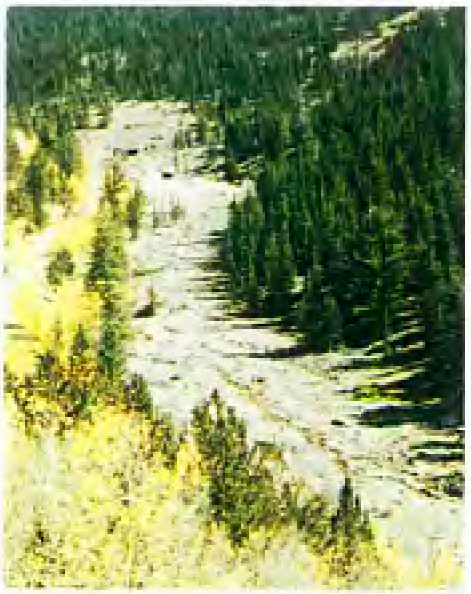
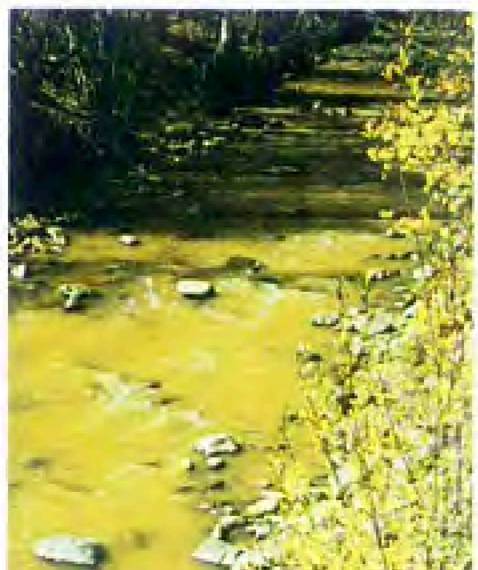
Colorado

WATER RESOURCES

CIRCULAR NO. 21





EFFECT OF MINE DRAINAGE ON THE QUALITY OF STREAMS IN COLORADO, 1971-1972

1974

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In charge of cooperative water-resources investigations in Colorado.

COVER: These are examples of surface waters in Colorado which are adversely affected by metal-mine drainage. See the back cover for explanation.

COLORADO WATER RESOURCES
CIRCULAR NO. 21

EFFECT OF MINE DRAINAGE ON THE QUALITY OF STREAMS IN COLORADO, 1971-72

By Dennis A. Wentz

Prepared by the
U.S. GEOLOGICAL SURVEY
in cooperation with the
COLORADO WATER POLLUTION CONTROL COMMISSION

COLORADO WATER CONSERVATION BOARD
1845 Sherman Street
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1974

PREFACE

This report is the first product of a cooperative agreement between the U.S. Geological Survey and the Colorado Water Pollution Control Commission regarding the effects of mine drainage on streams in Colorado. The extensive background section in this first report serves to set the stage for a discussion of the problem at hand, and provides a means for keeping the results of the study in perspective. As this report is intended for a broad spectrum of the public, the Background section has been written using nontechnical language insofar as possible. The section on The Process of Acid Formation and Trace Element Liberation involves considerable chemistry, and will be of interest only to those with training in this area. However, the nontechnical reader should not suffer greatly in his comprehension of the rest of the report if this section is omitted.

For the benefit of the reader, a separate Glossary and List of Mineral Names and Formulae are included in the report.

Dennis A. Wentz
Research Hydrologist
June 29, 1973

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[Plates are in pocket]

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GLOSSARY

acidophilic.--Pertaining to an organism which is adapted to or restricted to growth under acid conditions.

adit.--A horizontal or nearly horizontal passage driven from the surface for the working or dewatering of a mine.

anaerobic.--Pertaining to the absence of free oxygen.

antagonism.--In toxicology, the relationship between two substances whereby one counteracts the effects of the other.

anticline.--A fold, the core of which contains the stratigraphically older rocks; it is convex upward.

base metal.--Any of the more common and more chemically active metals, *e.g.* copper, lead, zinc.

bioassay.--A determination of the concentration of a material which will effect a response in a test plant or animal under known laboratory conditions.

biotic.--Pertaining to life or biological processes.

Celsius temperature scale.--Equivalent to the centigrade temperature scale.

chemoautotrophic.--Pertaining to an organism that obtains nourishment from chemical reactions of inorganic substances.

complex ore.--As used in this report, an ore characterized by the close association of certain base metals (copper, lead, zinc) and precious metals (gold, silver).

dip net.--A fine-mesh nylon net with a long handle. It is used for collecting aquatic macroinvertebrates by sweeping through submerged plants and along the stream bottom.

drift mine.--A mine that opens into a horizontal or practically level seam of coal. This type of mine is generally the easiest to excavate as the mine opening enters into the coal outcrop.

Eh.--A measure of the oxidation-reduction potential of a system. It is somewhat analogous to pH in that it measures the ability of a system to supply electrons, rather than protons. Eh is generally expressed in millivolts. Negative and low positive numbers indicate reducing environments, while large positive numbers indicate oxidizing environments.

emetic.--A substance which causes vomiting.

epigenetic.--Pertaining to a mineral deposit of later origin than the enclosing rocks.

epithermal.--Pertaining to a hydrothermal mineral deposit formed within 3,000 feet of the earth's surface and in the temperature range of 50° to 200°C, occurring mainly as veins.

fault.--A surface or zone of rock fracture along which there has been displacement, from a few centimeters to a few kilometers in scale.

ferroalloy metal.--A metal which alloys with iron, including molybdenum, tungsten, vanadium.

fold.--A curve or bend of a planar structure such as rock strata.

geothermal gradient.--The rate of increase of temperature in the earth with depth; the *thermal gradient* of the earth. The approximate average geothermal gradient in the earth's crust is about 25°C/km.

heterotrophic.--Pertaining to an organism which obtains its energy from the break-down of organic compounds.

igneous.--Pertaining to a rock or mineral that solidified from molten or partly molten materials, *i.e.* from a magma.

intermontane.--Situated between or surrounded by mountains or mountain ranges.

intrusive.--A rock formed by the process of emplacement of magma in pre-existing rock.

lipid.--One of the three major classes of organic substances which, along with carbohydrates and proteins, make up the bulk of organic matter in living organisms. Lipids are also known as fats.

mafic.--Pertaining to an igneous rock composed chiefly of one or more ferromagnesian, dark-colored minerals.

magma.--Naturally occurring mobile rock material, generated within the earth and capable of intrusion and extrusion, from which igneous rocks are thought to have been derived through solidification and related processes.

MATC.--Maximum acceptable toxicant concentraion.

mesothermal.--Pertaining to a hydrothermal mineral deposit formed at considerable depth and in the temperature range of 200° to 300°C.

metamorphic.--Pertaining to any process by which consolidated rocks are altered in composition, texture, or internal structure by conditions and forces not resulting simply from burial and the weight of the subsequently accumulated overburden.

microbial.--Pertaining to micro-organisms.

mine drainage.--As used in this report, the term *mine drainage* refers to man-induced drainage from active or abandoned mines and milling operations, and to natural drainage from ore deposits, the implication being that such drainage is detrimental to surface-water quality because of its high acidity and (or) high trace-element content.

mole.--Gram molecular weight. A mass numerically equal (in grams) to the molecular weight (in atomic weight units).

orogeny.--The process of mountain formation.

pH.--A measure of the hydrogen-ion concentration of a solution. A pH unit is expressed as the negative $\log_{10}$ of the hydrogen-ion concentration. The pH of pure water is 7.0. Acid water has a lower pH, and alkaline water has a higher pH.

pipe.--A cylindrically shaped, more or less vertical orebody.

polymorph.--In mineralogy, one of the several manifestations of a compound which can crystallize in more than one form.

porphyry.--An igneous rock of any composition that contains conspicuous large crystals in a finer grained groundmass.

precious metal.--A general term for gold, silver, or any of the metals of the platinum group.

primary mineral.--A mineral formed at the same time as the rock enclosing it.

replacement deposit.--A mineral deposit which has been formed by mineral solutions taking the place of some earlier, different substance.

ruby silver.--A red silver-sulfide mineral; specifically, "dark ruby silver" (pyrargyrite) and "light ruby silver" (proustite).

secondary mineral.--A mineral formed later than the rock enclosing it. It is formed from a primary mineral as a result of weathering, metamorphism, or solution activity.

sedimentary.--Pertaining to a rock resulting from the consolidation of loose fragmental material eroded from pre-existing rocks.

sorption.--The process by which a substance in solution is taken up by a surface. It includes absorption, adsorption, and ion exchange.

specific conductance.--A measure of the ability of water to conduct an electrical current. It is expressed in micromhos per centimeter at 25°C. Pure water has a very small electrical conductance, but the conductance increases with increasing concentration of dissolved minerals.

spoil.--Debris or waste material from a coal mine, including overburden when referring to a surface mine. It is often pyritic.

stockwork.--A mineral deposit in the form of a network of veinlets diffused in the country rock.

stoichiometric.--Pertaining to a chemical reaction which is balanced so that it contains the same amount of each element on either side of the equation.

synergism.--In toxicology, the relationship between two substances whereby the two acting together produce an effect which is greater than the sum of the two each acting independently.

tailings.--Those portions of mined ore which are separated in the milling process because they are of no interest or because they are too low in metal content to be processed economically.

TL_m.--This represents "tolerance limit, median," and expresses the concentration of a toxic substance which will kill 50 percent of the test organisms in the designated time period.

trace elements.--As used in this report, this term refers to those elements which occur in relatively minor amounts (less than 1 mg/l) in most natural waters. In mine-drainage waters, trace elements are often present in much higher concentrations.

trophic level.--A stage of nourishment representing one of the segments of the food chain.

valence.--Pertaining to the combining capacity or oxidation state of an atom. Valence may be positive or negative. Oppositely charged atoms will combine in the proper proportions to form neutral molecules: Zn^{++}(+2 valence) + $CO_3^{=}$(-2 valence) $\rightleftarrows$ $ZnCO_3$.

vein.--An epigenetic mineral filling of a fracture in a host rock, in tabular or sheetlike form.

yellow boy.--The pale-yellow to orange coating of ferric hydroxide commonly found covering the bottoms of streams affected by mine drainage.

LIST OF MINERAL NAMES AND FORMULAE

alabandite. . . . . . . MnS

argentite . . . . Ag_2S

arsenopyrite. . . . . . $FeAsS$

calaverite. . . . . . . $AuTe_2$

carnotite . . . . $K(UO_2)_2(VO_4)_2 \cdot 3H_2O$

chalcopyrite. . . . . . $CuFeS_2$

chlorite. . . . . $(Mg,Fe,Al)_6(Al,Si)_4O_{10}(OH)_8$

cinnabar. . . . . HgS

covellite . . . . CuS

ferberite . . . . $FeWO_4$

galena. . . . . PbS

greenockite . . . . . . CdS

gypsum. . . . . $CaSO_4 \cdot 2H_2O$

huebnerite. . . . . . . $MnWO_4$

hydromica . . . . $(K,H_3O^+)(Al)_2AlSi_3O_{10}(OH)_2$

magnetite . . . . Fe_3O_4

marcasite . . . . FeS_2

molybdenite . . . . . . MoS_2

montroseite . . . . . . $VOOH$

niccolite . . . . $NiAs$

polydymite. . . . . . . Ni_3S_4

proustite . . . . Ag_3AsS_3

pyrargyrite . . . . . . Ag_3SbS_3

pyrite. . . . . FeS_2

LIST OF MINERAL NAMES AND FORMULAE--Continued

roscoelite.	$KV_2AlSi_3O_{10}(OH)_2$
smaltite.	$(Co,Ni)As_{3-x}$
sphalerite.	ZnS
tennantite.	$(Cu,Fe)_{12}As_4S_{13}$
tetrahedrite.	$(Cu,Fe)_{12}Sb_4S_{13}$

EFFECT OF MINE DRAINAGE ON THE QUALITY OF STREAMS IN COLORADO, 1971-72

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ABSTRACT

Most of the metal deposits in Colorado are predominantly complex ore, a mixture of copper, lead, zinc, and silver sulfides, and native gold. Pyrite (FeS_2) associated with this complex ore oxidizes to yield acid water containing high concentrations of iron and sulfate; this water is commonly known as mine drainage. The oxidation of the other metal sulfides under acid conditions releases high concentrations of trace elements to the water, but no additional acidity. Because Colorado presently has no trace-element standards for waters classed as cold-water fisheries, criteria that might be used by State agencies in developing standards are presented.

Field observations of temperature, specific conductance, pH, stream-bottom conditions, and aquatic biota at 995 stream sites in Colorado during 1971-72 were used as a guide in collecting 192 samples for analysis of sulfate and dissolved trace elements. These data and additional data to be published in a subsequent report indicate that approximately 450 miles (724 kilometers) of streams in 25 different areas are adversely affected by metal-mine drainage. Coal-mine drainage is not a problem, apparently because of the low sulfur content of Colorado's coal.

Manganese, selenium, and sulfate concentrations, and specific conductance appear to be poor indicators of mine drainage because natural sources can cause the values of these parameters to be high even in relatively undisturbed areas. Of the trace elements for which the U.S. Public Health Service (1962, 1970) has established drinking water standards, cadmium exceeds its limit in more than 12 percent of the samples, while arsenic and lead exceed their limits in only 1-3 percent of the samples. Mercury and silver standards are not surpassed; chromium was not detected. Copper and zinc appear to present the greatest danger insofar as toxicity to resident aquatic life is concerned. Acid production is less of a problem in Colorado streams draining metal-mining areas than in streams draining the coal-mining areas of Appalachia.

INTRODUCTION

Metal and coal mining have been important factors in the economic development of Colorado for more than a century. It is only recently, however, that much consideration has been given to the effects of these industries on the environment. One possibility is the deterioration of surface-water quality as a result of low pH and high concentrations of trace elements (see the Glossary for the definition of trace elements as used in this report) which occur in drainage originating from mining and milling operations. As a result, the water may be rendered unsuitable as a fishery, for irrigation, and for domestic and many industrial uses. In a State where the surface-water resource contributes 79 percent of the public supply and 85 percent of the total supply (Murray and Reeves, 1972), such a problem deserves serious consideration.

Previous studies (Theobald and others, 1963; U.S. Public Health Service, 1965; Bingham, 1966, 1967, 1968; Colorado Game, Fish and Parks Div., 1969; Goettl and Sinley, 1970; Rouse, 1970; Upper Colorado Region State-Federal Inter-Agency Group, 1970; U.S. Forest Service, 1971; Goettl and others, 1971, 1972, 1973) have concerned themselves either incidentally with the effects of mine drainage (see the Glossary for the definition of mine drainage as used in this report) on surface-water quality, or they have been restricted as to the area or areas studied. No statewide appraisal of the problem has previously been attempted. Moreover, estimates of stream distances affected vary widely, namely from 120 miles (193 km) for Western-slope streams only (Upper Colorado Region State-Federal Inter-Agency Group, 1970, p. 81) to between 500 miles (804 km) and 1,000 miles (1,609 km) for the entire State (Colorado Game, Fish and Parks Div., written commun., 1970, 1971). Were the problem accurately defined, it would be possible to establish priorities for stream restoration.

English units in this report may be expressed as metric units by use of the following conversion factors:

From	Multiply by	To obtain
miles	1.609	kilometers (km)
feet	.3048	meters (m)
tons	.9072	metric tons (mt)
pounds	.4536	kilograms (kg)

PURPOSE AND SCOPE

In July 1971, a study of the effects of mine drainage on Colorado's streams was begun in cooperation with the Colorado Water Pollution Control Commission. The objectives of this study were to determine the extent and magnitude of the problem as a whole, and to gain a greater understanding of the processes and their potential ramifications by detailed definition of problems in specific areas. In order to accomplish these objectives, a three-pronged approach was devised to include: (1) a reconnaissance of the entire State to locate problem areas, (2) the detailed study of selected problem areas on a short-term basis, and (3) the monitoring of selected problem areas on a long-term basis.

