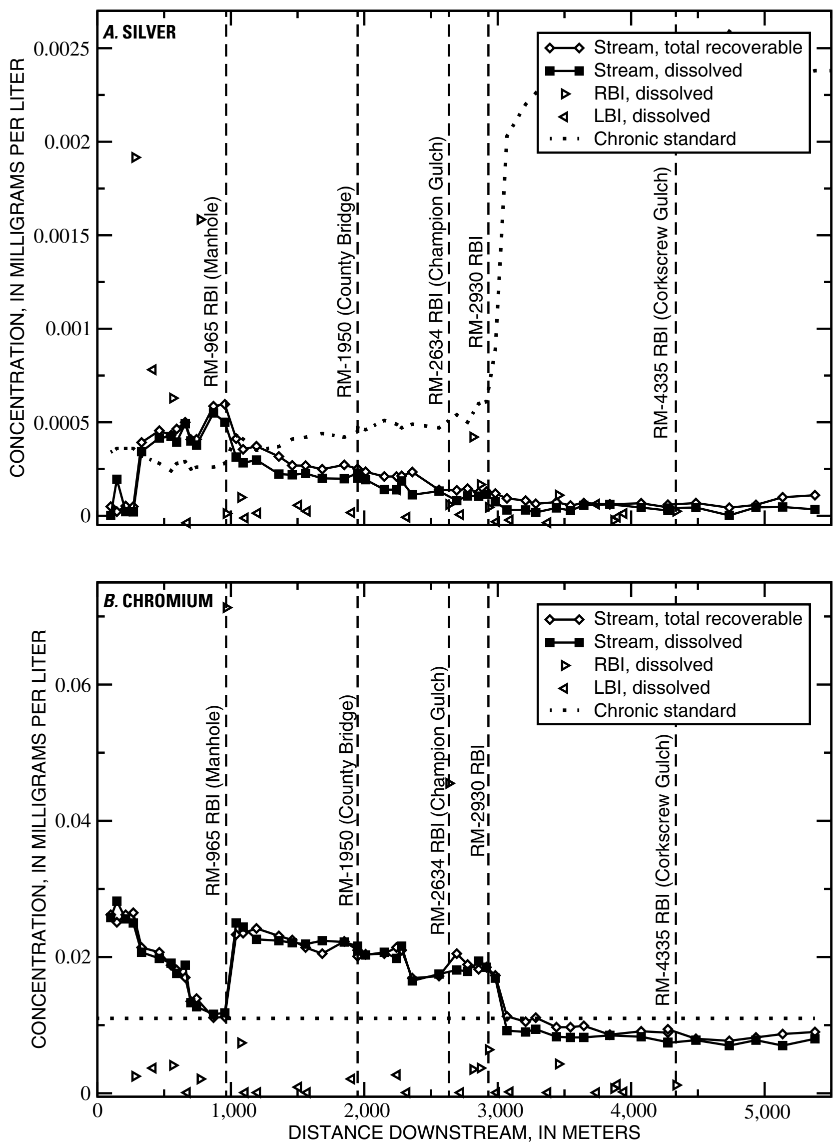

Figure 19. Spatial profiles of (*A*) silver concentrations, and (*B*) chromium concentrations, Red Mountain Creek, Colo., August 2002 (RBI, right bank inflow; LBI, left bank inflow). Chronic standards are shown for comparison purposes only (numeric water-quality standards have not been established by the State of Colorado for Red Mountain Creek).

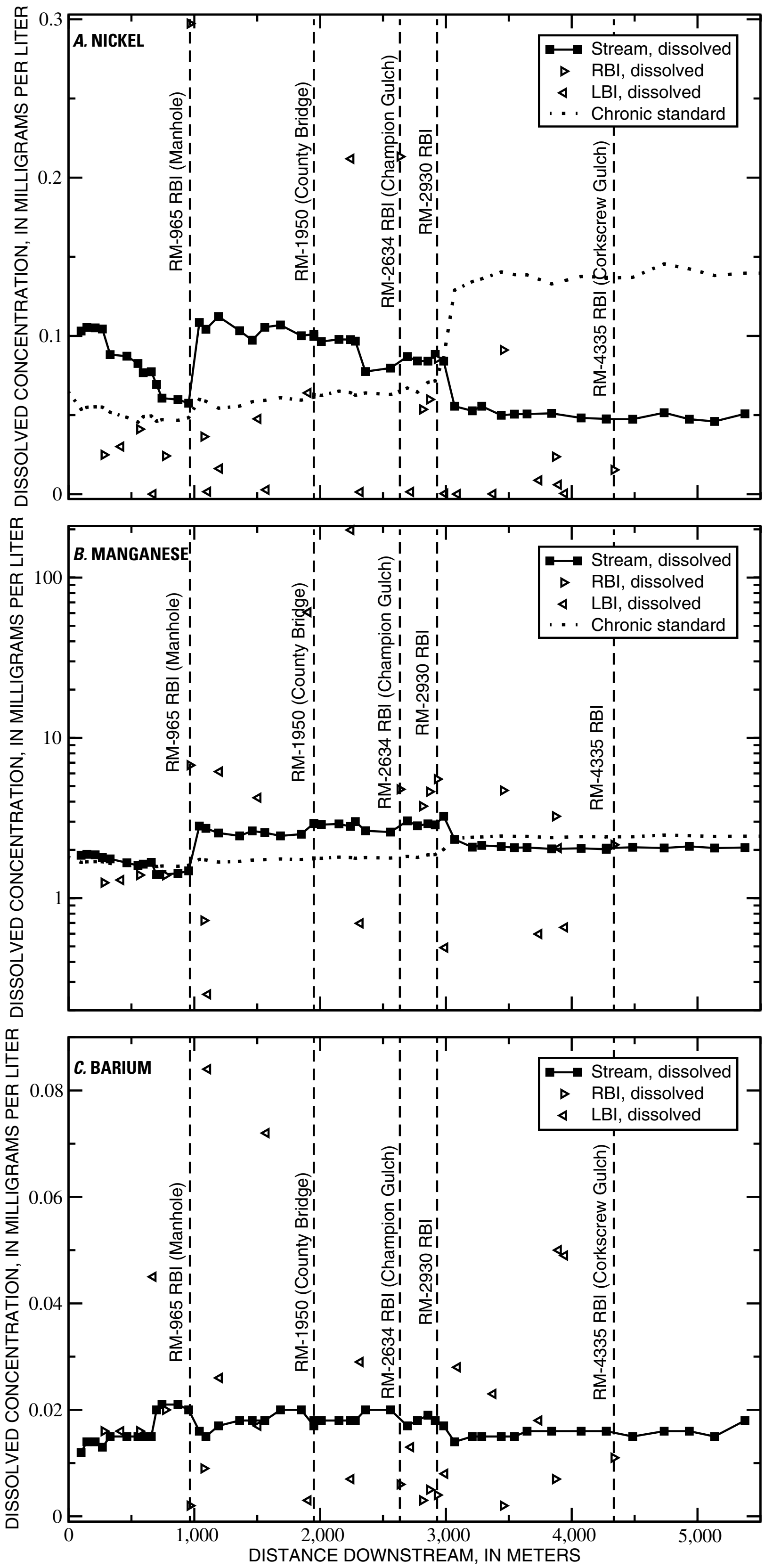

Figure 20. Spatial profiles of (*A*) nickel concentrations, (*B*) manganese concentrations, and (*C*) barium concentrations, Red Mountain Creek, Colo., August 2002 (RBI, right bank inflow; LBI, left bank inflow). Chronic standards are shown for comparison purposes only (numeric water-quality standards have not been established by the State of Colorado for Red Mountain Creek).