This report summarizes the results of the reconnaissance phase. It describes some basic physical, chemical, and biological water-quality characteristics of the streams, discusses observed effects of mine drainage on the surface-water environment, delineates problem areas, and provides a list of streams where intensive study and subsequent monitoring might provide further insight into the various problems encountered.

BACKGROUND

Physiographically, Colorado is divided into three provinces: the Great Plains which cover the eastern part of the State, the Rocky Mountains which traverse the west-central part from north to south, and the Colorado Plateau to the far west (fig. 1). Each province reflects different processes of formation and, as such, conveys its own topographic and geologic expression.

The Great Plains surface slopes gently eastward, from 6,000 feet (1,829 m) to 7,000 feet (2,134 m) above sea level near the mountain front to 3,500 feet (1,067 m) to 4,000 feet (1,219 m) at the Colorado-Kansas border. With few exceptions, the topography is relatively flat, whereas the sedimentary rocks beneath are gently folded. These rocks, which overlie the Precambrian basement, range from less than 1,000 feet (305 m) to greater than 14,000 feet (4,267 m) thick (Jensen, 1972) and represent all periods of the geological column except for the Silurian (table 1).

At approximately 105° west longitude, the Rocky Mountains rise abruptly from the Great Plains in a slightly sinuous north-south line. These conspicuous topographic features were formed as a result of uplift which occurred during the Laramide orogeny and by subsequent erosion. The Laramide orogeny is considered by Tweto (1968, p. 562) to extend from Late Cretaceous to middle Eocene time.

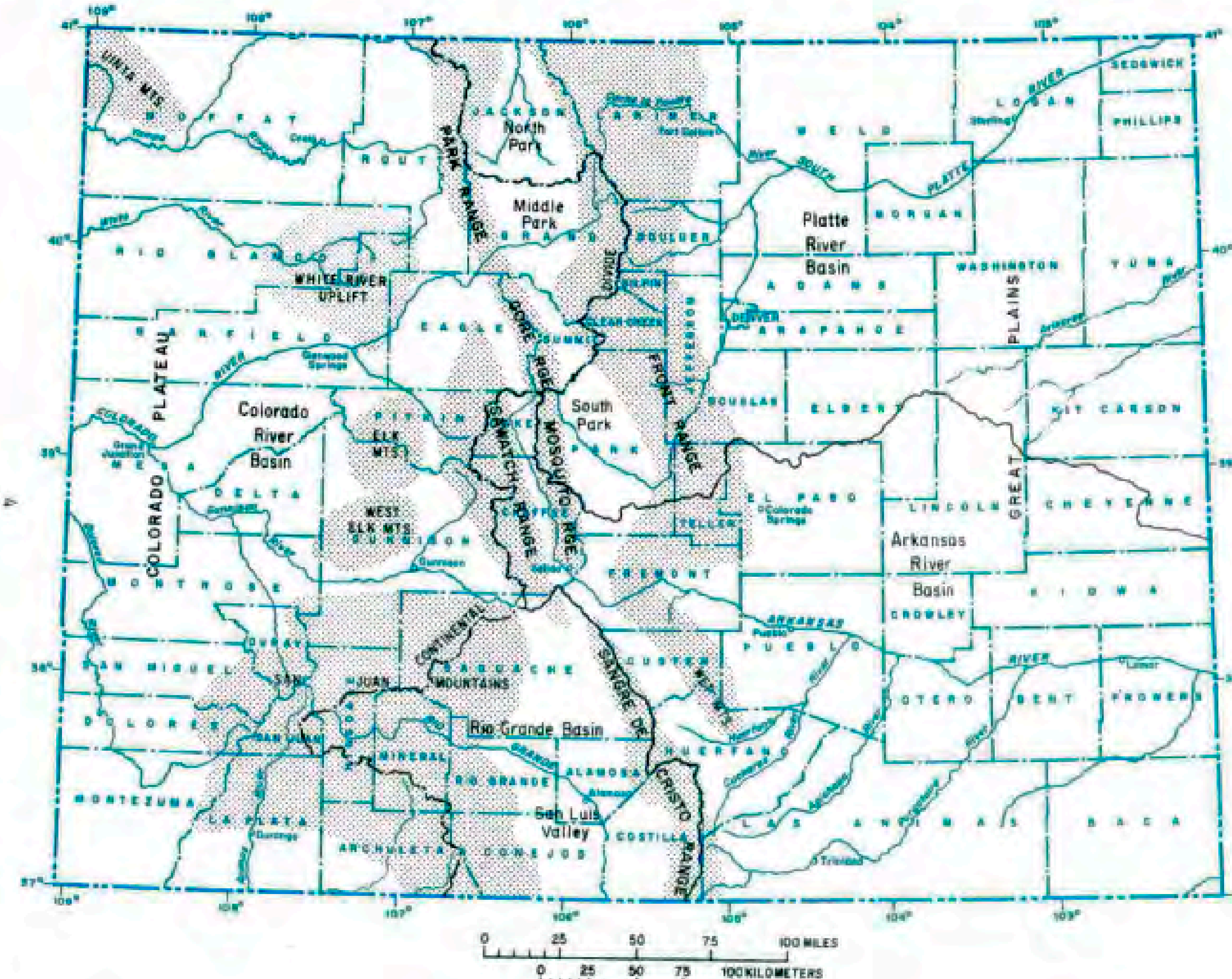

Figure 1.--Physiographic features of Colorado (modified after Fennenman, 1931, and Tweto. 1968).

Table 1.--*Major stratigraphic and time divisions*

[From Geologic Names Committee, 1972]

Subdivisions in use by the U.S. Geological Survey			Age estimates commonly used for boundaries (in million years)[1]	
Era or Erathem	System or Period	Series or Epoch	(A)	(B)
Cenozoic	Quaternary	Holocene		
		Pleistocene	1.5-2	1.8
	Tertiary	Pliocene	ca. 7	5.0
		Miocene	26	22.5
		Oligocene	37-38	37.5
		Eocene	53-54	53.5
		Paleocene	65	65
Mesozoic	Cretaceous[3]	Upper (Late) Lower (Early)	136	
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195	
	Triassic	Upper (Late) Middle (Middle) Lower (Early)	225	
Paleozoic	Permian[3]	Upper (Late) Lower (Early)	280	
	Pennsylvanian[3]	Upper (Late) Middle (Middle) Lower (Early)	320[2]	
	Mississippian[3]	Upper (Late) Lower (Early)	345	
	Devonian	Upper (Late) Middle (Middle) Lower (Early)	395	
	Silurian[3]	Upper (Late) Middle (Middle) Lower (Early)	430-440	
	Ordovician[3]	Upper (Late) Middle (Middle) Lower (Early)	ca. 500	
	Cambrian[3]	Upper (Late) Middle (Middle) Lower (Early)	570	
Precambrian	Time subdivisions of the Precambrian: Precambrian Z--base of Cambrian to 800 m.y. Precambrian Y--800 m.y. to 1,600 m.y. Precambrian X--1,600 m.y. to 2,500 m.y. Precambrian W--older than 2,500 m.y.			

[1]Estimates for ages of time boundaries are under continuous study and subject to refinement and controversy. Two scales are given for comparison:

(A) Geological Society of London, 1964, The Phanerozoic time-scale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, suppl., p. 260-262.

(B) Berggren, W. A., 1972, A Cenozoic time-scale--some implications for regional geology and paleobiogeography: Lethaia, v. 5, no. 2, p. 195-215.

In addition to these, a useful time scale for North American mammalian stages is given by:

Evernden, J. F., Savage, D. E., Curtis, G. H., and James, G. T., 1964, Potassium-argon dates and the Cenozoic mammalian chronology of North America: Am. Jour. Sci., v. 262, p. 145-198.

[2]From Table 1: Correlation chart for the Carboniferous of north-west Europe, Russia, and North America: Geol. Soc. London, 1964[1], p. 222.

[3]Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms--early, middle, and late--may be used for the eras, for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms--lower, middle, and upper--may be used where there is no formal subdivision of an era, system, or series.

The Laramide orogeny was characterized by large-scale uplift, folding, and faulting, with localized movements forming the majority of the presently recognized mountain ranges (fig. 1). These are commonly known as faulted anticlines. Most of the sedimentary cover was subsequently eroded from the mountain tops into the intermontane basins or onto the Great Plains, thus exposing the underlying Precambrian igneous and metamorphic rocks. The major exception to the above is the San Juan Mountains: these were formed at the edge of the Colorado Plateau in the southwestern part of the State by volcanic activity during the middle Tertiary (Burbank and others, 1947).

Altitudes in excess of 14,000 feet (4,267 m) are reached by about 50 peaks in the Colorado Rockies, where even the large intermontane basins are 7,500 feet (2,286 m) to 10,000 feet (3,048 m) above sea level. The Continental Divide (fig. 1) runs through the State along the mountain summits, partitioning it into western and eastern slopes: water falling on one side flows into the Colorado River and thence to the Pacific Ocean; on the other side, water flows into the Rio Grande and the Platte and Arkansas Rivers to the Gulf of Mexico.

The western boundary of the Rockies is not nearly as distinct as that on the east. On the west, the country flattens gradually into the broad flat-topped mesas and deep intervening canyons characteristic of the Colorado Plateau. Altitudes of the mesas range from 6,000 feet (1,829 m) to 10,000 feet (3,048 m) with 1,500 feet (457 m) to 4,000 feet (1,219 m) of relief to the valleys below. Exposed rocks are predominantly sedimentary, and, except for minor folding and faulting, they are relatively undeformed.

Geologic Environment of Mineral Deposition

As expected from the topographic and geologic differences within the State, there are also differences in the associated mineral deposits. General summaries of these deposits have been prepared by Vanderwilt (1947), Landis (1959), Del Rio (1960), the U.S. Congress (1964), Tweto (1968), and the U.S. Geological Survey (1971). This report is concerned only with metal and coal deposits and the drainage from them that is detrimental to surface-water quality.

Colorado Mineral Belt

Most of the metal mining in Colorado has occurred within a region commonly known as the Colorado mineral belt. This is a narrow, irregularly shaped area extending diagonally across the State from near Durango in the San Juans to Boulder in the Front Range (fig. 2). It is, in general, at a rather high altitude, containing or paralleling the Continental Divide throughout most of its length.

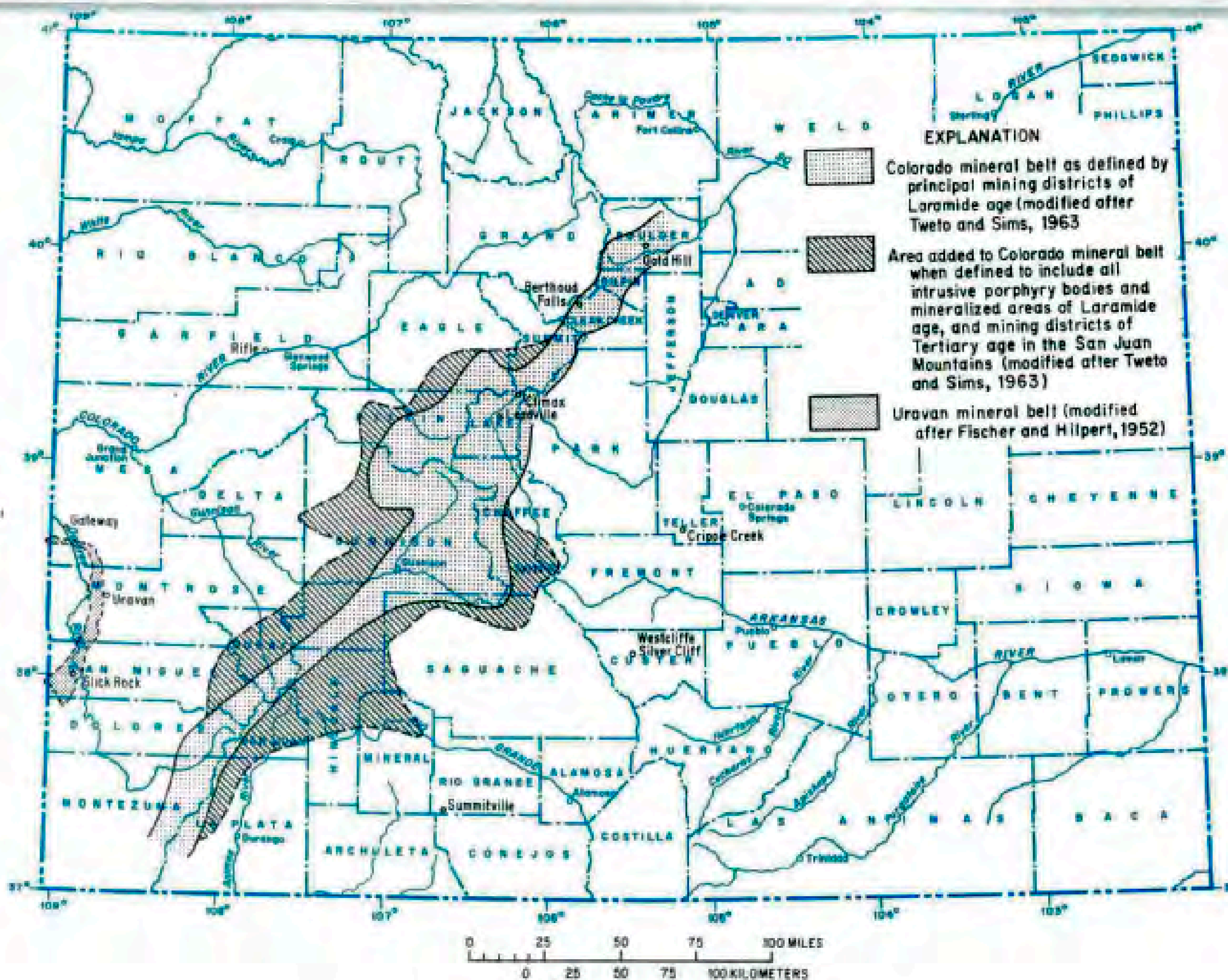

Figure 2.--Colorado and Uravan mineral belts.

The belt coincides with a zone of weakness characterized by Precambrian shear zones of northeasterly trend (Tweto and Sims, 1963). During the Laramide orogeny, magma ascended along faults and fractures, imparting to the mineral belt its characteristic features--intrusive igneous rocks (typically porphyries) and associated ore deposits. Moreover, a second period of intrusive igneous activity appears to have occurred during the Oligocene, in association with the creation of the San Juan Mountains (Tweto, 1968).

Metal Deposits

Consistent with the events contributing to the formation of the mineral belt, non-sedimentary metal deposits in Colorado are generally considered to be of three distinct ages: Precambrian, Laramide, and post-Laramide or Oligocene (Tweto, 1968). Typical of all of these is an assemblage characterized by the close association of certain base metals (copper, lead, zinc) and precious metals (gold, silver). This assemblage is commonly termed "complex ore" (U.S. Congress, 1964, p. 29).

The complex ores can vary considerably in the relative proportions of the various metals present; however, except for gold, all exist primarily as sulfides (Bergendahl, 1964). Lead and zinc commonly occur together as galena (PbS) and sphalerite (ZnS). Copper is found in several forms, including chalcopyrite ($CuFeS_2$), tennantite [$(Cu,Fe)_{12}As_4S_{13}$], and tetrahedrite [$(Cu,Fe)_{12}Sb_4S_{13}$]. Although widely distributed, the copper is usually present in relatively small amounts. Silver occurs as argentite (Ag_2S), ruby silver, and as a substitution product in other metal sulfides. It also exists less commonly as native silver, usually in association with native gold. The latter is the most common form of gold in complex ores, although gold telluride minerals [for example, calavarite ($AuTe_2$)] are important in some areas.

The Precambrian ore deposits are relatively small. The more important of these are epigenetic contact metamorphic deposits, representing local, rather than widespread, mineralization. They contain metal sulfides in association with mafic rocks and are mined chiefly for copper (chalcopyrite), although deposits in the vicinity of Gold Hill contain considerable nickel (primarily polydimite, Ni_3S_4) and some cobalt.

The ores formed during the Laramide are mesothermal veins and replacement deposits. Sulfide veins in the Precambrian rocks are valuable chiefly for precious metals (gold and silver) and are usually of high grade. Veins and replacement deposits in the younger sedimentary rocks are characterized by complex ores, usually in association with pyrite (FeS_2). Oxidation of galena and sphalerite to secondary lead and zinc carbonates, however, is not unusual in limestones and dolomites, as in the Leadville area (Bergendahl, 1964).

Ores deposited during the Oligocene appear to be epithermal in origin. Included among these are the ferberite ($FeWO_4$) tungsten veins and the gold-silver telluride veins in the mineral belt west of Boulder, the molybdenite (MoS_2) stockworks at the Urad Mine west of Berthoud Falls and [with associated huebnerite ($MnWO_4$)] at Climax, and precious- and base-metal veins and pipes in volcanic rocks. The latter are found principally within the mineral belt in the San Juan Mountains. Also, at least three important volcanic deposits are known from outside the San Juan area. These occur at Summitville, Cripple Creek, and Westcliffe-Silver Cliff. Though subordinate to gold and silver, the majority of the volcanic complex ores contain appreciable amounts of base metals. Moreover, the occurrence of gold as a telluride mineral is not uncommon. For example, the veins at Cripple Creek are characterized by this gold-telluride association, and gold has been virtually the only product of this area.

In contrast to the previous discussion, Colorado's vanadium is largely the product of a sedimentary environment. The vanadium is generally closely associated with uranium, and is found primarily in the Salt Wash Sandstone Member of the Morrison Formation and within the boundaries of the Uravan mineral belt (fig. 2). This mineral belt is an area of the Colorado Plateau where the ". . . carnotite [$K(UO_2)_2(VO_4)_2 \cdot 3H_2O$] deposits generally have closer spacing, larger size, and higher grade than those in the adjoining areas and the region as a whole" (Fischer and Hilpert, 1952, p. 3); it extends from Gateway, through Uravan, to Slick Rock.

Although carnotite is the principal uranium ore found in the oxidized zone throughout the Uravan mineral belt, it is relatively unimportant as a source of vanadium (Colorado School of Mines Research Foundation, Inc., 1961; Motica, 1968). The primary vanadium ores, that is, those contained in the unoxidized zone below the water table, are characterized by low-valent vanadium in clays and oxides; they are accompanied by copper, iron, lead, and zinc sulfides, arsenides, and selenides. The vanadiferous clays consist of chlorite [$(Mg,Fe,Al)_6(Al,Si)_4O_{10}(OH)_8$] and hydromica [$(K,H_3O^+)(Al)_2AlSi_3O_{10}(OH)_2$] in which vanadium substitutes for aluminum. The oxide montroseite (VOOH) is also of considerable importance. The vanadium silicates are relatively unaffected during oxidation; however, montroseite does yield secondary vanadates, principally those of calcium and uranium.

Somewhat surprisingly, the largest vanadium deposit in Colorado is found outside the Uravan mineral belt in the Entrada and Navajo(?) Sandstones near Rifle (Fischer, 1964). The ore minerals here are similar to those just discussed, except that there is, in addition, an abundance of roscoelite [$KV_2AlSi_3O_{10}(OH)_2$] and an associated micaceous chromium-bearing mineral. Roscoelite-containing gold telluride veins and vanadium-bearing titaniferous magnetites are also known in Colorado, but they are relatively unimportant as ores.

Coal Deposits

Coal deposits, like most of the aforementioned types of vanadium deposits, are also associated with periods of deposition. The generally accepted sequence which leads to the formation of coal begins with plant debris, usually terrestrial in origin, accumulating in swampy areas. The organic matter undergoes partial decomposition via microbial activity to humic substances (peat stage). This results in an anaerobic environment characterized by Eh values from -0.1 to -0.5 volt and pH values from 6 to 7 (Krauskopf, 1967, p. 314-315). Eventually, the humic materials are covered by accumulating sediments, and the formation processes change from biotic to abiotic in nature.

Degens (1965) favors heat in the form of the geothermal gradient as the primary abiotic force involved in the alteration of peat to coal; whereas Breger (1958) is concerned with the role of pressure, particularly as a result of shear forces. Whatever the mechanism, the eventual result is usually a coal in the sequence from lignite through subbituminous to bituminous. Although this ranking is based on increased carbon content, it also approximates increased disappearance of plant material, increased hardness, and increased ash content. Moreover, the implication of a progression through a continuous series with increased time, temperature, and pressure may be valid for most coals; however, there is no evidence that this is always true. Anthracite, which is of higher rank than bituminous coal, is formed under metamorphic conditions.

Coal is a mixture of organic compounds characterized by high molecular weight, a high percentage of carbon, and lesser percentages of hydrogen, oxygen, nitrogen, and, usually, sulfur. The sulfur occurs primarily in organic combination, as calcium and iron sulfate, and as pyrite and marcasite (FeS_2, a polymorph of pyrite) (Walker and Hartner, 1966). As will be seen later, it is the latter two minerals which result in the acid conditions often associated with coal-mine drainage. Trace elements in coal have been discussed by several investigators, including Breger (1958), Averitt (1969), and Szilagyi (1971).

The coal found in Colorado is mostly bituminous and subbituminous, though some anthracite is found west and northwest of Crested Butte where the coal reserves intersect the Colorado mineral belt (fig. 3). Total reserves are large and widely distributed: 28 percent of the State is underlain by coal-bearing strata (Landis, 1964), all of Cretaceous and early Tertiary age. Descriptions of the various coal fields are given by Landis (1959, 1964).

Mining in Colorado: Past, Present, Future

Colorado's mining industry was born with the discovery of gold in 1858 near the present city of Denver, and it has had a significant impact on the State's economy since that time. In 1970, for example, Colorado ranked first among all the States in total production of molybdenum and

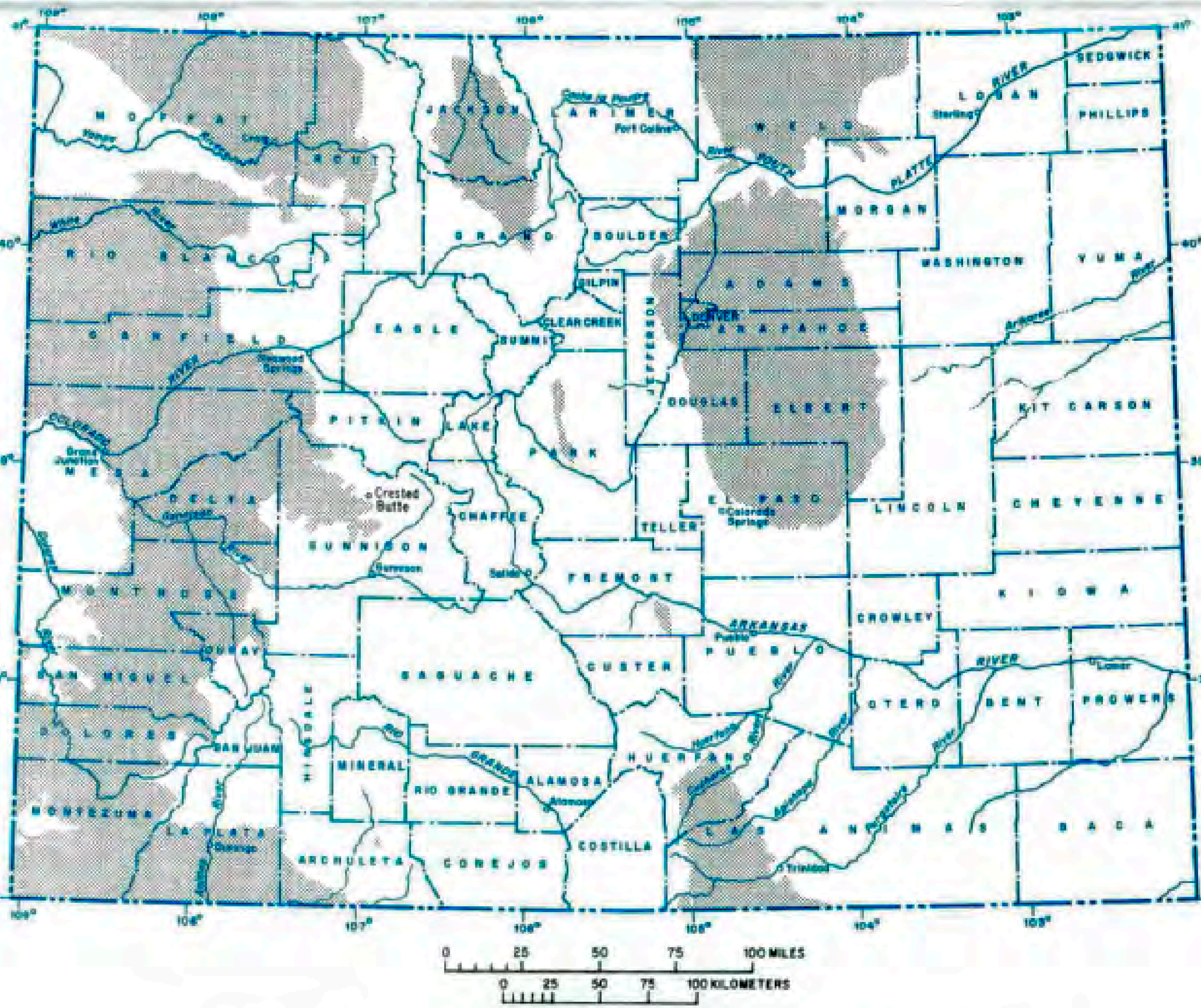

Figure 3.--Coal regions (shaded) of Colorado (modified after Landis, 1959).

vanadium, second in tungsten, third in zinc, fourth in lead, fifth in gold and silver, and ninth in copper (U.S. Bur. Mines, 1970). Trends in the production of these commodities from 1870 through 1970 are presented in figure 4. These data show the initial dominance of the precious metals, eventually yielding to that of the ferroalloy metals (tungsten, molybdenum, and vanadium) during the 1940's. Iron and manganese have generally accounted for less than 2 percent of Colorado's ferroalloy-metal production (Colorado Bur. Mines, 1970) and are not included here. The only ferroalloy-metal production recorded prior to 1944 was in 1924 when $4 million worth of tungsten, molybdenum, and vanadium was mined. Copper, lead, and zinc production has gradually increased since 1870, except for a short period during the 1930's; however, base metals have never been the major product of Colorado's metal-mining effort.

For the year 1971, the Colorado Bureau of Mines (1972) reported approximately 230 mines and 30 mills which were actively engaged in the extraction of precious, base, and ferroalloy metals. Were these the only concern of this investigation, an assessment of the impact on surface-water quality would be a relatively simple matter. After all, a great deal of information is available regarding the nature of these active operations. Unfortunately, the problem is considerably compounded and confounded by the many abandoned metal-mining endeavors which pock Colorado's landscape. The number of these in existence is not accurately known, but estimates run as high as 30,000 (Colorado Dept. Health, no date).

The outlook for metal mining in Colorado is bright. For example, Tweto (1968) indicates good possibilities for the discovery of new base- and precious-metal deposits, particularly in the San Juan Mountains. Molybdenum will apparently continue to play a dominant role, as evidenced by the Henderson project under construction for the AMAX Company on both sides of the Continental Divide west of Berthoud Falls. Finally, with restrictions recently having been lifted on the free-market price of gold, there has been speculation that it may be economically feasible to reopen some of the presently inactive gold mines.

The mining of coal in Colorado began in the 1860's in response to permanent settlements which grew out of the early gold rush. Figure 5 shows production figures for the years 1864 to 1970 and indicates that there was a gradual increase in coal production until 1910. Thereafter began a general decline, though there were two brief periods of intensification in response to the stimulated economy of the World Wars: the peak production of 12,658,055 tons (11,483,388 mt) was recorded in 1918 (Colorado Dept. Nat. Resources, 1971). Production leveled off at an average of about 3.4 million tons per year (3.1 million mt per year) during the 1950's and early 1960's, and since that time has undergone only a slight revitalization. In 1971, the coal yield of 5,307,271 tons (4,814,756 mt) was fourth in dollar value ($30,251,443) among all mineral commodities of Colorado, being exceeded only by molybdenum, petroleum, and sand and gravel (Colorado Bur. Mines, 1972).

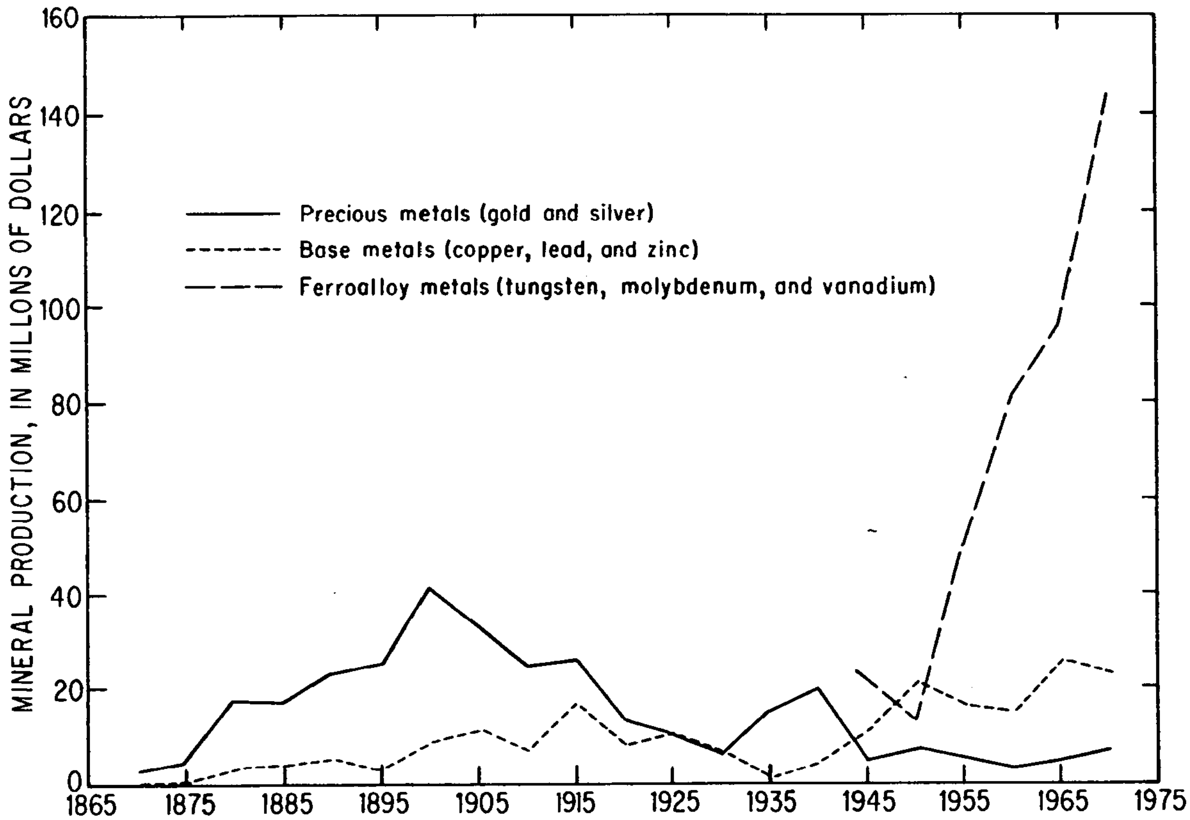

Figure 4.--Production of precious, base, and ferroalloy metals in Colorado from 1870 through 1970 (data from Colorado Bur. Mines, 1970; only every fifth year plotted).