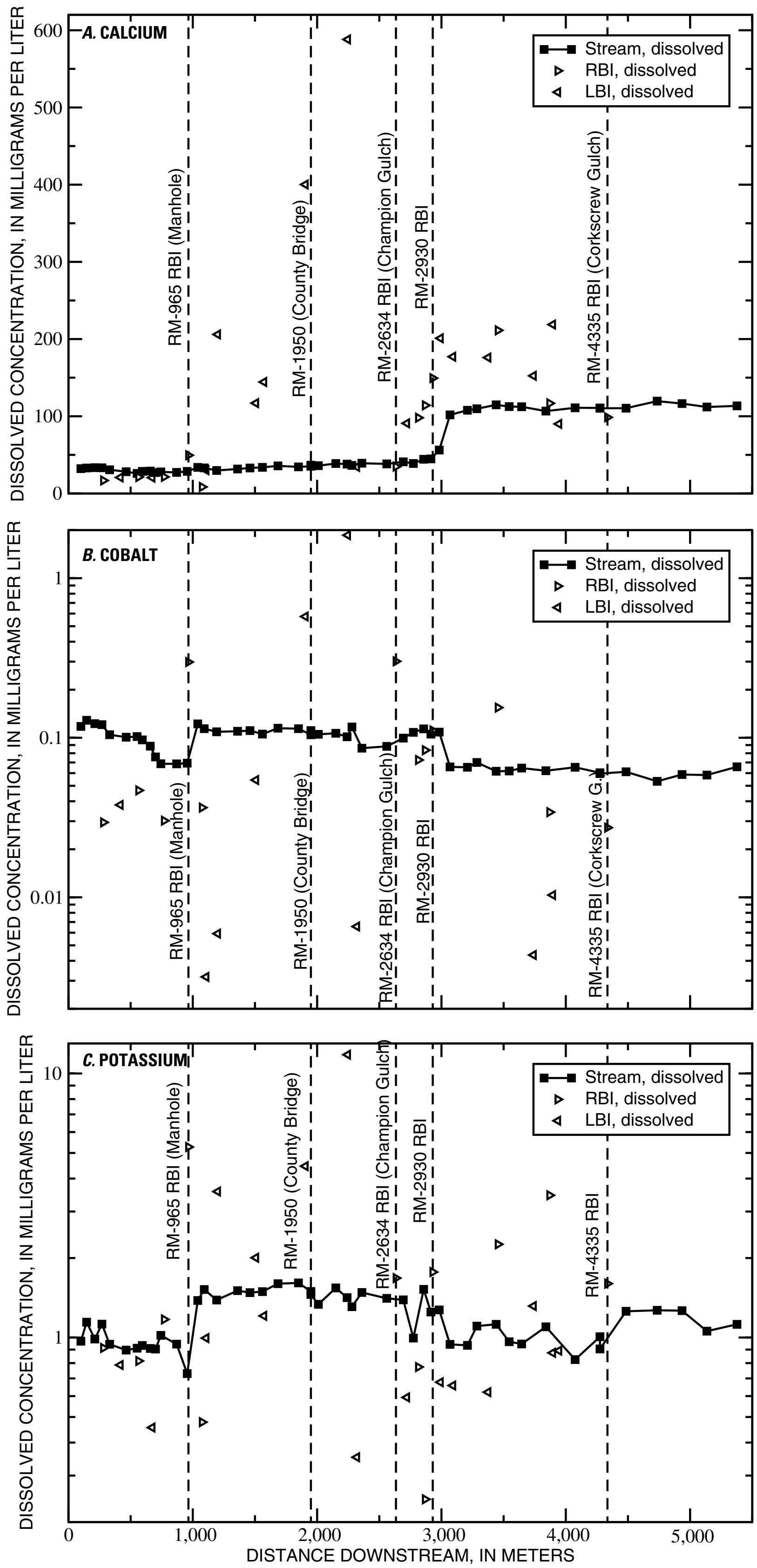

Figure 21. Spatial profiles of (*A*) calcium concentrations, (*B*) cobalt concentrations, and (*C*) potassium concentrations, Red Mountain Creek, Colo., August 2002 (RBI, right bank inflow; LBI, left bank inflow).

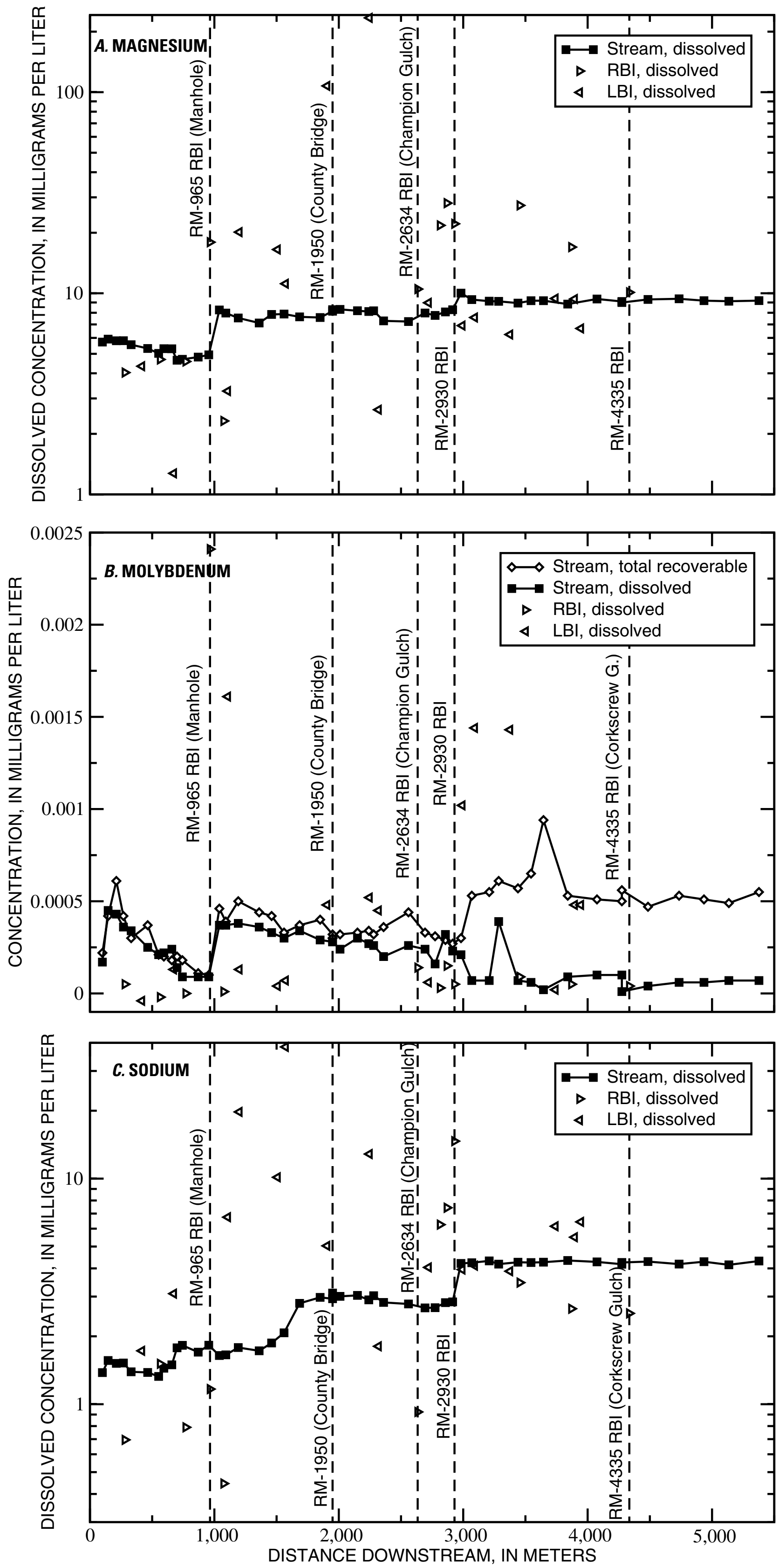

Figure 22. Spatial profiles of (*A*) magnesium concentrations, (*B*) molybdenum concentrations, and (*C*) sodium concentrations, Red Mountain Creek, Colo., August 2002 (RBI, right bank inflow; LBI, left bank inflow).

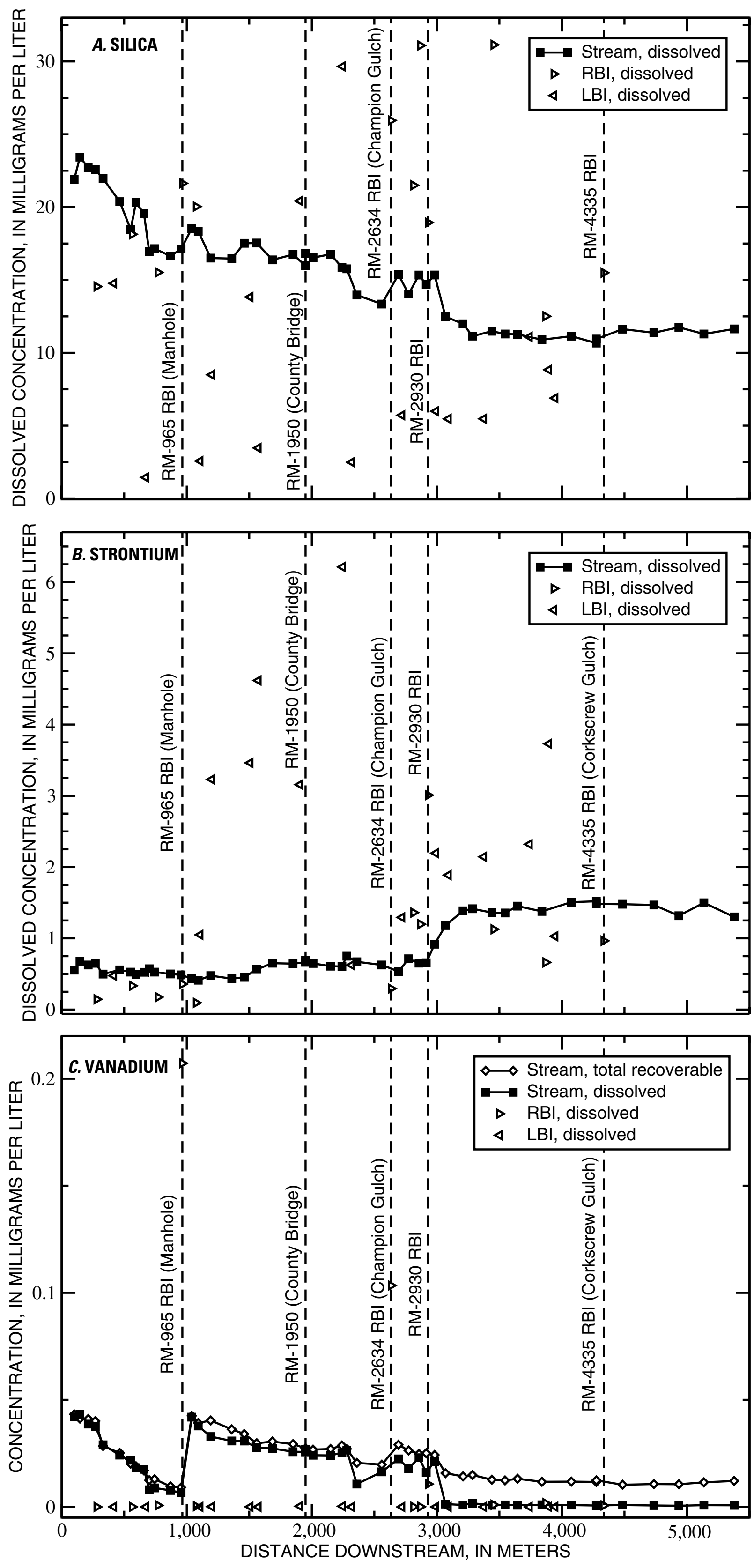

Figure 23. Spatial profiles of (*A*) silica concentrations, (*B*) strontium concentrations, and (*C*) vanadium concentrations, Red Mountain Creek, Colo., August 2002 (RBI, right bank inflow; LBI, left bank inflow).