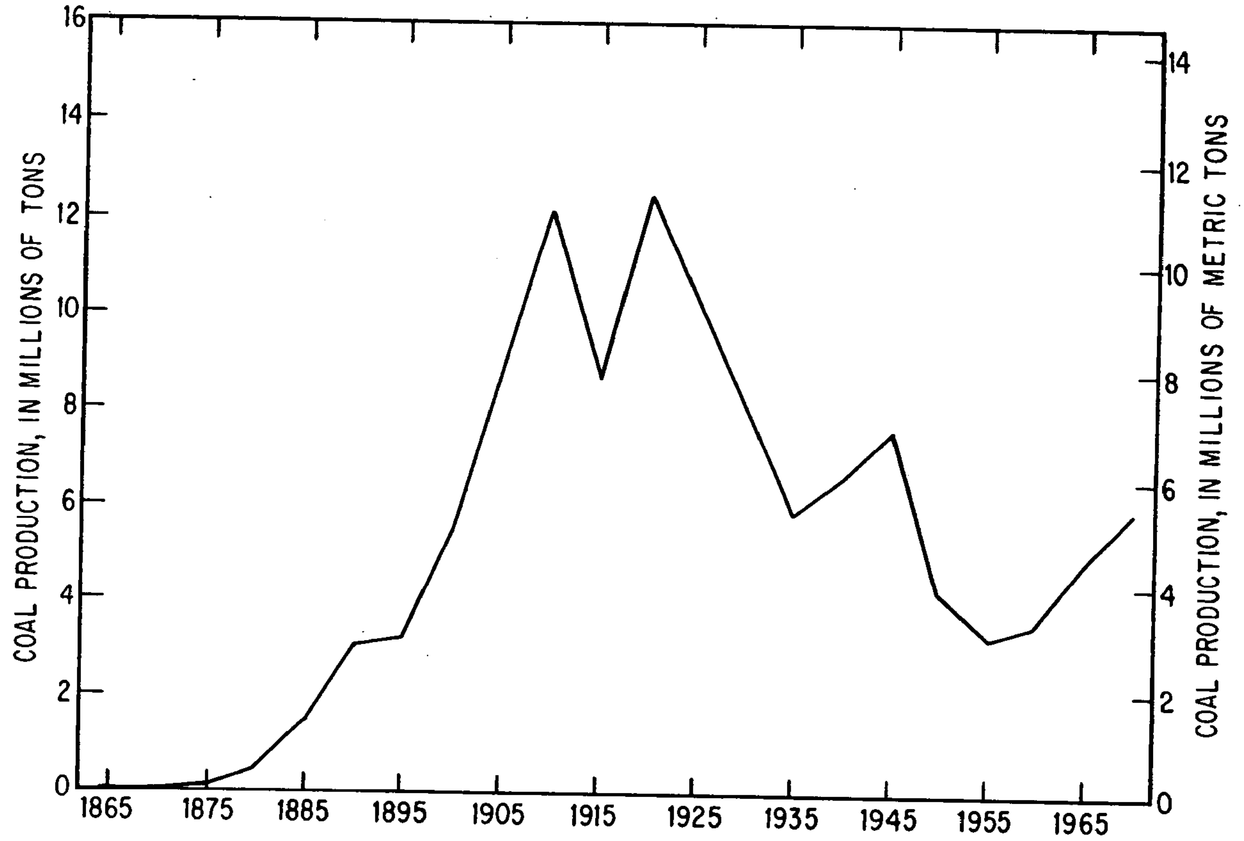

Figure 5.--Production of coal in Colorado from 1864 through 1970 (data from Colorado Dept. Nat. Resources, 1971; only every fifth year plotted).

Colorado ranked twelfth in combined bituminous coal and lignite production in 1970 (U.S. Bur. Mines, 1970). This production resulted from 48 active mines, of which 40 were underground and the rest were strip operations. No information is available regarding the number and location of abandoned coal-mining operations in the State.

The future of bituminous coal production in Colorado appears to be good: Colorado presently ranks seventh in recoverable reserves (U.S. Bur. Mines, 1970). Moreover, most of Colorado's coal is used for electric-power production and for domestic and industrial heating; it is not likely that these uses will be curtailed in the near future.

The Process of Acid Formation and Trace Element Liberation

Theoretically, the degradation of water quality so often associated with metal- and coal-mining operations would not manifest itself if the metal-sulfide minerals were allowed to remain in the reducing environments under which they were formed. Problems arise only when these minerals become oxidized, as when they are transported to the earth's surface.

Because of the common association of pyrite and marcasite with coal in the Appalachian region of the eastern United States, a great deal of research has been conducted regarding the oxidation mechanism of FeS_2 (Coal Industry Advisory Comm., 1965, 1968, 1970). A review of the present state of knowledge in this field has been compiled by the Ohio State University Research Foundation (1971).

Coal-Mine Drainage

The model presented here for the oxidation of FeS_2 is essentially that proposed by Stumm and Morgan (1970, p. 540-542); it is summarized in figure 6. The individual stoichiometric reactions which comprise the model are given below (equation numbers refer to those in fig. 6):

$$FeS_{2(s)} + \frac{7}{2}O_2 + H_2O \rightleftarrows Fe^{++} + 2SO_4^{=} + 2H^+, \quad (1)$$

$$Fe^{++} + \frac{1}{4}O_2 + H^+ \rightleftarrows Fe^{3+} + \frac{1}{2}H_2O, \quad (2)$$

$$Fe^{3+} + 3H_2O \rightleftarrows Fe(OH)_{3(s)} + 3H^+, \quad (3)$$

$$FeS_{2(s)} + 14Fe^{3+} + 8H_2O \rightleftarrows 15Fe^{++} + 2SO_4^{=} + 16H^+. \quad (4)$$

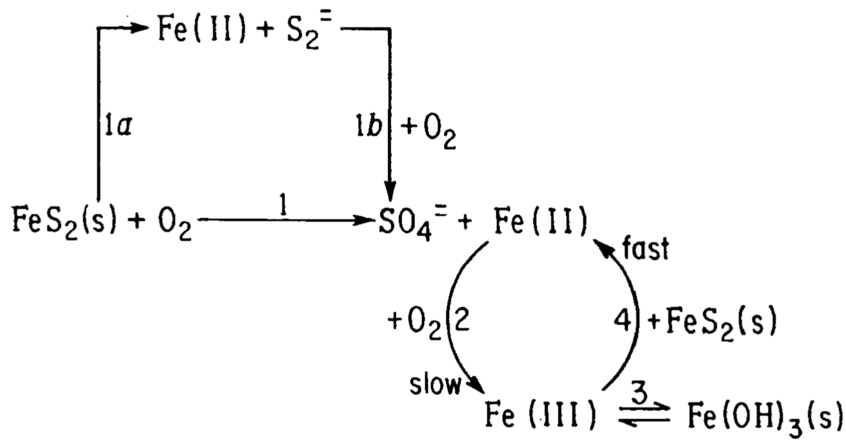

Figure 6.--Chemical model for the oxidation of pyrite in coal-mine drainage (after Stumm and Morgan, 1970, p. 541).

During the mining operation, pyrite is exposed to air and water. The $S_2^{=}$ is oxidized (reaction 1), thus releasing sulfate, acidity (H^+), and ferrous iron (Fe^{++}) to the water. An alternate view is that the FeS_2 first dissolves in water, and the sulfur is then oxidized (reactions 1*a* and 1*b*, fig. 6). The results are the same by either pathway. The dissolved ferrous iron is subsequently oxidized to ferric iron (Fe^{3+}) via reaction 2. Ferric iron is extremely insoluble in the normal pH range and largely precipitates (reaction 3) as a hydrous ferric oxide [very often represented as ferric hydroxide, $Fe(OH)_3$, though it may be more complex than this]. This process causes the substrate of adits and streams to be covered with a pale-yellow to orange coating commonly known to the miners as "yellow boy." In addition, the hydrolysis leading to the above precipitation (reaction 3) releases additional acidity to the water.

The sum of reactions 1 through 3,

$$FeS_{2(s)} + \frac{15}{4}O_2 + \frac{7}{2}H_2O \rightleftarrows Fe(OH)_{3(s)} + 2SO_4^{=} + 4H^+, \qquad (5)$$

shows a net of 4 moles of H^+ liberated for each mole of FeS_2 oxidized--2 from the oxidation of sulfur and 2 from the oxidation of iron. This is one of the most acidic weathering reactions known.

Reaction 5 is a useful representation of the overall process, in that it focuses attention on the primary reactants (FeS_2 and oxygen) and the ultimate products (yellow boy and sulfuric acid). It is somewhat misleading, however, in that reactions 1, 2, and 3 do not necessarily occur at the same location. In a strip mine, for example, reaction 1 would occur as water percolates through the spoil; whereas in a draining, abandoned drift mine, this same reaction might occur at the FeS_2 surface deep within the ground. Reaction 3, on the other hand, would likely be more important after the draining water has issued into a receiving stream and pH values have increased as a result of carbonate buffering and dilution.

Reaction 4 shows that ferric iron, once formed, can also oxidize FeS_2, itself being reduced to the ferrous form. The overall oxidation of FeS_2 by this pathway includes not only reaction 4 but also reaction 3 plus 15 times reaction 2 (the latter to account for the 15 moles of ferrous iron produced by reaction 4). The result is the same as given in reaction 5.

The relative importance of oxygen versus ferric iron as the oxidizing agent which attacks the FeS_2 is still not clear. Previous studies have been summarized by Smith (1971), who notes that both possibilities are adequately described by models based on the sorption of the oxidant onto the FeS_2 surface. The reaction sites appear to be different, and the oxidation rates by the two mechanisms are independent. In the case of oxidation by molecular O_2, the reaction rate increases with O_2 concentration and with pH's above 3. In the case of oxidation by ferric iron, the rate increases with Fe^{3+}/Fe^{++} ratio and with total dissolved iron concentration. These latter two variables are complexly related to the Eh, pH, and chemical composition of the aqueous environment in question (Stumm and Morgan, 1970, p. 173, 186; Hem, 1972). However, both the Fe^{3+}/Fe^{++} ratio and the total iron tend to decrease with increasing pH because of solubility controls, the effect on total iron being the more dramatic of the two. The pH effect is particularly important in the range from about 2 to 4, where the amount of Fe^{3+} in equilibrium with $Fe(OH)_3$ decreases from about 4,000,000 to 4 µg/l.

Singer and Stumm (1970) have reported that the oxidation rate of pyrite in the presence of Fe^{3+} is the same regardless of whether or not oxygen is excluded from the system. Conversely, they have also shown that this same oxidation does not occur at a detectable rate in the absence of ferric ions. Based on this and the information presented previously by Smith (1971), it appears that Fe^{3+} oxidation is the principal mechanism of FeS_2 breakdown and that direct oxidation by molecular O_2 is important only in highly oxidizing environments at pH values somewhere above 3. However, it is important to remember that molecular O_2 also plays a significant, though indirect, role in the oxidation of FeS_2 by Fe^{3+}, since it is the O_2 which converts the Fe^{++} produced in reaction 4 back to Fe^{3+} again. The distinction being made above is, as stated, purely mechanistic.

Moreover, since the system of interest is likely not at equilibrium (the environment of a draining mine to a greater or lesser degree is always open to the atmosphere), the rate of FeS_2 oxidation by molecular O_2 is dependent on both the rate of oxygen transfer to the FeS_2 surface and on the rate of reaction 1. Alternatively, when ferric iron is the oxidant of interest, the rate of FeS_2 oxidation is a function of (1) the rates of both oxygen and ferric iron transfer to their respective reaction sites, and (2) the rates of reactions 2 and 4.

Neglecting transport limitations, reaction 2 appears to be the rate-determining step in the latter case (Singer and Stumm, 1970). This rate is a rather sensitive function of hydrogen ion concentration, decreasing with pH down to about 4.5 according to the expression

$$-\frac{d[Fe^{++}]}{dt} = k[Fe^{++}][O_2][OH^-]^2,$$

$$= \frac{k[Fe^{++}][O_2]K_w^2}{[H^+]^2}, \qquad (6)$$

where t is time, k is the rate constant, K_w is the dissociation constant for water, and the brackets [] represent concentrations of the various chemical species. From pH 4.5 to 3.5 there is a transition to the relationship

$$-\frac{d[Fe^{++}]}{dt} = k'[Fe^{++}][O_2]. \qquad (7)$$

Equation 7 holds at pH values less than 3.5; here the reaction is extremely slow and independent of pH.

Thus, in order for ferric ion oxidation of FeS_2 to be relatively more important than direct O_2 oxidation at pH's below 3.5, something must accelerate the rate of Fe^{++} conversion to Fe^{3+}. Stumm and Lee (1961) found that dissolved Cu^{++}, Mn^{++}, and Co^{++} would increase the Fe^{++} oxygenation rate significantly, as would anions which form complexes with the Fe^{3+} produced, for example $H_2PO_4^-$. Singer and Stumm (1970), however, have determined that micro-organisms are considerably more efficient at catalyzing the reaction: they noted rate increases of greater than 10^6 times due to microbial activity.

The micro-organisms involved are *Ferrobacillus ferrooxidans, F. sulfooxidans*, and *Thiobacillus ferroxidans* (Silverman and Ehrlich, 1964). These are aerobic, acidophilic, chemoautotrophic bacteria which obtain energy from the oxidation of Fe^{++} much as photosynthetic organisms use energy from the sun. Since this is a rather inefficient process, large amounts of Fe^{++} must be oxidized: 224 g (grams) to create 1 g of bacterial mass (Stumm and Morgan, 1970, p. 557-558). The important point to realize, however, is that the bacteria do not alter the Fe^{++} oxygenation reaction; they merely accelerate it! And, since they cannot compete with the purely chemical reaction above pH 4.5, they are effective only at low pH's where the abiotic rate is slow.

Bacteria of the genera *Leptothrix* and *Gallionella* are filamentous heterotrophic aerobes which live at neutral pH's. These bacteria are also able to oxidize ferrous iron (Brock, 1970), the ferric hydroxide produced being deposited around the bacterial cell. However, they do not gain energy from the oxidation reaction, and they are relatively unimportant in regard to acid formation.

In addition to their role in the ferric conversion of FeS_2 to Fe^{++} and back to Fe^{3+}, the system we have been discussing, there is also evidence to indicate that the *Ferrobacillus-Thiobacillus* group of micro-organisms can biologically mediate the oxidation of sulfide minerals via direct contact (Silverman and Ehrlich, 1964). Strangely enough, however, this mechanism has been shown to work best with iron-free minerals, such as molybdenite and covellite.

Sato (1960) has postulated that the dissolution of pyrite involves the release of neutral diatomic sulfur molecules (S_2^o), as opposed to $S_2^=$ ions. Since the sulfur molecules are unstable, they are immediately converted to higher oxidation states. Bacteria which can utilize such higher oxidation states of sulfur as S^o and $S_2O_3^=$ are well known. They include the aforementioned iron-oxidizing bacteria, *Ferrobacillus sulfooxidans* and *Thiobacillus ferrooxidans*, in addition to the species *T. thiooxidans*, which can oxidize only sulfur compounds (Brock, 1970). Like the others, *T. thiooxidans* is also an aerobic chemoautotroph which is restricted to low pH's.