Appendix 3. Total Recoverable Loads—Additional Constituents

Table 17. Percent relative errors at replicate sites, Red Mountain Creek, Colo., August 2002.

[ND, Percent relative error not determined—total recoverable silver concentration of RM-4275A is less than the method detection limit]

Constituent	Percent relative error, at replicate site:	
	RM-1950	RM-4275
Silver	12.8	ND
Barium	5.7	11.0
Calcium	8.9	4.9
Cobalt	5.8	4.3
Chromium	5.2	6.3
Potassium	3.3	7.5
Magnesium	10.2	2.9
Manganese	7.6	2.9
Molybdenum	6.3	11.9
Sodium	10.4	7.7
Nickel	7.7	6.0
Silica	10.5	1.1
Strontium	7.7	5.9
Vanadium	6.5	7.8

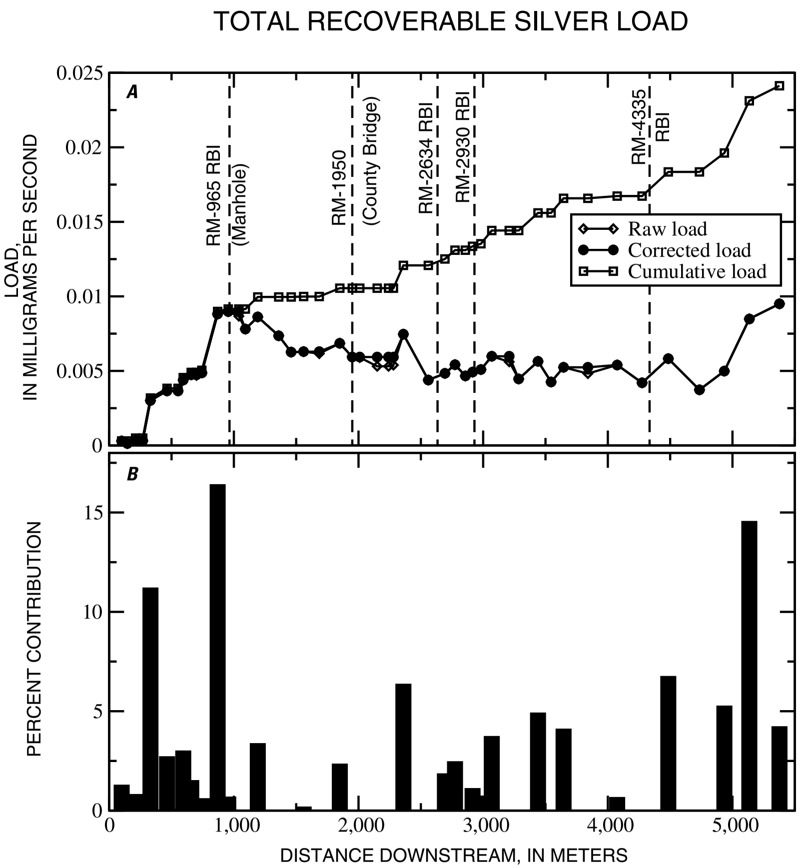

Figure 24. Total recoverable silver load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

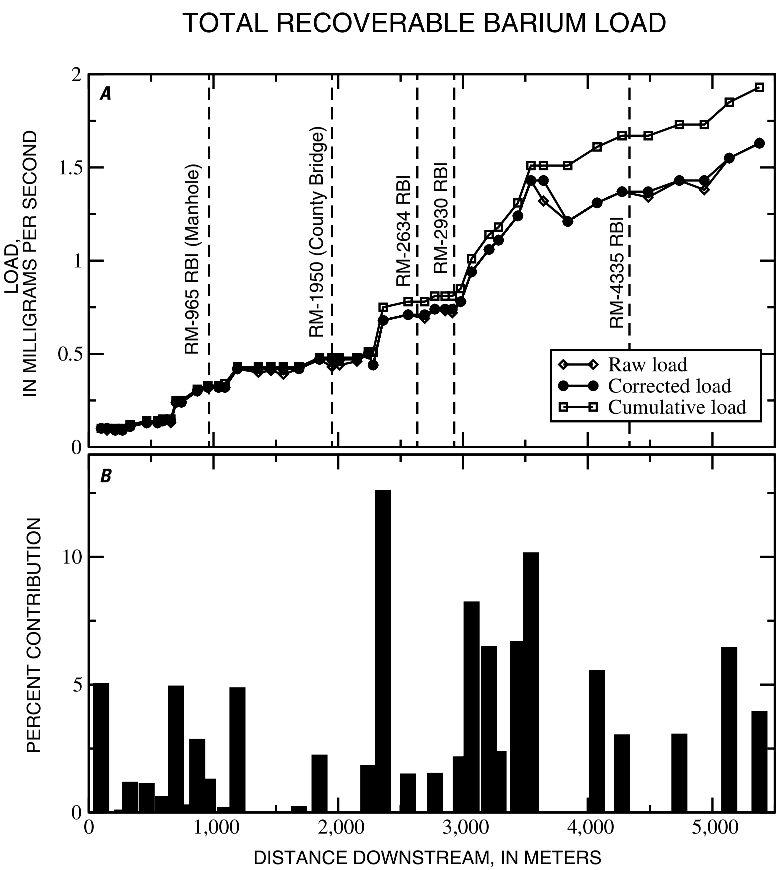

Figure 25. Total recoverable barium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

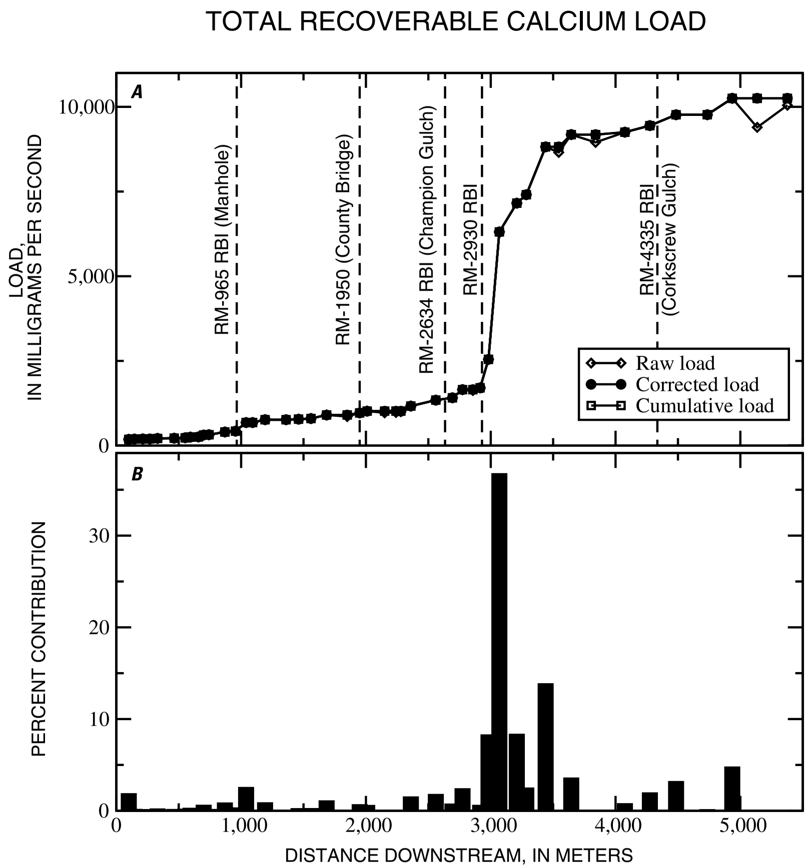

Figure 26. Total recoverable calcium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

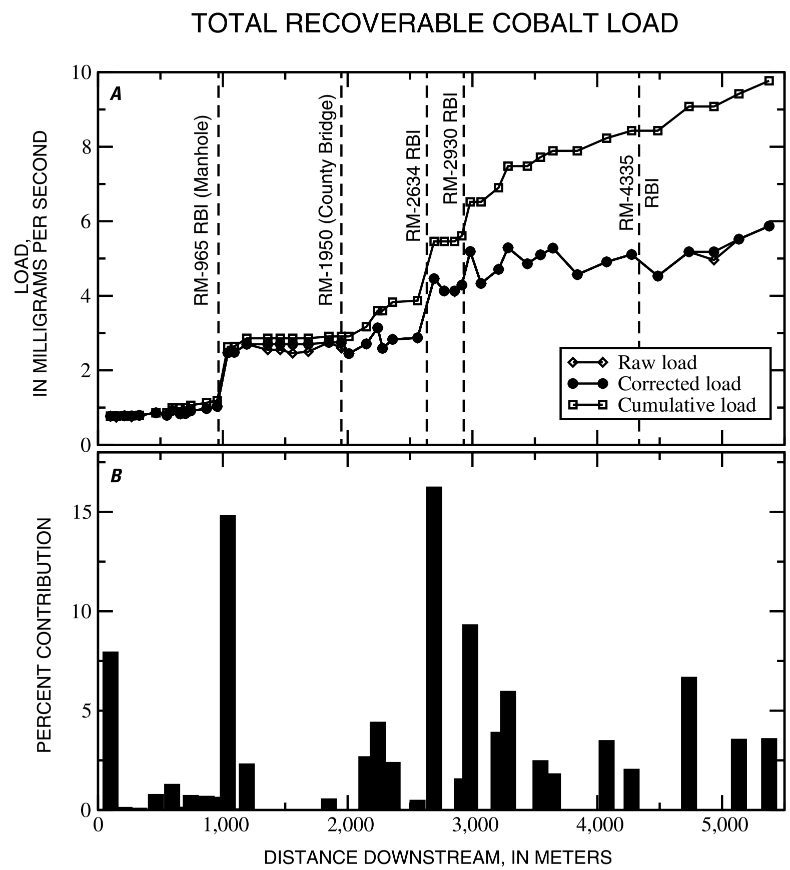

Figure 27. Total recoverable cobalt load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

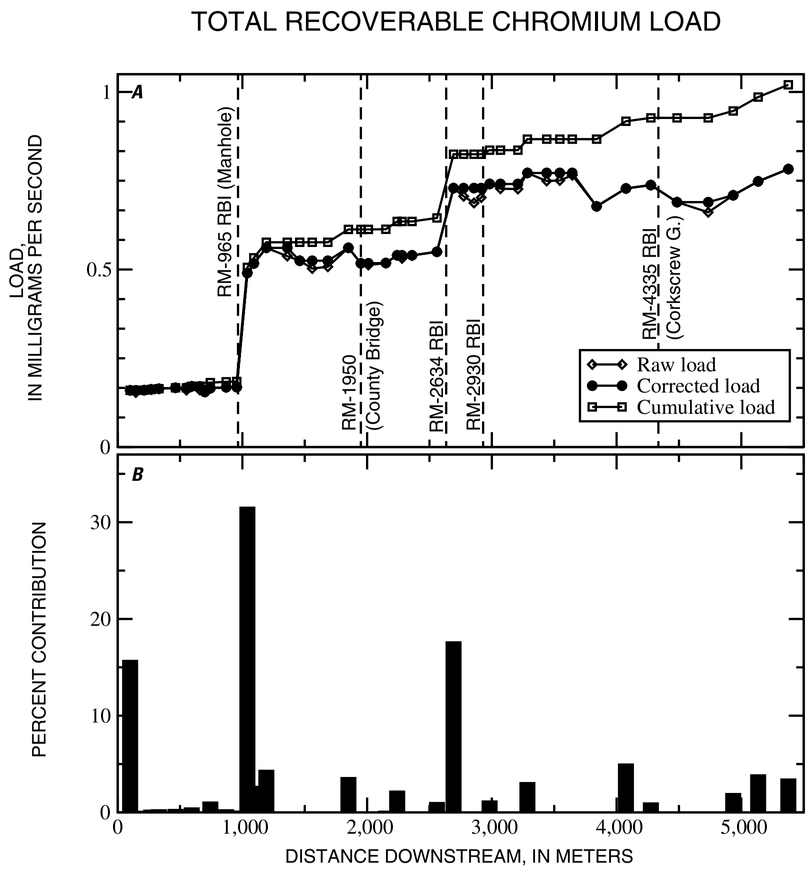

Figure 28. Total recoverable chromium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

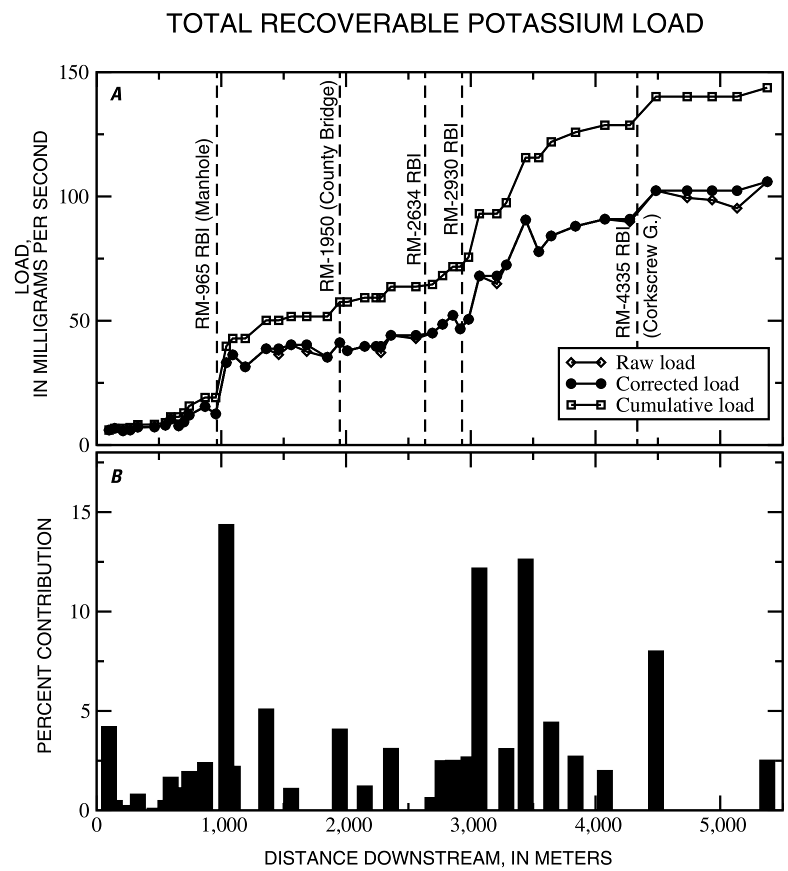

Figure 29. Total recoverable potassium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

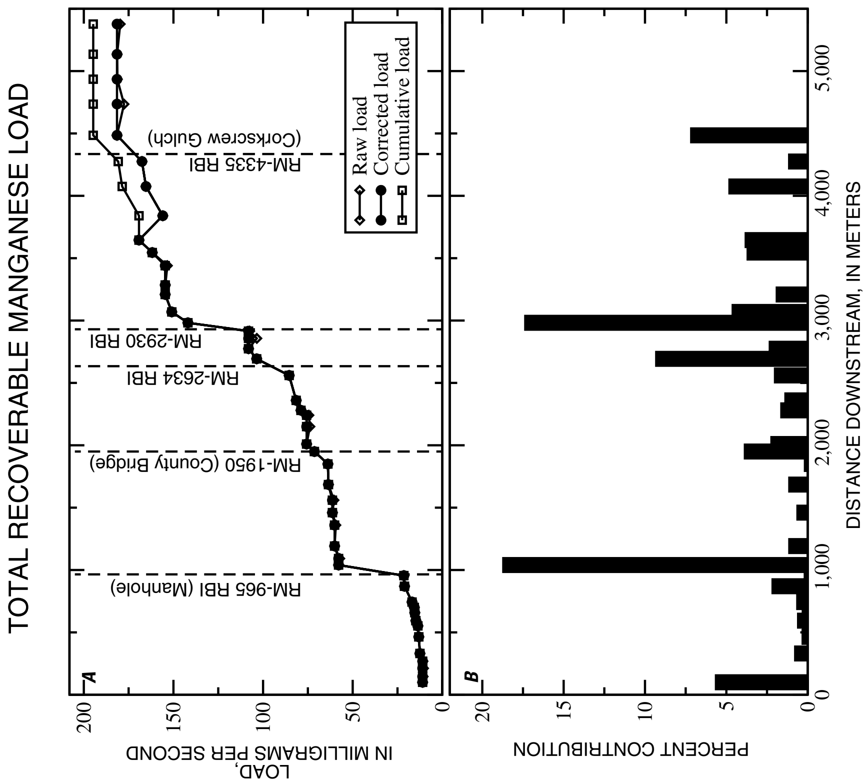

Figure 31. Total recoverable manganese load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