The dilemma of progressing from pH's above 4.5, where the abiotic oxidation rate of Fe^{++} is significant, to pH's below 3.5, where the *Ferrobacillus-Thiobacillus* group takes over, has been postulated by Walsh and Mitchell (1972) as resolvable by the genus *Metallogenium*. This filamentous iron bacterium catalyzes the ferrous iron oxidation in the pH range from 3.5 to 5.0 with an optimum at pH 4.1.

In summary then, we have the hypothetical situation where oxygen-laden water at a pH near neutral infiltrates a coal seam or spoil bank containing pyritic material. The FeS_2 is oxidized, probably by molecular O_2 at first (reaction 1), thus releasing Fe^{++} and lowering the pH. In addition, large amounts of $SO_4^{=}$ are produced. Some of the Fe^{++} is oxidized abiotically to Fe^{3+} (reaction 2) which in turn also oxidizes FeS_2 (reaction 4). As the pH and the amount of available O_2 decrease, reaction 1 becomes less important. Moreover, the abiotic rate of reaction 2 also decreases, thus limiting oxidation of FeS_2 by Fe^{3+}. However, at this point (about pH 4.5-5) the iron bacterium *Metallogenium* becomes important and catalyzes reaction 2 until a pH of about 3-3.5 is reached. Below this value, the *Ferrobacillus-Thiobacillus* group takes over the catalysis. It is these latter organisms which are responsible for the pH's of less than 3 seen in nature. And, because of the inefficient nature of the Fe^{++} to Fe^{3+} oxidation, these organisms also contribute to the deposition of large amounts of $Fe(OH)_3$ (reaction 3).

Finally, a discussion of the mechanism of FeS_2 oxidation would not be complete without mention of the pathway postulated by Barnes and Clarke (1964) and Barnes and others (1964). These investigators proposed the anaerobic reaction

$$FeS_{2(s)} + 8H_2O \rightleftarrows Fe^{++} + 2SO_4^{=} + 2H^{+} + 7H_2 \qquad (8)$$

to account for pyrite oxidation in northeastern Pennsylvania coal mines. Thermodynamic considerations suggest that such a mechanism might be possible in a system which is not open to atmospheric circulation and which is in contact with organic material, such as coal (see Appendix). However, these restrictions prevent it from having general applicability.

Metal-Mine Drainage

Much of the previous discussion regarding coal-mine drainage is also applicable to areas of metal mining, such as those typically found in Colorado. There is, however, at least one important difference to be considered: the mineral being mined is a metallic ore, usually a metal sulfide, rather than coal. As with coal, however, pyrite is commonly found in close association, and as before, it is the oxidation of the pyrite which causes the acid production. The metal-sulfide ore minerals, such as CuS, PbS, ZnS, and Ag_2S, do not contribute to the formation of acid waters. This is important.

As an example, let us look at the oxidation of sphalerite by molecular O_2. The overall reaction for direct oxidation of the solid in an aqueous, oxygen-bearing solution might be written as follows:

$$ZnS_{(s)} + 2O_2 \rightleftarrows Zn^{++} + SO_4^{=}. \qquad (9)$$

The actual mechanism of this reaction is thought to involve the release of Zn^{++} ions into solution with an increase in the S/Zn ratio in the remaining solid (Sato, 1960):

$$ZnS_{(s)} \rightleftarrows Zn^{++} + S^{o}_{(s)} + 2e^{-}. \qquad (10)$$

When only S^{o} is left, it is then oxidized to $SO_4^{=}$.

Another possibility is for the reaction to occur in two steps, with the sulfide being oxidized after dissolution:

$$ZnS_{(s)} + H_2CO_3 \rightleftarrows Zn^{++} + HS^{-} + HCO_3^{-}, \qquad (11)$$

and

$$HS^{-} + 2O_2 \rightleftarrows SO_4^{=} + H^{+}. \qquad (12)$$

In any event, there is no net liberation of free acidity from this weathering process as there is from the weathering of pyrite. This is a reflection of the apparent difference in the oxidation states of the sulfur associated with the two minerals. In sphalerite and most other common metal sulfides, sulfur occurs as $S^{=}$; in pyrite, it exists as $S_2^{=}$. The respective oxidation reactions of these two species in oxygenated waters indicate the acid production or absence thereof:

(sphalerite) $$S^{=} + 2O_2 \rightleftarrows SO_4^{=}, \qquad (13)$$

(pyrite) $$S_2^{=} + \frac{7}{2}O_2 + H_2O \rightleftarrows 2SO_4^{=} + 2H^{+}. \qquad (14)$$

A second explanation for the above-noted absence of acidity is the lack of a reaction comparable in magnitude to reaction 3. The metal ions Cu^{++}, Pb^{++}, Zn^{++}, and Ag^{+}, for example, do not hydrolyze to the extent that Fe^{3+} does.

However, as explained previously, acid production does result from oxidation of the pyrite associated with the metallic ores; and, as a consequence, large quantities of metals can be brought into solution. At low pH's (for example, less than about 4.5) reaction 11 becomes

$$ZnS_{(s)} + 2H^{+} \rightleftarrows Zn^{++} + H_2S. \qquad (15)$$

Reaction 15 is comparable to reaction 11 with the H^{+} being contributed by the oxidation of FeS_2 rather than from the dissociation of H_2CO_3. The abiotic oxidation of dissolved sulfide is very slow at these low pH values (less than about pH 6 according to Chen and Morris (1972)), and this would limit the extent to which reaction 15 could occur were it not for catalysis by the *Ferrobacillus-Thiobacillus* group of bacteria. The process has been discussed previously under Coal-Mine Drainage. One might expect the process to be self-limiting because of the eventual toxicity of accumulating metals to the bacteria. However, it has been reported that up to 15,000 mg/l Cu, 40,000 mg/l Fe, and 40,000 mg/l Zn can be tolerated by these organisms (Silverman and Ehrlich, 1964).

Acidity and metals can also be contributed to streams from the tailings deposits associated with metal mines. Tailings are those parts of the mined ore which are separated in the milling process because they are of no interest or because they are too low in metal content to be processed economically.

In the past, times were good and technology was poor. Pyrite and copper, lead, and zinc ores were often bypassed in the search for gold and silver. As a result, the sulfide minerals commonly ended up in the tailings. These tailings were often deposited behind dams in stream channels and in close association to the mining operation.

That such tailings can contribute acidity and metals to water flowing through them has been shown by Mink and others (1972) and Galbraith and others (1972). Moreover, the extent of this effect depends on many factors, including time of year, flow conditions, initial water quality, and composition of the tailings.

As technology increased and gold and silver mining waned, the base metals became increasingly more important to Colorado's economy. Recovery techniques, at first inefficient, have reached the point where virtually no sulfide minerals, with the possible exception of some pyrite, remain in the discarded tailings. Moreover, it has even been shown that some modern tailings have the potential for removing dissolved metals from mine drainage (Miller, 1972).

The discussion up to this point has been concerned primarily with simple sulfides of iron (pyrite), copper (covellite, CuS), lead (galena), zinc (sphalerite), and silver (argentite). With the exception of covellite, these are the primary ores found throughout most of Colorado (see Metal Deposits). Copper, although present as covellite in some areas, is more commonly found as chalcopyrite.

Other metals, which occur as sulfides but which are not as widespread in occurrence as those mentioned above, include cadmium (as greenockite, CdS; substituted for zinc in sphalerite), cobalt (substituted for iron in pyrite), manganese (as alabandite, MnS), mercury (as cinnabar, HgS), and nickel (as polydimite; substituted for iron in pyrite). Molybdenite is restricted geographically, but occurs in a few rather large deposits.

Arsenic is chemically similar to sulfur. It can substitute for the sulfur in metal sulfides to form arsenides, or for the metal to form sulfosalts. Examples of the more common minerals of this type found in Colorado include arsenopyrite (FeAsS), proustite (Ag_3AsS_3), tennantite, niccolite (NiAs), and smaltite [$(Co,Ni)As_{3-x}$]. Selenium also behaves much the same as sulfur. In Colorado, a mineral tentatively identified as a gold or silver selenide is known from near Telluride (Luttrell, 1959, p. 871). However, most primary selenium probably occurs substituted for sulfur in other metal sulfides, often those associated with uranium-vanadium deposits (Coleman and Delevaux, 1957).

The above documented occurrences of minerals are primarily from Schrader and others (1917) and Vanderwilt (1947). It is thus easy to appreciate why many different trace elements might be expected to occur in high concentrations in areas affected by metal-mine drainage.

The Consequences of Mine Drainage

Many, perhaps most, trace elements are essential to life in small amounts. Common examples include cobalt (a constituent of vitamin B_{12}) and iron (contained in hemoglobin). Other trace elements, including arsenic and cadmium, presently have no known biological function. However, the number of these elements is rapidly diminishing: even lead (Environmental Sci. Technology, 1973) and mercury (Goldwater, 1971) have been suggested recently as having beneficial roles in life processes.

On the other hand, all trace elements can be toxic. They merely need be ". . . given in large enough quantity, by the appropriate route of administration, and in the proper physical form . . ." (Pfitzer, 1972). There are many manifestations and complications involved in this statement, and these should be elaborated upon before continuing.

Our first concern is with what constitutes a toxic effect. This may be anything from a slight amount of discomfort or damage up to, in the extreme, death. Moreover, the toxicity may be regarded as either acute (an immediate, often violent, reaction due to a large, single dose) or chronic (a gradual reaction due to accumulation of the toxicant over a long period of time).

Complications arise in regard to the victim being considered. Grazing animals and wildlife normally drink from surface-water sources and ingest both dissolved materials and those in suspension. On the other hand, people are able to avoid much of the suspended materials. If a surface-water source is used as a municipal supply, for example, the water is generally flocculated, settled, and (or) filtered before distribution. Moreover, ground water generally contains only slight amounts of material in suspension even in shallow alluvial aquifers with local surface-water recharge. With regard to aquatic organisms, only absorption of dissolved materials normally need be considered in the case of plants. Animals, additionally, pass a certain amount of suspended material through their systems in the process of obtaining food. Moreover, the ability of organisms to concentrate trace elements must be considered as one goes up the food chain to higher trophic levels.

There are many other complexities which must be considered when discussing trace-element toxicity. For humans, the toxicity of arsenic in the +III oxidation state is considered to be greater than when in the +V oxidation state, and hexavalent chromium is thought to be more toxic than the trivalent form (U.S. Public Health Service, 1962). On the other hand, trivalent chromium appears to be more toxic to fish than hexavalent chromium (McKee and Wolf, 1963).

Mercury in organic combination (example, methylmercury, CH_3Hg^+) can be synthesized by bacteria from inorganic mercury in solution (Gavis and Ferguson, 1972). In this form, it appears to be considerably more toxic than in inorganic combination, probably because of its greater solubility in lipids. This also accounts for its concentration via the food chain.

Environmental factors also exert controls on trace-element toxicities. For example, the toxicities of copper, lead, and zinc to fish are all inversely proportional to dissolved oxygen concentration. The control of reaction rates by temperature (example, metabolic uptake) and ionization by pH (example, H_2SeO_4 versus $SeO_4^{=}$) might also be expected to affect toxicities.

Antagonistic and synergistic affects of other metals are factors which are of concern. Hardness (principally calcium and magnesium ions) is known to be antagonistic toward the toxicity of cadmium, chromium, cobalt, copper, molybdenum, lead, nickel, vanadium, and zinc to fish and other aquatic life (McKee and Wolf, 1963). On the other hand, cadmium, zinc, and copper are synergistic in their effect on these organisms. For example, fish which could survive 8,000 μg/l Zn alone and 200 μg/l Cu alone for 8 hours died when exposed to 1,000 μg/l Zn and 25 μg/l Cu in the same solution. This synergistic effect disappeared in hard water. In mammals, the individually toxic elements selenium and arsenic are antagonistic (McKee and Wolf, 1963). As a matter of fact, arsenic is sometimes used to treat selenium poisoning in livestock.

Because of the associated differences in physiology, such things as species, life-cycle stage, and age can have considerable effect on the response of an organism to high trace-element concentrations. A classic example is the considerably lower toxicity threshhold for zinc and copper to fish than to humans.

An additional problem resulting from high concentrations of some trace elements in natural waters arises because of esthetic considerations. Iron and manganese, in particular, are undesirable because of staining problems (U.S. Public Health Service, 1962). Copper imparts an unpalatable taste to water, and zinc acts as an emetic.

Table 2 lists the drinking water standards which presently apply to municipal supplies in the United States, in general, and in Colorado, in particular. Included for comparison are European standards promulgated by the World Health Organization and reservoir standards in use by the Union of Soviet Socialist Republics (USSR). It is worth noting that for those constituents where all organizations have set standards, there is fairly good agreement among the limits. It is also important to point out, however, that the United States presently has no limits for several elements which are known to be toxic to mammals, including nickel and vanadium (Lee, 1972).

Although drinking water standards are reasonably well established, this is definitely not the case regarding stream standards for fish and other aquatic life. The State of Colorado, in establishing criteria for class B waters (waters to be used as cold-water fisheries), states simply that the water shall be "Free from . . . toxic . . . substances attributable to municipal, domestic, or industrial wastes, or other controllable sources in levels, concentrations, or combinations sufficient to be harmful to aquatic life" (Colorado Dept. Health, 1971b). The Federal Water Pollution Control Administration (1968) goes one step further by recommending standards for cadmium, chromium, copper, and zinc for fresh-water organisms in terms of fractions of the 96-hour TL_m. In the strictest interpretation, this would imply that each species would have to be bioassayed under all possible environmental conditions to which it is exposed in order to determine the various TL_m values. The minimum value might then be chosen and applied to a specific body of water or reach of stream. In the author's opinion, such standards are not workable.

Because of the obvious void described above, the author has summarized those criteria which might be applied to Colorado's class B waters. These criteria, which are presented in table 3, are based primarily on the minimum concentrations of metals and acidity known to be toxic as reviewed by McKee and Wolf (1963), the Federal Water Pollution Control Administration (1968), Schneider (1971), and the Great Lakes Laboratory (1971); and on the minimum MATC values recommended by Goettl and others (1971, 1972, 1973).

The discussion regarding the consequences of mine drainage has been concerned, thus far, mainly with the toxicity of acid and metals to the resident aquatic organisms and to the people and other animals that directly consume the water. In addition to these consequences, there are other adverse manifestations which, though they are of lesser importance, should at least be mentioned. These manifestations include (1) corrosion of concrete and metal, and potential problems with structures in the water and limitations regarding industrial use of the water, (2) restrictions pertaining to use of the water for irrigation and food processing, and (3) inhibition of bacteria needed for sewage digestion and stream self-purification.

Table 2.--*Comparative drinking water standards for trace elements*
[Concentrations in micrograms per liter]

Water-quality parameter	U.S. Public Health Service (1962, 1970); Colorado Dept. Health (1971a)	World Health Organization 1961 European Standards (McKee and Wolf, 1963, p. 91)	USSR standards for reservoir water (Arthur D. Little, Inc., 1971, p. 238)
Aluminum------	-------	-------	500
Antimony------	-------	-------	50
Arsenic-------	[1]50, ([2]10)	[1]200	[3]50
Barium--------	[1]1,000	-------	4,000
Bismuth(III)--	-------	-------	[3]500
Bismuth(V)----	-------	-------	[3]100
Cadmium-------	[1]10	[1]50	10, ([3]0.1)
Chromium(VI)--	[1]50	[1]50	-------
Cobalt--------	-------	-------	1,000
Copper--------	[2]1,000	[2]3,000	100
Cyanide-------	[1]200, ([2]10)	[1]10	[3]100
Fluoride------	([4])	[2]1,500	[3]1,500
Iron----------	[2]300	[2]100	500
Lead----------	[1]50	[1]100	[3]100
Manganese-----	[2]50	[2]100	-------
Mercury-------	[1]5	-------	[3]5
Molybdenum----	-------	-------	500
Nickel--------	-------	-------	[3]100
Selenium------	[1]10	[1]50	[3]10
Silver--------	[1]50	-------	-------
Titanium------	-------	-------	[3]100
Uranium-------	-------	-------	600
Vanadium------	-------	-------	[3]100
Zinc----------	[2]5,000	[2]5,000	1,000

[1]Maximum permissible concentration.