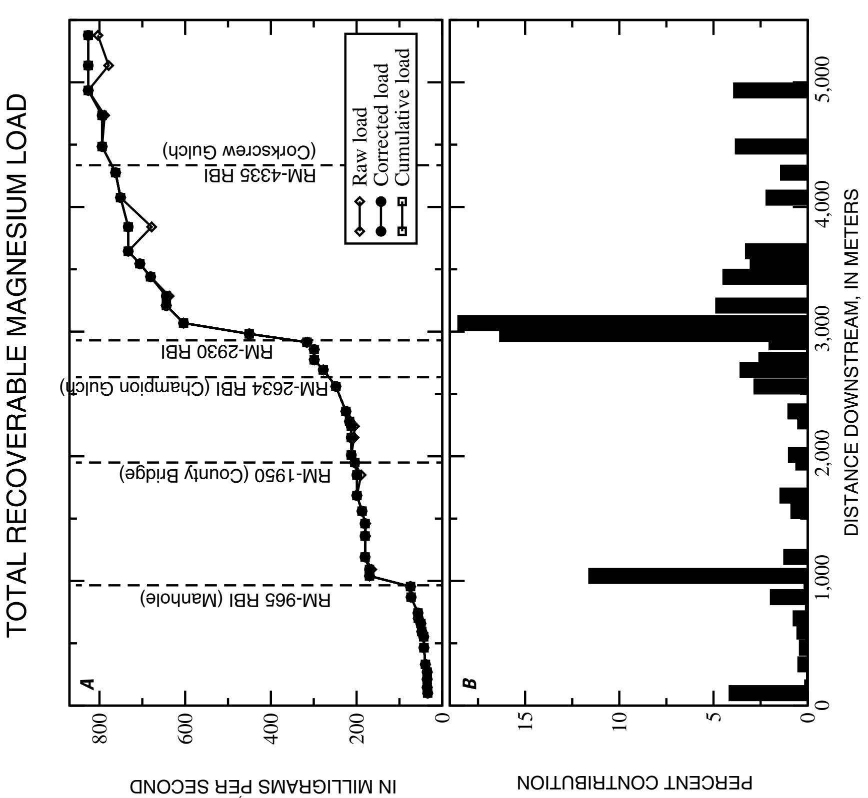

Figure 30. Total recoverable magnesium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

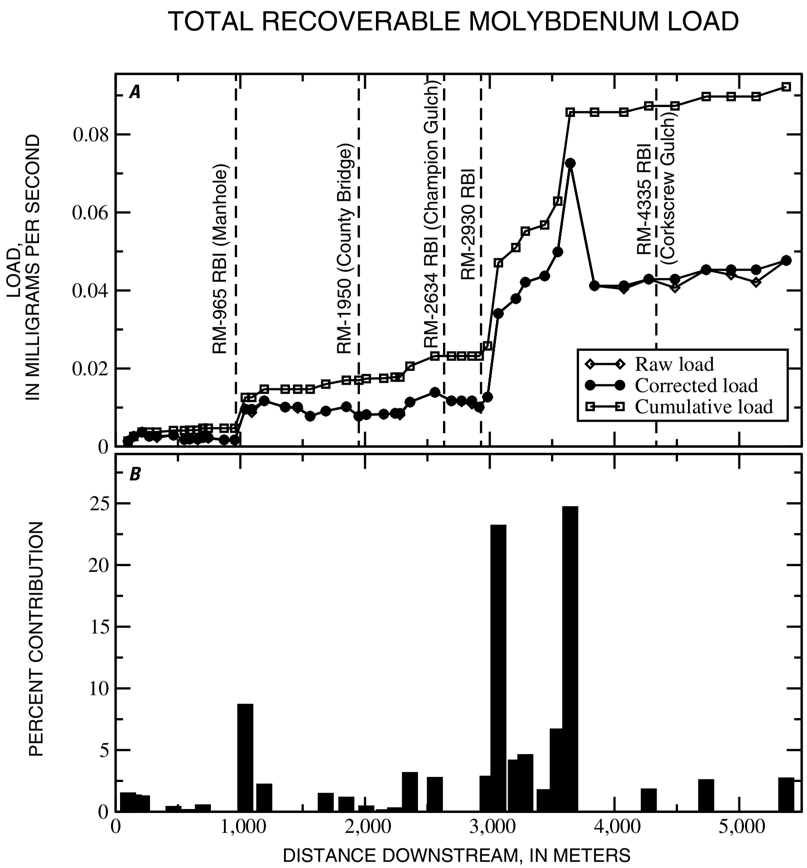

Figure 32. Total recoverable molybdenum load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

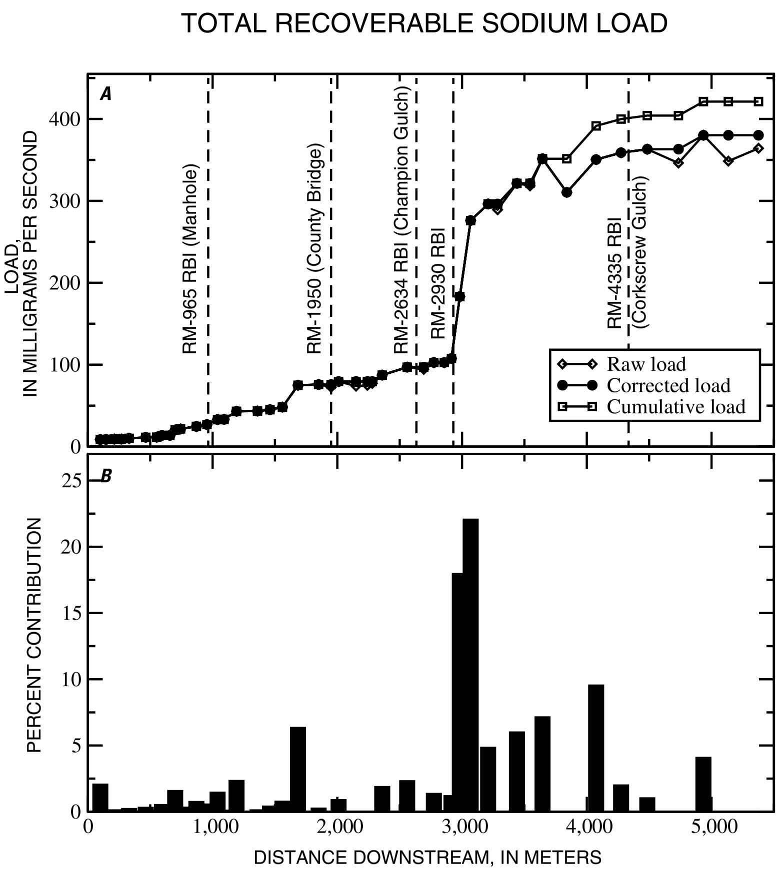

Figure 33. Total recoverable sodium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

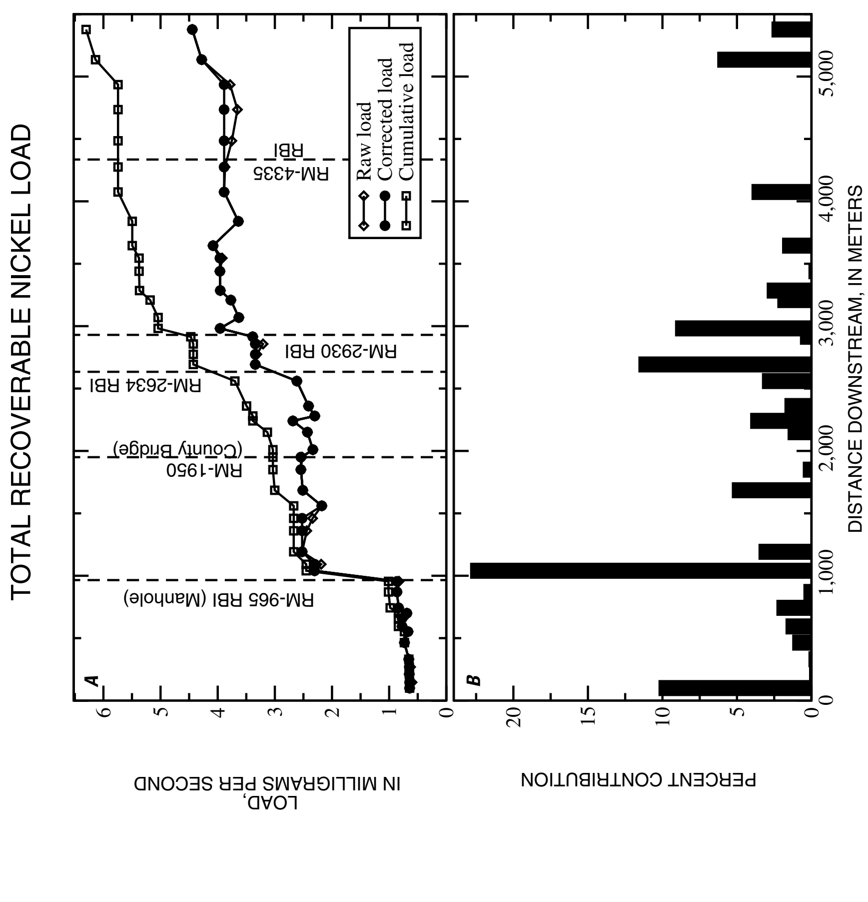

Figure 34. Total recoverable nickel load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