[2]Recommended limit.

[3]Limit based on toxicological considerations.

[4]Varies inversely with average annual maximum daily air temperature.

Table 3.--*Summary of stream criteria for fish and other aquatic life*
[All values expressed as micrograms per liter, unless otherwise specified]

Water-quality parameter	Maximum suggested concentration[1]	Remarks
Arsenic------	1,000	Recommended by McKee and Wolf (1963).
Cadmium------	10	Based on data presented by McKee and Wolf (1963), Schneider (1971), and the Great Lakes Laboratory (1971).
Chromium-----	50	Recommended by McKee and Wolf (1963).
Cobalt-------	500	Based on data presented by McKee and Wolf (1963), Schneider (1971), and the Great Lakes Laboratory (1971).
Copper-------	10-20	Based on data presented by Goettl and others (1971, 1972, 1973).
Iron---------	300	Based on data presented by McKee and Wolf (1963), Schneider (1971), and the Great Lakes Laboratory (1971).
Lead---------	5-10	Based on data presented by Goettl and others (1971, 1972, 1973).
Manganese----	1,000	Recommended by McKee and Wolf (1963).
Mercury------	1	Based on data presented by McKee and Wolf (1963), Schneider (1971), and the Great Lakes Laboratory (1971).
Molybdenum---	-------	Not enough information available to allow recommendation of a realistic criterion.
Nickel-------	50	Based on data presented by McKee and Wolf (1963), Schneider (1971), and the Great Lakes Laboratory (1971).
Selenium-----	1,000	Based on data presented by McKee and Wolf (1963), Schneider (1971), and the Great Lakes Laboratory (1971).
Silver-------	.1	Based on data presented by Goettl and others (1971, 1972, 1973).
Vanadium-----	-------	Not enough information available to allow recommendation of a realistic criterion.
Zinc---------	30-70	Based on data presented by Goettl and others (1971, 1972, 1973).
pH (units)---	6.0	Recommended by the Federal Water Pollution Control Administration (1968).

[1]Minimum value shown for pH as this is equivalent to maximum acidity.

APPROACH

Because the areas of ore deposits and the coal regions of Colorado generally do not overlap (figs. 2, 3), a decision was made to examine separately the effects on stream quality resulting from the mining of these two resources.

Potential stream-quality degradation due to metal-mine drainage was considered first, primarily because some information was already available. (See Introduction for references to previous studies.) Guided in part by this prior knowledge, and in part by information on known occurrences of metal deposits (U.S. Geol. Survey, 1971), stream sites were selected for field visitation (pl. 1). An attempt was made to survey all first-order streams that are shown on U.S. Geological Survey maps (scale 1:250,000) and that drain areas of known metal deposits. In addition, streams which lie within the boundaries of the Colorado and Uravan mineral belts, but which do not drain areas of known metal deposits, were selected at random. This was an attempt to insure that any subtle manifestations of metal-mine drainage were not completely overlooked. Finally, some stream sites were included based on observations made in the field.

A total of 642 sites were surveyed between September 20, 1971, and January 28, 1972. Three additional sites were visited on July 18-19, 1972. Streamflow throughout Colorado during these periods was generally at or near base flow. For those instances where locally heavy runoff existed, site visitation was postponed until base-flow conditions were again approached.

The field survey designed to delineate areas affected by coal-mine drainage took place from April 19 through July 19, 1972. The stream sites surveyed (pl. 2) were selected from information regarding the locations of coal deposits and mines (Landis, 1959; Colorado Dept. Nat. Resources, 1971). First-order streams shown on the U.S. Geological Survey's map of Colorado (1969, scale 1:500,000) were used as the basis for site selection. This map scale was chosen (1) because the area to be sampled was considerably larger than the area sampled during the metal-mine survey (compare the areas in figs. 2, 3), and (2) because of the lack of any history of water-quality problems due to coal-mine drainage in Colorado. A total of 337 sites were visited. Streamflow conditions during the period of the field survey were at or approaching base flow at the lower altitudes, and on the recession side of the snowmelt-runoff peak at the higher altitudes.

Thirteen control sites were also sampled in conjunction with the two above-mentioned field surveys (fig. 7). Two of these sites were hydrologic bench-mark stations (Cobb and Biesecker, 1971); they were visited during the metal-mining survey. Eleven additional control sites were chosen specifically so as to lie outside the boundaries of the

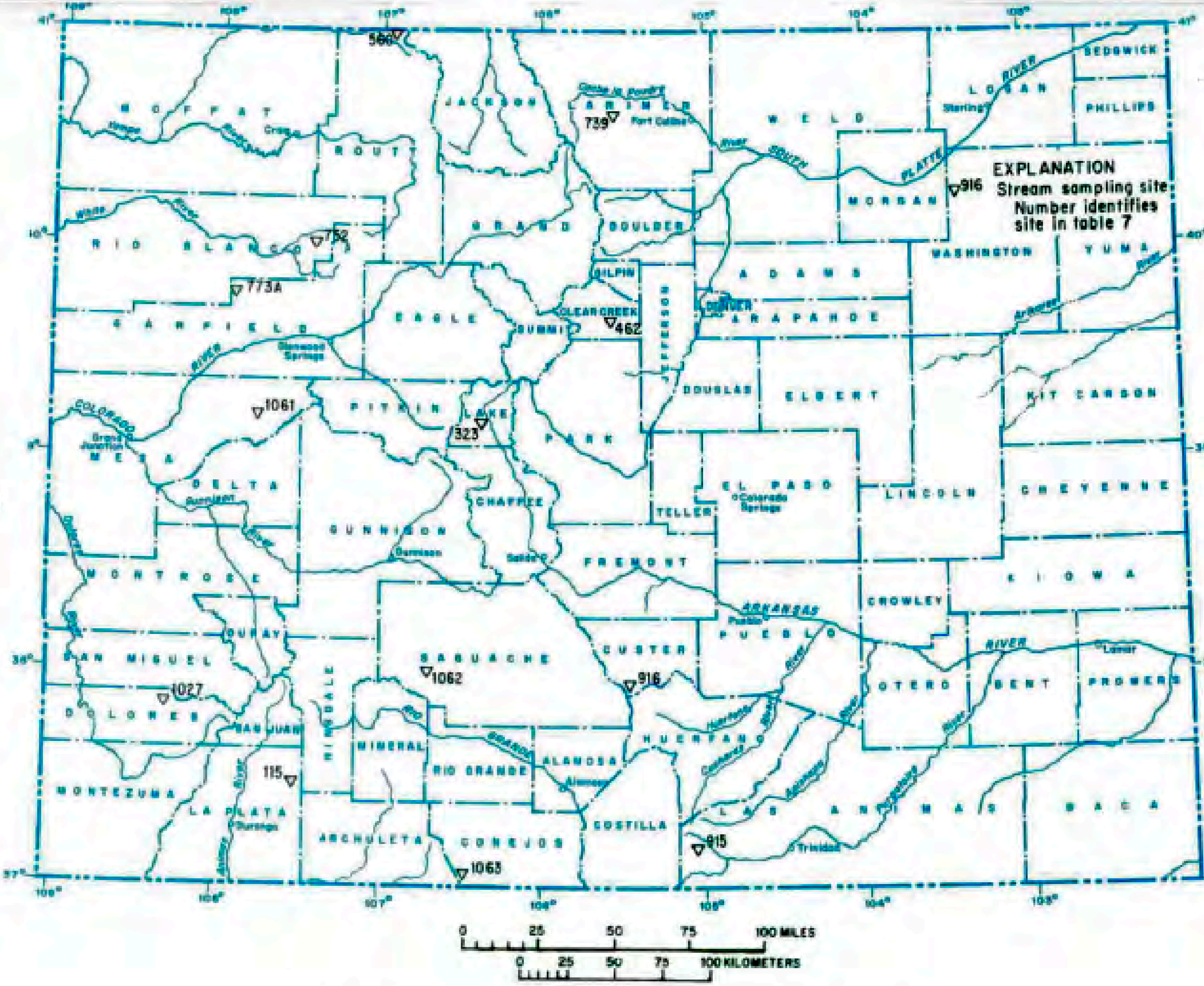

Figure 7.--Location of control sites in Colorado, 1971-72.

Colorado and Uravan mineral belts and the coal regions; these were visited during the coal-mining survey. Moreover, the control streams all drain areas where there are no known coal or metal deposits.

TECHNIQUES

Field measurements of stream temperature, pH, and specific conductance were made at each site visited. In addition, a visual analysis of the condition of the water and channel bottom was recorded, as was information regarding the aquatic biota. The purpose of each of these observations is explained below.

Temperature

Stream temperatures tend to follow ambient air temperatures, unless influenced by some outside force. In Colorado, stream temperatures commonly vary from about 0°C (degrees Celsius) during the winter months to about 15° to 25°C during late summer (U.S. Geol. Survey, 1972), the lower maximum temperatures occurring at the higher altitudes. Ground-water temperatures in Colorado range from 7° to 17°C in the shallow aquifers and from 15° to 30°C at depths of about 2,000 feet (610 m) (Scott and Voegeli, 1961), the increase with depth generally being attributed to the geothermal gradient. Considerably higher temperatures (as high as 84°C) occur in waters issuing from hot springs (Pearl, 1972, p. 2). Moreover, annual fluctuations in ground-water temperatures tend to be fairly small; these fluctuations would be expected to be largest near the surface and to decrease with depth. Thus, it would not be unlikely for water from a draining mine to raise or lower a stream's temperature considerably, depending on the time of the year and the depth of the ground-water source.

In addition to the above, water temperatures were needed in order to accurately determine pH and specific conductance.

pH

Baas Becking and others (1960) have reported a pH range of approximately 4.3 to 9.3 for some 347 fresh-water rivers and lakes from around the world. About 85 percent of the values are within the range from pH 6 to 8. Because of the acidic nature of the reactions involved in the oxidation of pyritic materials, it might be predicted that streams receiving such drainage would have pH's considerably below normal. Indeed, Baas Becking and others (1960) reported a pH range of about 2.1 to 8.5 for oxidized mine waters; almost 45 percent of the values were less than pH 4.5. (The pH values less than about 4.3 to 4.5 are generally considered a reflection of the presence of free mineral acidity. In accordance with the American Public Health Association (1971), the value 4.5

is used here.) Moreover, Biesecker and George (1966) reported a pH range of 2.8 to 9.0 for streams receiving coal-mine drainage in the Appalachian region. Of these, 14 percent had pH values less than 4.5.

Specific Conductance

Specific conductance values for Colorado streams vary considerably (U.S. Geol. Survey, 1972). Generally speaking, mountain streams are in contact with igneous and metamorphic rocks that contribute little mineralization to the water; these streams commonly have specific conductances up to several hundred micromhos per centimeter at 25°C. Streams of the plateau and plains areas, on the other hand, have been associated with sedimentary rocks containing minerals which are generally quite soluble; these streams may have specific conductances of several thousand micromhos per centimeter at 25°C. In addition, the complication of dilution by runoff low in dissolved solids during periods of snowmelt and heavy rainfall must be considered. Thus, the specific conductance to be expected depends both on location and weather conditions. The oxidation of pyrite and other metal sulfides releases acidity, metal ions, and sulfate in solution. All these contribute to the specific conductance of the water, and streams receiving drainage high in these materials would be expected to have higher than normal specific conductances. Such a manifestation would obviously be most noticeable in streams whose specific conductances are normally low.

Visual Observations

As explained previously, the metal ions released by the oxidation of sulfide ores are generally quite soluble in low-pH mine waters. However, when these waters issue into a stream, the pH value of the combined waters approaches neutrality as a result of both dilution and carbonate buffering. At this point, many of the metal ions will precipitate, generally either as a hydroxide or, in high-alkalinity waters, perhaps as a carbonate. In the case of iron, neutralization is often not required: it precipitates as the hydroxide at pH values above approximately 3 when the water reaches the earth's surface and the ferrous iron is oxidized to the ferric form. The finely divided precipitate which is formed imparts an apparent color to the water while in suspension. Later, this precipitate settles out and coats the stream bottom.

Aquatic Biota

The aquatic biota of a stream are the organisms which live within the stream. Here we are concerned only with the periphyton (algae growing attached to the substrate), the macrophytes (higher plants), and the benthic macroinvertebrates (bottom-dwelling animals). Clean streams tend to have moderate populations of a great many organisms, that is, they have a relatively high diversity. Polluted streams, on the other hand, have a relatively low diversity: living conditions are so restrictive that only a few types of organisms will be able to survive, and these often increase tremendously in numbers because of the lack of competition. If the conditions in a polluted stream become severe enough, the environment becomes completely toxic, and all living things may be eliminated. The effects of low pH and high concentrations of trace metals on stream life have previously been discussed. The important point to be made here is that the aquatic biota are excellent integrators. Because of their relative immobility, aquatic organisms reflect the conditions in a stream over a long period of time. The most restrictive conditions during that period will dictate which organisms cannot survive and which are prefered. Thus, the aquatic biota present at a particular time will tell quite a bit about conditions in the stream during the past.

Field Procedure

Temperature measurements were made with a mercury thermometer and are accurate to the nearest 0.5°C. Measurements of pH were made with a portable pH meter. Two-point calibration procedures were used (pH 4 and 7 or pH 7 and 10), and sample measurements were made in a beaker. The values reported are accurate to within ±0.05 pH unit. Determinations of specific conductance were made directly in the stream using an instrument having a range of 50 to 8,000 μmhos/cm (micromhos per centimeter) at 25°C. Values are accurate to within ±2 percent of the number reported. The visual observations of the stream conditions represent a subjective judgment on the part of the particular investigator. Because the field work was done by several persons, there will obviously be some lack of comparability among this data; however, this is not believed to be significant.

The determination of the aquatic biota presents a problem not encountered in the observations discussed above. Here again, a subjective judgment is required. Moreover, semi-quantitative information is being conveyed. The procedure most often used was to (1) randomly select 10 rocks (approximately fist size) from a riffle area, (2) study the organisms found on the rocks, with the aid of a hand lens if necessary, and classify the organisms into broad taxonomic groups (mostly orders, but some classes and some families), and (3) estimate the relative abundance of each group (five categories: absent, present, present to common, common, and abundant).

At times, an attempt was made to sample the macroinvertebrates in the vegetation (if any) hanging in the water along the stream edge. This was done with the aid of a dip net. (A common food strainer works almost as well.) The net is dragged through the vegetation, and the specimens collected are deposited in a white enamel tray (or a white, plastic dishpan) where they are easily seen and identified. By sampling the same length of shoreline at each station, results can be made comparable.

If the stream bottom was composed of silty or sandy material, it was sometimes sampled for burrowing organisms. The material was simply scooped up with a shovel and searched by hand. A more complete method would have involved passing the material through a U.S. Standard Sieve No. 70 [0.210-mm (millimeter) mesh opening]. Again, by taking the same size and number of shovelfuls at each station, results can be made comparable.

Of the above biological sampling procedures, the "10-rock" method was used whenever possible. The "dip net" and "shovel" methods were considered primarily as alternatives to the 10-rock method for areas where there were no suitable riffles to be sampled. However, at the discretion of the particular field investigator, two or more of the procedures were sometimes used at a particular site.

Laboratory Analyses

Based on the results of the field observations (temperature, pH, specific conductance, water and streambed conditions, and aquatic biota), a decision was made as to whether to obtain a water sample for chemical analysis. During the metal-mining survey, 149 samples were collected; 30 samples were collected in conjunction with the coal-mining survey; and samples were collected at all 13 of the control sites.

All samples were passed through a 0.45 μm (micrometer) membrane filter at the time of collection. The decision to use filtered samples, as opposed to whole-water samples, was based primarily on economics. Since the object of the reconnaissance phase was to locate problem areas, it was felt that filtered samples would provide the most data at the least expense: the analytical cost for a filtered sample is about two-thirds as much as for an unfiltered sample. Immediately after filtration, those samples collected for trace-element analysis were acidified with 1.5 ml (milliliter) double-distilled, analytical-grade nitric acid per liter of water. Samples were stockpiled and sent in lots of 50 to 100 to the U.S. Geological Survey's Central Laboratory in Salt Lake City, Utah, where they were analyzed according to accepted procedures (Brown and others, 1970).

In addition to sulfate, most of the samples were analyzed for arsenic, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. Chromium, molybdenum, selenium, and vanadium were determined only in samples from areas where these elements were specifically expected to occur. Although very important to the history of mining in Colorado, gold was not determined as part of the study, due to the lack of an analytical capability for this element. Information regarding gold concentrations in Colorado waters is given by Gosling and others (1971).

The total dissolved form was determined for all constituents. Estimates of the analytical precision are presented in table 4.

Table 4.--*Estimates of precision for laboratory analyses*

[Frances ReMillard, written commun., 1973]

Water-quality parameter	Standard deviation for dissolved constituent (determined at mean concentration given in parentheses), micrograms per liter[1]	
Arsenic------------	4	(28)
Cadmium------------	.6	(9.5)
Chromium-----------	4	(7)
Cobalt-------------	2	(10)
Copper-------------	10	(242)
	61	(639)
Iron---------------	10	(121)
	29	(829)
Lead---------------	5.4	(22.9)
Manganese----------	9	(65)
	12	(117)
Mercury------------	.64	(6.57)
Molybdenum---------	1	(18)
Nickel-------------	1.1	(3.3)
	3.3	(24.1)
Selenium-----------	6	(24)
Silver-------------	1	(10)
Vanadium-----------	.25	(1.5)
Zinc---------------	27	(528)
Sulfate (mg/l)-----	.7	(21.4)
	7	(399)

[1]All values expressed as μg/l, unless otherwise specified.

RESULTS AND DISCUSSION

The results of the field observations and laboratory analyses are presented in tables 5, 6, and 7 for the metal-mining, coal-mining, and control-site surveys, respectively. When studying the biological information presented in these tables, the reader should note that the column labeled "Mayflies" actually refers to three-tailed mayflies only, while the column labeled "Stoneflies" includes both stoneflies and two-tailed mayflies.

Except for chromium, selenium, sulfate, and specific conductance, the maximum value of each water-quality parameter was determined to occur in the samples collected during the metal-mining survey (table 8). Furthermore, these values are, for the most part, considerably greater than those measured during the coal-mining and control-site surveys. Values from the latter two surveys are generally quite similar, except for iron, manganese, selenium, sulfate, and specific conductance. Chromium was not detected in the 26 samples analyzed for this constituent; and, although 185 samples were analyzed for silver, it occurred at detectable levels in only 6 of these. Moreover, there is virtually no difference among the three surveys in regard to the maximum concentrations of silver found.

Samples were analyzed for sulfate because of its formation during the oxidation of sulfide ores. Unfortunately, sulfate is also quite commonly associated with streams of the plains and plateau regions of Colorado (Rainwater, 1962, pl. 2), where it probably is dissolved from gypsum ($CaSO_4 \cdot 2H_2O$) deposits present in these areas (Vanderwilt, 1947, p. 242-244). It is interesting to note that the maximum sulfate value measured during the metal-mining survey (most samples were from mountain streams) is from an area which is considered to be affected by mine drainage, whereas the maximum value noted during the coal-mining survey (most samples were from the plains and plateau areas) is thought to reflect a natural occurrence of mineral sulfate. The maximum sulfate concentration associated with coal-mine drainage is 1,600 mg/l, about one-third the reported overall maximum for the coal-mining survey.

The dependence of specific conductance on rock type for Colorado streams has been previously discussed. Of the maximum specific conductance values listed in table 8 for the metal- and coal-mining surveys, neither appears to be the result of mine drainage. Rather, these values are manifestations of the geologic environments through which the streams in question are passing. The maximum specific conductances measured in areas affected by mining are 2,600 and 3,000 μmhos/cm at 25°C for the metal- and coal-mining surveys, respectively.

The high maximum value for selenium listed under the coal-mining survey is also likely due to a natural source. The stream in question drains an area underlain by the Niobrara Group and the Pierre Shale (Burbank and others, 1935); both of these are considered to be naturally high in selenium (Trelease and Beath, 1949, p. 87). In addition, both the maximum manganese concentration and the minimum pH reported from the coal-mining survey appear to be unrelated to coal-mine drainage.

In areas affected by metal-mine drainage, anomalously high concentrations of dissolved sulfate, and dissolved forms of all trace elements studied except chromium and silver, can occur, along with high specific conductance and low pH. The same can be said of iron, sulfate, and specific conductance for streams receiving coal-mine drainage. Moreover, the values are likely to be higher in streams receiving metal-mine drainage.

Sulfate appears to be a poor general indicator of mine drainage, at least in areas where one runs the risk of encountering high background concentrations of this constituent. The same might be said of selenium, manganese, and specific conductance. (Indeed, many of the high specific conductance values are probably partially the result of high natural sulfate concentrations.)

Table 9 shows the percentage of sample sites where concentrations exceed the recommended U.S. Public Health Service (1962, 1970) drinking water standards. It is rather surprising that, for the metal-mining survey, manganese exceeds its limit more frequently than any other constituent. Moreover, it is the only constituent which was found above its limit at any of the control sites. This is a good indication that dissolved manganese is naturally high in Colorado streams.

Somewhat more expectedly, sulfate and iron are next in the number of times their standards are exceeded. (Selenium is not considered in this discussion because of the bias built into the numbers; see table 9, footnote 2.) They are also the only two constituents, other than manganese, to exceed their standards at coal-mining survey sites.

It is significant that cadmium occurs above acceptable limits in greater than 12 percent of the metal-mining survey sites. This is the highest frequency noted for any constituent whose standards are based on toxicity considerations. (The standards for manganese and iron are based on esthetic objections, while high concentrations of sulfate have a laxative effect when consumed.) As might be predicted based on their close geologic association (Berry and Mason, 1959, p. 313), cadmium is followed closely by zinc, with 9 percent of the metal-mining survey samples surpassing the suggested upper limit.

Table 5.--*Chemical and biological quality of surface water at sites sampled to determine the effect of metal mining in Colorado, 1971-72*

[STATION NAME: ab, above; bl, below; Bk, Brook; Cn, Canyon; CO, Colorado; Co., County; C, Creek; di, distributary; D, Ditch; E, East; F, Fork; Ft., Fort; Gdn, Golden; Gl, Gulch; Hwy, Highway; Lk, Lake; L, Little; M, Middle; mo, mouth; Mtn, Mountain; nr, near; N, North; No., Number; Re, Reservoir; R, River; St., Saint; stp, sewage treatment plant; S, South; Spgs, Springs; tr, tributary; U.S., United States; W, West.

PRINCIPAL MERIDIAN: NM, New Mexico; S, Sixth; U, Ute.

STREAM CONDITIONS: IR, irrigation return flow suspected; NF, no flow; RO, runoff due to rain; SF, flow primarily from underground spring(s) just upstream; SM, runoff due to snowmelt. BGC, blue-gray coating on rocks; BOC, black-orange coating; GBC, gray-brown coating; OC, orange coating; OTC, orange-tan coating; RC, red coating; ROC, red-orange coating; TC, tan coating. BS, black stain on rocks; GBS, gray-brown stain; OS, orange stain; RS, red stain. BT, water has brown tinge; GT, gray tinge; GBT, gray-brown tinge; OT, orange tinge; WT, white tinge; YT, yellow tinge. VST, water is very slightly turbid; ST, slightly turbid; T, turbid; VT, very turbid.

AQUATIC ORGANISMS ("10-rock" riffle sample unless otherwise specified under Miscellaneous): A, absent; 1, one organism observed; P, present; P-C, present to common; C, common; C+, abundant; (?), classification questionable; *, no suitable riffle for sampling rocks.]

Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
				PLATTE RIVER BASIN											
				Boulder County											
378	S St. Vrain C ab M St. Vrain C nr Riverside, CO	S	T02N R72W	-	-	12-09-71	1310	0	8.4	70	-	A	C	P-C	A
379	S St. Vrain C ab Central Gl nr Lyons, CO	S	T03N R71W	-	-	12-09-71	1355	0	8.0	65	-	A	P-C	P-C	A
381	M St. Vrain C at mouth nr Riverside, CO	S	T02N R72W	-	-	12-09-71	1325	0	8.0	60	-	A	P-C	C	A
383	Central Gulch at mouth nr Lyons, CO	S	T03N R71W	-	-	12-09-71	1345	0	7.9	70	-	A	P-C	P-C	A
384	Geer Canyon C at mouth nr Springdale, CO	S	T02N R71W	-	-	12-09-71	1430	2.0	7.5	260	-	A	P-C	C	A
385	Lefthand C nr Boulder, CO (06724500)	S	T02N R71W	-	-	12-09-71	1500	1.0	7.5	240	-	A	P-C	P-C	A
386	Sixmile Canyon C at mo nr Springdale, CO	S	T02N R71W	40 06 37	105 18 19	12-03-71	1500	.5	7.4	550	-	A	P-C	C	A
387	Lefthand C ab Sixmile Canyon C nr Springdale, CO	S	T02N R71W	-	-	12-03-71	1515	0	7.4	200	-	-	-	-	-
388	James C at mouth nr Jamestown, CO	S	T02N R71W	-	-	11-19-71	1430	0	7.5	180	-	A	P-C	P-C	A
389	L James C at mouth at Jamestown, CO	S	T02N R71W	40 06 59	105 23 27	12-03-71	1415	0	5.5	1800	TC OS YT	A	A	P	A
390	James C ab L James C at Jamestown, CO	S	T02N R71W	-	-	12-03-71	1400	0	7.5	60	-	A	P-C	C	A
391	Lefthand C ab James C nr Springdale, CO	S	T02N R71W	-	-	11-19-71	1500	0	7.5	260	-	A	P-C	P	A
392	Spring Culch at mouth nr Gold Hill, CO	S	T01N R72W	-	-	11-19-71	1515	0	7.5	100	-	A	P-C	P	A
393	Lefthand C ab Spring Gl nr Gold Hill, CO	S	T01N R72W	-	-	11-19-71	1530	0	7.5	180	-	A	P-C	P-C	A
394	S St. Vrain C ab Beaver C nr Peaceful Valley, CO	S	T02N R72W	-	-	12-03-71	1300	0	7.4	100	-	A	P-C	P-C	A
395	Beaver C at mouth nr Peaceful Valley, CO	S	T02N R72W	-	-	12-03-71	1315	0	7.4	60	-	A	P-C	C	A
396	Fourmile Canyon C nr Boulder, CO	S	T01N R71W	40 03 53	105 18 02	12-09-71	1145	0	8.0	500	-	A	P-C	C	A
397	Fourmile C at Orodell, CO (06727500)	S	T01N R71W	40 01 06	105 19 33	11-19-71	0945	0	6.6	450	-	A	P-C	C	A
398	Fourmile C ab Pennsylvania Gl nr Wallstreet, CO	S	T01N R72W	-	-	11-19-71	1130	0	7.4	70	-	A	P-C	P-C	A
398A	Old Scandia Group Mine nr Wallstreet, CO	S	T01N R72W	40 02 14	105 28 38	11-19-71	1200	1.5	7.6	350	-	-	-	-	-
399	Pennsylvania Gl at mo nr Wallstreet, CO	S	T01N R72W	-	-	11-19-71	1125	-	-	-	NF	-	-	-	-
400	Boulder C nr Orodell, CO (06727000)	S	T01N R71W	-	-	12-02-71	0935	0	7.9	260	-	A	P-C	C	A
401	N Boulder C at mouth nr Sunnyside, CO	S	T01N R72W	-	-	12-02-71	1005	0	7.1	140	-	A	P-C	P-C	A
402	M Boulder C at mouth nr Sunnyside, CO	S	T01N R72W	-	-	12-02-71	1025	0	7.6	250	-	A	P-C	P-C	A
403	N Boulder C tr ab Lakewood Re, CO	S	T01S R73W	-	-	12-02-71	1305	0	7.4	90	-	A	P-C	C	A
404	N Boulder C nr Switzerland Park, CO	S	T01S R72W	-	-	12-02-71	1245	0	7.5	60	-	A	P-C	-	A
405	N Beaver C at mouth at Nederland, CO	S	T01S R73W	-	-	12-02-71	1330	0	7.3	60	-	-	-	-	-
406	M Boulder C at Nederland, CO (06725500)	S	T01S R73W	-	-	12-02-71	1415	0	7.4	60	-	A	P-C	C	A
409	Gordon C at mouth at Switzerland Park, CO	S	T01N R72W	-	-	12-02-71	1135	0	7.5	220	-	A	P-C	P-C	A
410	N Boulder C ab Gordon C at Switzerland Park, CO	S	T01N R72W	-	-	12-02-71	1120	0	7.5	140	-	A	P-C	P	A
424	S Boulder C nr Eldorado Springs, CO (06729500)	S	T01S R71W	-	-	12-09-71	1045	0	7.4	60	-	A	P-C	-	A
677	Fourmile C ab Gold Run at Salina, CO	S	T01N R71W	-	-	11-19-71	1055	0	7.1	280	-	A	P-C	C	A
678	Gold Run at mouth at Salina, CO	S	T01N R71W	40 03 02	105 22 21	11-19-71	1030	0	7.1	900	-	A	P-C	C	A
				Clear Creek County											
441	W F Clear C ab Woods C at Berthoud Falls, CO	S	T03S R75W	39 46 16	105 49 13	12-16-71	1115	2.0	8.6	1000	TC	A	A	C	A
444	Woods C at mouth at Berthoud Falls, CO	S	T03S R75W	39 45 57	105 49 04	12-16-71	1315	.5	7.2	1120	OTC	A	A	P-C	A
445	W F Clear C ab Mad C nr Empire, CO	S	T03S R74W	-	-	12-16-71	1510	0	8.4	790	-	A	C	P	A
446	Mad C at mouth at Empire, CO	S	T03S R74W	-	-	12-16-71	1600	0	7.4	50	-	A	C	A	A
447	Bard C at mouth at Empire, CO	S	T03S R74W	-	-	12-17-71	1100	0	7.3	70	-	A	C+	A	A
448	Miller C at mouth at Empire, CO	S	T03S R74W	-	-	12-17-71	1130	1.5	7.3	180	-	A	-	A	A
449	W F Clear C nr Empire, CO (06716000)	S	T03S R74W	39 45 31	105 39 50	12-17-71	1200	0	8.0	560	-	A	C+	P	A
450	Mill C at mouth at Dumont, CO	S	T03S R73W	-	-	12-22-71	1045	0	7.4	60	-	A	C+	A	A
451	Fall R nr Idaho Springs, CO (06717000)	S	T03S R73W	39 45 22	105 33 21	12-22-71	1120	0	7.4	90	-	A	C	P	A
452	Virginia Canyon C at mo at Idaho Springs, CO	S	T03S R73W	39 44 44	105 30 47	12-15-71	1605	1.5	3.0	2600	-	A	A	P-C	A
453	Soda C at mouth at Idaho Springs, CO	S	T03S R73W	39 44 23	105 30 43	12-15-71	1520	2.5	7.7	400	-	A	C+	P	A
454	Clear C ab N Clear C nr Hidden Valley, CO	S	T03S R72W	39 44 48	105 23 55	12-23-71	1145	0	8.6	340	YT ST	A	P-C	A	A
455	Quayle C at mouth at Bakerville, CO	S	T04S R75W	-	-	12-17-71	1420	0	7.6	140	OS	A	P	A	A
456	Clear C ab Quayle C at Bakerville, CO	S	T04S R75W	39 41 31	105 49 00	12-21-71	1005	0	7.7	130	-	A	C	P	A