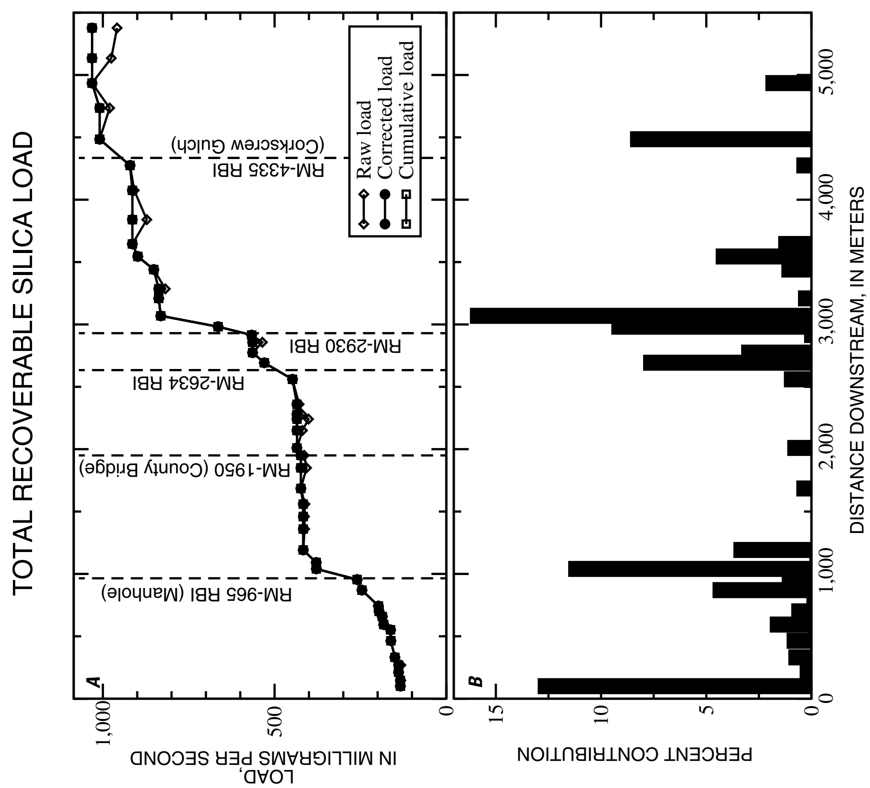

Figure 35. Total recoverable silica load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

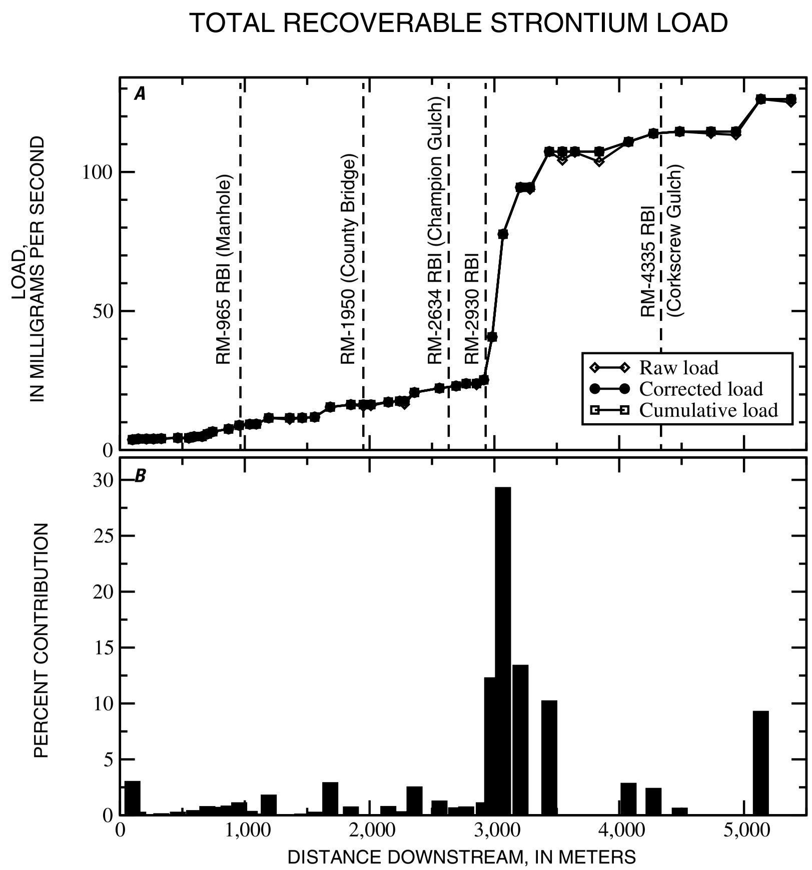

Figure 36. Total recoverable strontium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

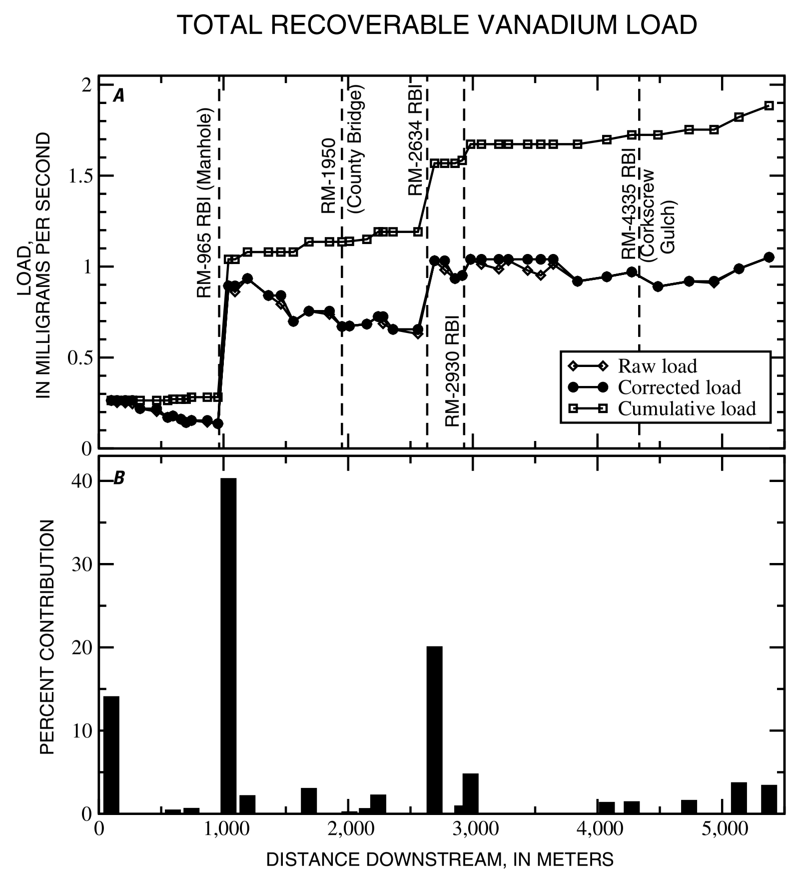

Figure 37. Total recoverable vanadium load in terms of (*A*) raw, corrected, and cumulative load profiles and (*B*) percent contribution to cumulative load, Red Mountain Creek, Colo., August 2002.

Appendix 4. Additional Data—April 2003 and September 2004

Table 18. Site descriptions and locations for sites sampled April 2003 and September 2004 (U.S. Environmental Protection Agency, 2003, 2004).

[Distance, distance downstream, in meters; Source, type of sample collected where S denotes stream sample, LBI denotes left bank inflow, and RBI denotes right bank inflow; Latitude and longitude, site coordinates based on the North American Datum of 1983 (NAD83); --, not applicable]

Site	Distance[1]	Source[2]	Description	Latitude and longitude, in degrees, minutes, seconds
URRM-1	--	LBI	West branch, Red Mountain Creek, near Mile Post 81	37 54 28.54 N 107 42 22.05 W
RM-965	965	RBI	Manhole discharge	37 54 39.69 N 107 41 59.40 W
URRM-1B	1,950	S	Red Mountain Creek at County Road 31 bridge	37 55 06.59 N 107 41 50.45 W
URRM-CG1	2,634	RBI	Champion Gulch at mouth	37 55 22.32 N 107 41 39.15 W
URRM-2A	5,377	S	Red Mountain Creek at County Road 20 bridge	37 56 20.55 N 107 40 18.24 W
URRM-2	8,000	S	Red Mountain Creek upstream from Crystal Lake	37 57 34.39 N 107 39 42.65 W
URCL-1	8,100	LBI	Crystal Lake	37 57 34.12 N 107 39 44.22 W
URRM-3	9,000	S	Red Mountain Creek downstream from Hendrick Gulch	37 57 59.61 N 107 39 36.12 W
UR-1	11,700	RBI	Uncompahgre River upstream from Red Mountain Creek	37 59 18.22 N 107 38 57.93 W
URBC-1	13,100	RBI	Bear Creek at Highway 550	38 00 00.42 N 107 39 36.13 W
UR-2	16,300	S	Uncompahgre River upstream from Canyon Creek	38 01 09.45 N 107 40 34.03 W
UR-3	19,500	S	Uncompahgre River near Ouray (USGS gage 09146020)	38 02 35.77 N 107 40 59.80 W
UR-4	24,350	S	Uncompahgre River at Highway 23 bridge	38 04 50.28 N 107 42 11.76 W
UR-6	34,500	S	Uncompahgre River at Ridgway (Highway 62 bridge)	38 09 05.54 N 107 45 06.66 W
UR-7	38,500	S	Uncompahgre River upstream from Ridgway Reservoir (USGS gage 09146200)	38 11 02.43 N 107 44 45.92 W

[1]Distances for URRM-1B, URRM-CG1, and URRM-2A based on 2002 synoptic study GPS analysis; remaining distances estimated using a topographic map.

[2]Stream sites include those from the 2002 Red Mountain Creek synoptic and sites located on the Uncompahgre River downstream of confluence with Red Mountain Creek; remaining sites are inflows.

Table 19. Selected data from April 2003, including pH, specific conductance, temperature, dissolved oxygen, and streamflow (U.S.Environmental Protection Agency, 2003), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with a optional DUP suffix to denote sample that are part of a field replicate; pH, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature, in degrees Celsius; Dissolved oxygen, in milligrams per liter; Streamflow, in cubic feet per second; --, no data]

Sample	Date	Time	pH	Specific conductance	Temperature	Dissolved oxygen	Streamflow
URRM-1	4/15/03	14:15	7.11	69	1.0	8.34	--
URRM-1B	4/15/03	12:20	3.59	467	0.7	8.92	1.0
URRM-2A	4/15/03	11:00	3.70	599	0.4	8.92	3.4
URRM-2	4/15/03	16:35	3.96	629	4.4	9.49	14.2
URCL-1	4/15/03	17:15	7.16	551	1.8	9.19	3.3
URRM-3	4/15/03	15:30	5.07	573	3.6	10.00	23.2
UR-1	4/15/03	10:00	7.73	181	1.7	8.64	--
UR-1DUP	4/15/03	10:00	--	--	--	--	--
URBC-1	4/15/03	18:10	8.10	144	1.3	11.34	--
UR-2	4/15/03	17:15	7.30	343	3.2	8.61	38.1
UR-3	4/15/03	11:10	7.83	365	4.5	9.96	116.0
UR-3DUP	4/15/03	11:10	--	--	--	--	--
UR-4	4/15/03	09:35	7.97	353	4.7	9.93	127.0
UR-6	4/15/03	08:20	7.90	404	5.4	9.97	127.0
UR-7	4/14/03	15:30	8.00	457	12.0	8.27	108.0

Table 20. Total recoverable concentrations from unfiltered samples for aluminum (Al), arsenic (As), boron (B), barium (Ba), beryllium (Be), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), and iron (Fe). Selected data from April 2003 (U.S. Environmental Protection Agency, 2003), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with an optional DUP suffix to denote samples that are part of a field replicate; all concentrations in milligrams per liter; <, less than]

Sample	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe
URRM-1	0.27	<0.005	0.090	0.0398	<0.0003	16.7	<0.0005	0.0009	<0.0005	0.013	0.236
URRM-1B	9.94	0.149	0.086	0.0412	0.0019	31.8	0.0059	0.0168	0.0027	1.280	17.800
URRM-2A	9.52	0.052	0.102	0.0429	0.0019	67.8	0.0039	0.0194	0.0018	0.637	17.600
URRM-2	7.50	0.029	0.085	0.0319	0.0013	90.5	0.0029	0.0167	0.0011	0.462	10.400
URCL-1	0.52	<0.005	0.083	0.0304	<0.0003	101.0	<0.0005	0.0035	<0.0005	0.003	1.760
URRM-3	5.62	0.022	0.089	0.0312	0.0012	88.9	0.0023	0.0137	0.0008	0.342	9.010
UR-1	0.77	<0.005	0.092	0.0393	<0.0003	28.1	0.0049	0.0005	<0.0005	0.058	0.435
UR-1DUP	0.73	<0.005	0.086	0.0387	<0.0003	27.6	0.0057	0.0013	<0.0005	0.057	0.433
URBC-1	1.87	<0.005	0.090	0.0859	<0.0003	25.0	<0.0005	0.0014	0.0005	0.006	1.150
UR-2	2.71	<0.005	0.083	0.0501	0.0004	53.1	0.0016	0.0054	<0.0005	0.115	3.760
UR-3	3.90	0.006	0.097	0.0871	0.0008	61.3	<0.0005	0.0040	0.0013	0.091	5.650
UR-3DUP	3.58	0.007	0.095	0.0829	0.0029	60.5	0.0023	0.0066	0.0022	0.092	5.390
UR-4	2.61	<0.005	0.097	0.0635	0.0005	60.0	<0.0005	0.0030	0.0007	0.064	3.200
UR-6	3.97	<0.005	0.105	0.0789	0.0008	63.7	<0.0005	0.0032	0.0010	0.063	5.260
UR-7	7.04	0.007	0.114	0.1260	0.0009	75.7	<0.0005	0.0045	0.0019	0.067	6.660

Table 21. Total recoverable concentrations from unfiltered samples for potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), lead (Pb), titanium (Ti), thallium (Tl), vanadium (V), and zinc (Zn). Selected data from April 2003 (U.S. Environmental Protection Agency, 2003), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with an optional DUP suffix to denote samples that are part of a field replicate; all concentrations in milligrams per liter; <, less than]

Sample	K	Mg	Mn	Na	Ni	Pb	Ti	Tl	V	Zn
URRM-1	0.3	1.25	0.0407	5.1	<0.0007	<0.002	0.002	0.004	<0.0004	0.054
URRM-1B	0.8	3.65	0.6810	8.1	0.0156	0.065	0.001	0.006	0.0042	1.890
URRM-2A	0.9	6.18	1.1900	5.9	0.0136	0.042	0.004	0.005	0.0038	1.640
URRM-2	1.2	6.69	1.4900	5.5	0.0125	0.026	0.001	0.007	0.0019	1.370
URCL-1	1.4	4.57	0.4930	4.2	0.0016	<0.002	<0.001	0.007	0.0004	0.075
URRM-3	1.2	6.05	1.2000	5.1	0.0093	0.018	0.001	0.007	0.0017	1.050
UR-1	0.7	2.37	1.0800	1.6	0.0013	0.011	0.002	0.005	0.0004	1.210
UR-1DUP	0.5	2.34	1.0800	1.6	<0.0007	0.009	0.002	<0.003	<0.0004	1.200
URBC-1	0.8	2.30	0.0822	2.5	<0.0007	<0.002	0.025	0.005	0.0024	0.043
UR-2	0.9	3.76	0.6510	4.1	0.0037	0.009	0.007	0.005	0.0016	0.588
UR-3	1.8	4.57	0.5580	7.6	0.0040	0.017	0.039	0.008	0.0041	0.418
UR-3DUP	1.6	4.45	0.5460	7.6	0.0064	0.016	0.036	0.009	0.0056	0.457
UR-4	1.5	3.98	0.4130	7.2	0.0031	0.011	0.024	0.009	0.0024	0.305
UR-6	2.0	5.24	0.3890	9.7	0.0030	0.022	0.052	0.009	0.0044	0.249
UR-7	3.0	9.04	0.4900	14.5	0.0039	0.026	0.114	0.010	0.0094	0.232

Table 22. Dissolved concentrations from filtered samples for aluminum (Al), arsenic (As), boron (B), barium (Ba), beryllium (Be), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), and iron (Fe). Selected data from April 2003 (U.S. Environmental Protection Agency, 2003), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with an optional DUP suffix to denote samples that are part of a field replicate; all concentrations in milligrams per liter; <, less than]

Sample	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe
URRM-1	<0.030	<0.005	0.007	0.0363	<0.0003	16.1	<0.0005	0.0006	<0.0005	0.008	0.045
URRM-1B	8.960	0.009	0.019	0.0468	0.0009	30.8	0.0064	0.0171	0.0017	1.250	8.470
URRM-2A	8.350	<0.005	0.024	0.0358	0.0008	66.0	0.0041	0.0194	0.0008	0.610	6.000
URRM-2	6.870	<0.005	0.005	0.0258	0.0005	90.5	0.0033	0.0179	<0.0005	0.462	2.970
URCL-1	<0.030	<0.005	0.005	0.0269	<0.0003	100.0	<0.0005	0.0040	<0.0005	<0.003	0.558
URRM-3	4.310	<0.005	0.013	0.0293	0.0004	90.9	0.0025	0.0144	<0.0005	0.311	1.900
UR-1	0.065	<0.005	0.014	0.0386	<0.0003	27.3	0.0055	0.0013	<0.0005	0.016	0.011
UR-1DUP	0.048	<0.005	0.015	0.0412	<0.0003	27.4	0.0051	0.0010	<0.0005	0.014	0.010
URBC-1	0.065	<0.005	0.014	0.0580	<0.0003	23.6	<0.0005	0.0011	<0.0005	<0.003	0.027
UR-2	<0.030	<0.005	0.018	0.0424	<0.0003	52.7	0.0019	0.0053	<0.0005	0.007	0.014
UR-3	0.044	<0.005	<0.004	0.0400	<0.0003	57.7	0.0012	0.0036	<0.0005	0.004	0.010
UR-3DUP	0.038	<0.005	0.019	0.0395	<0.0003	57.6	<0.0005	0.0035	<0.0005	0.006	0.013
UR-4	0.058	<0.005	<0.004	0.0382	<0.0003	56.2	0.0011	0.0029	<0.0005	0.004	<0.009
UR-6	0.056	<0.005	0.014	0.0512	<0.0003	61.1	<0.0005	0.0018	<0.0005	0.004	0.013
UR-7	0.050	<0.005	<0.004	0.0738	<0.0003	71.3	0.0008	0.0032	<0.0005	<0.003	0.035

Table 23. Dissolved concentrations from filtered samples for potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), lead (Pb), sulfate (SO_4), titanium (Ti), thallium (Tl), vanadium (V), and zinc (Zn). Selected data from April 2003 (U.S. Environmental Protection Agency, 2003), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with an optional DUP suffix to denote samples that are part of a field replicate; all concentrations in milligrams per liter; <, less than]

Sample	K	Mg	Mn	Na	Ni	Pb	SO_4	Ti	Tl	V	Zn
URRM-1	0.3	1.20	0.0341	4.8	<0.0007	<0.002	23	<0.001	<0.003	<0.0004	0.050
URRM-1B	0.6	3.47	0.6360	8.1	0.0145	0.042	180	<0.001	<0.003	<0.0004	1.860
URRM-2A	0.8	5.94	1.1200	6.2	0.0169	0.022	270	<0.001	<0.003	<0.0004	1.670
URRM-2	0.9	6.57	1.4500	5.4	0.0128	0.014	320	<0.001	<0.003	<0.0004	1.360
URCL-1	1.2	4.45	0.4740	4.2	0.0011	<0.002	240	<0.001	<0.003	<0.0004	0.064
URRM-3	1.0	6.08	1.1900	5.3	0.0089	<0.002	290	<0.001	<0.003	<0.0004	1.080
UR-1	0.5	2.28	1.0200	1.8	<0.0007	<0.002	50	<0.001	<0.003	<0.0004	1.100
UR-1DUP	0.5	2.27	1.0200	1.8	<0.0007	<0.002	51	<0.001	<0.003	<0.0004	1.080
URBC-1	0.5	1.89	0.0169	2.4	<0.0007	<0.002	14	<0.001	<0.003	<0.0004	0.029
UR-2	0.6	3.57	0.6070	4.2	0.0030	<0.002	130	<0.001	<0.003	<0.0004	0.414
UR-3	0.7	3.73	0.4040	7.1	0.0015	<0.002	130	<0.001	<0.003	<0.0004	0.202
UR-3DUP	0.8	3.69	0.3980	7.0	0.0019	<0.002	130	<0.001	<0.003	<0.0004	0.192
UR-4	0.7	3.39	0.3350	6.6	0.0011	<0.002	120	<0.001	<0.003	<0.0004	0.123
UR-6	0.9	4.20	0.2100	9.5	0.0010	<0.002	130	<0.001	<0.003	<0.0004	0.065
UR-7	0.7	7.00	0.1800	14.5	<0.0007	<0.002	160	<0.001	<0.003	0.0005	0.043

Table 24. Selected data from September 2004, including pH, specific conductance, temperature, dissolved oxygen, and streamflow (U.S. Environmental Protection Agency, 2004), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with a optional DUP suffix to denote sample that are part of a field replicate; pH, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature, in degrees Celsius; Dissolved oxygen, in milligrams per liter; Streamflow, in cubic feet per second; --, no data]

Sample	Date	Time	pH	Specific conductance	Temperature	Dissolved oxygen	Streamflow
URRM-1	9/27/04	17:38	7.50	108	7.15	8.0	3.21
RM-965	9/28/04	13:20	2.57	4378	4.59	0.4	0.13
URRM-1B	9/27/04	14:16	3.34	628	8.82	7.8	5.35
URRM-CG1	9/28/04	10:50	2.77	1796	4.28	8.7	0.63
URRM-2A	9/27/04	13:02	3.52	672	8.67	8.1	15.70
URRM-2	9/27/04	10:46	3.77	628	5.76	8.8	21.20
URRM-2DUP	9/27/04	10:46	--	--	--	--	--
URCL-1	9/27/04	12:17	8.99	490	12.45	8.6	2.40
URRM-3	9/27/04	09:38	4.11	575	2.94	9.5	25.30
UR-1	9/27/04	15:20	7.71	184	6.95	9.4	16.80
URBC-1	9/27/04	15:05	7.81	241	6.27	9.8	--
UR-2	9/27/04	14:05	5.43	386	7.04	9.9	50.20
UR-3	9/27/04	12:30	7.32	401	8.66	9.5	94.70
UR-4	9/27/04	11:05	7.79	403	8.83	9.4	103.00
UR-4DUP	9/27/04	11:05	--	--	--	--	--
UR-6	9/27/04	10:05	7.77	506	9.10	9.2	128.00
UR-7	9/27/04	09:00	7.97	575	7.30	9.8	146.00

Table 25. Total recoverable concentrations from unfiltered samples for aluminum (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn). Selected data from September 2004 (U.S. Environmental Protection Agency, 2004), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with an optional DUP suffix to denote samples that are part of a field replicate; all concentrations in milligrams per liter; <, less than]

Sample	Al	As	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
URRM-1	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.013	<0.003	<0.005	0.017
RM-965	321.784	1.340	0.071	0.097	20.655	747.081	9.507	0.449	0.477	20.119
URRM-1B	21.685	0.060	0.006	0.006	1.653	36.055	0.931	0.031	0.068	1.803
URRM-CG1	122.084	0.032	0.013	0.024	2.042	191.767	2.640	0.119	0.050	3.150
URRM-2A	18.756	0.026	0.004	0.004	0.887	27.147	1.014	0.024	0.039	1.352
URRM-2	12.788	0.016	0.003	0.002	0.592	16.830	1.096	0.018	0.025	1.051
URRM-2DUP	12.639	0.015	0.004	0.002	0.586	16.734	1.090	0.018	0.024	1.041
URCL-1	<0.100	<0.010	<0.001	<0.002	<0.010	0.253	0.060	<0.003	<0.005	<0.010
URRM-3	10.640	0.012	0.003	<0.002	0.494	13.670	0.931	0.015	0.021	0.876
UR-1	0.126	<0.010	<0.001	<0.002	0.012	<0.200	0.079	<0.003	<0.005	0.175
URBC-1	1.848	<0.010	<0.001	<0.002	0.018	<0.200	0.227	<0.003	<0.005	0.101
UR-2	4.610	<0.010	0.002	<0.002	0.227	5.598	0.494	0.008	0.009	0.485
UR-3	2.383	<0.010	0.001	<0.002	0.113	2.750	0.295	0.004	<0.005	0.295
UR-4	2.164	<0.010	<0.001	<0.002	0.100	2.405	0.275	0.003	0.005	0.257
UR-4DUP	2.066	<0.010	<0.001	<0.002	0.095	2.294	0.274	0.003	<0.005	0.250
UR-6	1.313	<0.010	<0.001	<0.002	0.057	1.362	0.167	<0.003	<0.005	0.135
UR-7	1.047	<0.010	<0.001	<0.002	0.041	1.085	0.154	<0.003	<0.005	0.107

Table 26. Dissolved concentrations from filtered samples for aluminum (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), sulfate (SO_4), and zinc (Zn). Selected data from September 2004 (U.S. Environmental Protection Agency, 2004), used for comparison purposes (see section entitled "Additional Sources of Data").

[Sample, "Site" from table 18 with an optional DUP suffix to denote samples that are part of a field replicate; all concentrations in milligrams per liter; --, no data; <, less than]

Sample	Al	As	Cd	Cr	Cu	Fe	Mn	Ni	Pb	SO_4	Zn
URRM-1	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.010	<0.003	<0.005	25.4	0.024
RM-965	316.412	1.297	0.068	0.094	20.596	749.799	9.394	0.429	0.480	4160.0	20.063
URRM-1B	21.210	0.012	0.006	0.005	1.653	30.856	0.904	0.030	0.067	309.0	1.817
URRM-CG1	125.204	0.029	0.014	0.026	2.091	187.046	2.555	0.123	0.060	1330.0	3.186
URRM-2A	18.395	<0.010	0.004	0.003	0.908	20.096	1.018	0.024	0.037	354.0	1.388
URRM-2	12.293	<0.010	0.004	<0.002	0.586	10.621	1.086	0.017	0.024	324.0	1.051
URRM-2DUP	12.390	<0.010	0.004	<0.002	0.586	10.945	1.091	0.017	0.024	326.0	1.057
URCL-1	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.046	<0.003	<0.005	--	<0.010
URRM-3	10.380	<0.010	0.003	<0.002	0.492	8.250	0.929	0.015	0.018	303.0	0.891
UR-1	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.071	<0.003	<0.005	61.6	0.187
URBC-1	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.218	<0.003	<0.005	77.3	0.028
UR-2	1.048	<0.010	0.002	<0.002	0.190	3.028	0.487	0.006	<0.005	178.0	0.528
UR-3	<0.100	<0.010	0.001	<0.002	<0.010	0.225	0.292	<0.003	<0.005	175.0	0.238
UR-4	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.263	<0.003	<0.005	168.0	0.107
UR-4DUP	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.264	<0.003	<0.005	172.0	0.115
UR-6	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.151	<0.003	<0.005	188.0	0.075
UR-7	<0.100	<0.010	<0.001	<0.002	<0.010	<0.200	0.137	<0.003	<0.005	218.0	0.059