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations: Aquatic organisms: Fauna								Field observations: Aquatic organisms	Laboratory determinations: Trace elements, micrograms per liter															Laboratory determinations
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
											PLATTE RIVER BASIN													
											Boulder County													
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	C	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	C	A	-	1	1	-	1	4	20	3	58	0.1	-	1	-	0	-	170	76
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	140	-	49	740	2100	170	7600	.3	-	320	-	0	-	25,000	910
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	dragon fly(?):I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	1	6	-	0	6	30	3	0	.0	-	0	-	0	-	10	74
C	C	C	A	A	A	A	A	-	1	0	-	0	2	0	3	40	.5	-	5	-	0	-	30	98
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	0	0	-	1	0	10	1	0	.2	-	0	-	0	-	40	20
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C+	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	flatworms(?): C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	2	4	-	1	1	10	1	680	.3	-	160	-	0	-	650	440
											Clear Creek County													
P	A	1	A	A	A	A	A	-	0	0	-	2	2	10	0	5900	.4	4	4	-	0	-	220	180
A	A	A	1(?)	A	A	A	A	-	1	8	0	3	10	0	0	4800	.3	26,000	8	-	0	510	1800	290
P	P-C	P	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	P	P-C	A	P-C	A	A	A	water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	P-C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P-C	A	A	A	A	A	-	20	1	-	2	8	20	4	1300	.5	-	3	-	0	-	40	110
C	P	P-C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P-C	P-C	A	A	A	A	P	-	4	0	-	1	3	30	1	0	.3	-	0	-	0	-	50	16
A	A	A	A	A	A	A	A	-	0	520	-	280	10,000	5000	7	82,000	.4	-	900	-	0	-	99,000	1700
P-C	P	C	A	P-C	A	A	A	-	9	0	-	1	2	60	9	29	.4	-	0	-	0	-	80	62
A	C	P	A	P-C	A	A	A	fungal or bacterial slime: P-C	1	3	-	3	11	20	2	1700	.2	-	7	-	0	-	620	82
P-C	A	A	P(?)	A	A	A	P	net-winged midges: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	A	A	A	A	A	A	fungal or bacterial slime(?): P	3	0	-	0	2	100	2	36	.3	-	0	-	0	-	40	6.5

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Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	PLATTE RIVER BASIN (Continued)														
	Clear Creek County (Continued)														
457	Clear C ab S Clear C at Georgetown, CO	S	T04S R74W	39 42 22	105 41 54	12-21-71	1220	0	7.9	185	-	A	C	P	A
458	S Clear C at mouth at Georgetown, CO	S	T04S R74W	39 42 22	105 41 40	12-21-71	1530	.5	7.7	145	-	A	C	P	A
459	Leavenworth C at mouth nr Georgetown, CO	S	T04S R74W	39 41 01	105 42 10	12-21-71	1445	0	7.5	140	OS	A	C	A	A
460	S Clear C ab Cabin C Project nr Georgetown, CO	S	T05S R74W	-	-	12-21-71	1400	0	7.6	90	OS	A	C	A	A
461	Clear C ab W F Clear C nr Empire, CO	S	T03S R74W	39 45 06	105 39 42	12-22-71	0930	0	7.6	180	-	A	C	A	A
462	Chicago C ab S Chicago C nr Idaho Springs, CO	S	T04S R73W	-	-	12-15-71	1005	0	7.6	70	-	A	C	A	A
463	S Chicago C at mouth nr Idaho Springs, CO	S	T04S R73W	-	-	12-15-71	0945	0	7.3	70	-	A	C	A	A
464	W Chicago C at mouth nr Idaho Springs, CO	S	T04S R74W	-	-	12-15-71	1050	0	7.5	80	-	A	P-C	A	A
465	Ute C at mouth nr Idaho Springs, CO	S	T04S R73W	39 42 32	105 35 49	12-15-71	1215	0	7.4	150	-	-	-	-	-
466	Devils Cn C at mouth nr Idaho Springs, CO	S	T04S R73W	-	-	12-15-71	1350	-	-	-	NF	-	-	-	-
467	Chicago C ab Spring Gl at Idaho Springs, CO	S	T04S R73W	39 44 07	105 31 36	12-15-71	1415	0	7.5	100	-	A	C+	P	A
665	Clear C at Silver Plume, CO	S	T04S R75W	-	-	12-21-71	1125	0	7.6	150	-	A	C	A	A
666	Cascade C at mouth nr Idaho Springs, CO	S	T04S R73W	-	-	12-15-71	1120	0	7.5	60	-	A	P-C	P	P-C
667	Spring Gl at mouth at Idaho Springs, CO	S	T04S R73W	-	-	12-15-71	1410	-	-	-	NF	-	-	-	-
670	Lion C at mouth at Empire, CO	S	T03S R74W	39 45 42	105 41 02	12-17-71	0955	0	3.0	1060	OC OS	A	A	P	A
671	Clear C ab Chicago C at Idaho Springs, CO	S	T03S R73W	39 44 25	105 31 13	12-22-71	1215	0	8.1	355	-	A	P-C	P	A
672	Clear C bl Soda C at Idaho Springs, CO	S	T03S R73W	-	-	12-22-71	1315	0	8.0	325	-	-	-	-	-
672A	Clear C (left bank) bl Idaho Springs, CO (06718000)	S	T03S R72W	-	-	12-22-71	1400	0	7.2	360	OC YT ST	-	-	-	-
672B	Clear C (right bank) bl Idaho Springs, CO (06718000)	S	T03S R72W	-	-	12-22-71	1400	0	7.7	345	OC YT ST	-	-	-	-
673	Clear C ab stp outfall at Idaho Springs, CO	S	T03S R72W	39 44 42	105 29 15	12-22-71	1455	0	7.9	360	TC OS YT T	A	A	A	A
674	Clear C bl Sawmill Gulch nr Hidden Valley, CO	S	T03S R72W	39 44 46	105 26 13	12-23-71	1045	.5	8.1	340	YT T	-	-	-	-
	Gilpin County														
414	S Boulder C ab Mammoth Gl nr Tolland, CO	S	T02S R74W	-	-	12-03-71	1030	0	7.4	80	-	A	P-C	P-C	A
415	Mammoth Gulch at mouth nr Tolland, CO	S	T02S R74W	-	-	12-03-71	1040	0	7.5	55	-	A	P-C	P-C	A
416	S Boulder C ab Black Cn nr Tolland, CO	S	T02S R73W	-	-	12-03-71	1125	0	7.5	75	-	A	P-C	P-C	A
418	Beaver C ab Burns Gulch nr Pinecliffe, CO	S	T01S R72W	-	-	12-02-71	1440	0	7.4	140	-	A	P-C	P-C	A
419	Burns Gulch at mouth nr Pinecliffe, CO	S	T01S R72W	-	-	12-02-71	1450	-	-	-	NP	-	-	-	-
420	S Boulder C ab S Beaver C nr Pinecliffe, CO	S	T01S R72W	-	-	12-02-71	1515	0	7.7	90	-	-	-	-	-
421	S Beaver C at mouth nr Pinecliffe, CO	S	T01S R72W	-	-	12-02-71	1500	0	7.5	180	-	A	P-C	C	A
422	Boiling Gulch at mouth at Pinecliffe, CO	S	T01S R72W	-	-	12-02-71	1540	0	7.5	180	-	A	P-C	P-C	A
425	Black Canyon C at mouth nr Tolland, CO	S	T02S R73W	-	-	12-03-71	1055	2.0	7.6	65	-	A	P-C	C+	A
426	Jenny Lind Gulch at mouth nr Tolland, CO	S	T02S R73W	-	-	12-03-71	1110	0	7.5	85	-	A	P-C	P-C	A
427	Moon Gulch at mouth at Rollinsville, CO	S	T01S R73W	-	-	12-03-71	0940	0	7.5	120	-	A	P-C	P	A
428	N Clear C at mouth nr Idaho Springs, CO	S	T03S R72W	39 44 50	105 23 51	12-13-71	1530	1.0	6.2	550	OTC	A	A	A	A
429	N Clear C ab Russell Gl nr Blackhawk, CO	S	T03S R72W	39 45 56	105 26 47	12-13-71	1430	0	5.2	590	OS YT ST	-	-	-	-
430	Russell Gulch at mouth nr Blackhawk, CO	S	T03S R72W	39 45 52	105 26 47	12-13-71	1410	0	6.6	700	-	-	-	-	-
431	Elk C at mouth nr Apex, CO	S	T02S R73W	-	-	12-09-71	1235	0	7.1	70	-	A	C	A	A
432	N Clear C ab Pine C nr Apex, CO	S	T02S R73W	-	-	12-09-71	1040	0	7.6	60	-	A	C	P	A
433	N Clear C ab Pecks Gulch nr Blackhawk, CO	S	T02S R73W	-	-	12-09-71	1340	0	7.2	70	OS	A	C	A	P
434	Missouri C ab Missouri Lk nr Blackhawk, CO	S	T02S R73W	39 50 03	105 30 58	12-09-71	1510	0	7.0	120	OS	A	C(?)	A	A
435	Missouri C tr at mouth nr Blackhawk, CO	S	T03S R73W	-	-	12-10-71	0945	0	7.7	160	-	A	-	A	A
436	Gregory Gulch at mouth at Blackhawk, CO	S	T03S R72W	39 48 07	105 29 36	12-13-71	1120	0	3.9	420	TC OS OT ST	A	A	A	A
437	Nevada Gulch at mouth at Central City, CO	S	T03S R73W	-	-	12-10-71	1215	-	-	-	NF	-	-	-	-
438	Gregory Gl ab Nevada Gl at Central City, CO	S	T03S R73W	39 48 05	105 30 48	12-10-71	1400	0	6.5	130	OS OS YT	A	P-C	P-C	A

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Field observations									Laboratory determinations															
Aquatic organisms									Trace elements, micrograms per liter															Sulfate (SO_4), milligrams per liter
Fauna																								
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	
									PLATTE RIVER BASIN (Continued)															
									Clear Creek County (Continued)															
A	A	P	P(?)	C	P-C	A	A	-	2	2	-	1	1	20	1	43	0.3	-	0	-	0	-	880	20
C	P	P	A	A	A	A	A	net-winged midges: P	1	0	-	0	2	10	2	7	.3	-	0	-	0	-	0	17
C	P	P	A	A	A	A	A	-	0	0	-	0	1	10	2	14	.5	-	0	-	0	-	140	34
P	A	P-C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	P-C	A	A	P	-	2	1	-	0	1	30	5	75	.3	-	0	-	0	-	570	22
C	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	C	P(?)	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	6	1	-	1	2	20	30	36	.5	-	2	-	0	-	50	39
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	P	1(?)	A	A	A	A	misc. dipteran: P-C	1	0	-	0	2	60	2	100	.3	-	0	-	0	-	70	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P-C	C	P	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	6	-	100	1000	5000	6	13,000	.3	-	120	-	0	-	1000	520
A	P	P	A	A	A	A	A	-	0	2	-	3	24	20	1	630	.3	-	2	-	0	-	360	61
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	1	A	A	A	-	2	3	-	3	20	20	0	2000	.3	-	4	-	2	-	800	83
-	-	-	-	-	-	-	-	-	2	2	-	2	16	60	3	1800	.1	-	5	-	0	-	600	82
									Gilpin County															
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	8	9	-	21	310	5000	2	5700	.4	-	60	19	0	-	3400	250
-	-	-	-	-	-	-	-	-	8	10	-	30	450	14,000	11	7600	.3	-	84	24	0	-	3800	290
-	-	-	-	-	-	-	-	-	4	12	-	6	150	20	2	2100	.5	0	16	1	0	-	4000	340
P	P	P	A	A	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	A	A	A	A	A	A	-	6	0	-	1	1	20	2	0	.5	2	0	1	0	-	0	29
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	fungal or bacterial slime (?): C	1	19	-	11	1000	6000	30	2100	.3	-	200	23	0	-	3900	100
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	1	A	P	A	A	A	-	10	0	-	0	3	380	0	200	.5	5	0	2	0	-	210	24

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Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
			PLATTE RIVER BASIN (Continued)												
			Gilpin County (Continued)												
439	Chase Gulch at mouth at Blackhawk, CO	S	T03S R72W	39 48 12	105 29 54	12-10-71	1115	0	6.7	590	ST	-	-	-	-
440	Pecks Gulch at mouth nr Blackhawk, CO	S	T02S R73W	-	-	12-09-71	1425	0	7.2	95	-	A	C(?)	A	P
668	Pine C ab Elk C nr Apex, CO	S	T02S R73W	-	-	12-09-71	1135	.5	7.2	85	-	A	C	P	P
669	N Clear C ab Gdn Gilpin Mill at Blackhawk, CO	S	T03S R72W	-	-	12-10-71	1045	0	7.3	100	-	A	C+	P	A
669A	N Clear C bl Gdn Gilpin Mill at Blackhawk, CO	S	T03S R72W	39 48 15	105 29 48	12-13-71	1010	0	7.3	105	-	A	C	P	A
669B	N Clear C ab Gregory Gl at Blackhawk, CO	S	T03S R72W	39 48 08	105 29 36	12-13-71	1150	2.0	5.6	650	OC	A	A	A	A
			Jackson County												
562	S F Big C ab Wheeler C at Pearl, CO	S	T12N R81W	-	-	10-14-71	0720	3.5	8.1	80		P	-	P	C
563	Beaver C ab Rhea C nr Pearl, CO	S	T12N R82W	-	-	10-14-71	0750	3.5	8.0	70		A	-	P	A
564	Pinkham C tr at mouth nr Kings Canyon, CO	S	T11N R79W	-	-	10-13-71	1640	5.0	8.0	650		P	-	P	A
565	Pinkham C tr No. 2 at mouth nr Kings Canyon, CO	S	T11N R79W	-	-	10-13-71	1630	-	-	-	NF	-	-	-	-
566	Pinkham C tr No. 3 at mouth nr Kings Canyon, CO	S	T11N R79W	-	-	10-13-71	1620	-	-	-	NF	-	-	-	-
567	Lawrence C at mouth at Kings Canyon, CO	S	T11N R79W	-	-	10-13-71	1600	7.0	8.9	345	VST	P	-	P-C	A
568	Jack C at Jack Creek Ranch, CO	S	T05N R77W	-	-	10-14-71	0845	4.5	8.1	70	-	P	-	P-C	A
569	Illinois R bl Horse C nr Jack Creek Ranch, CO	S	T05N R77W	-	-	10-14-71	1010	4.0	8.2	100	-	A	-	C	A
			Jefferson County												
3	Bear C tr at mouth nr Kittredge, CO	S	T04S R70W	-	-	10-05-71	1330	-	-	-	NF	-	-	-	-
345	Roland Gulch at mouth nr Pine, CO	S	T07S R71W	-	-	10-05-71	0855	6.0	8.2	240	-	P	-	P	A
347	N F S Platte R ab Pine Gulch at Pine, CO	S	T07S R71W	-	-	10-05-71	0800	4.5	8.2	90	T	A	-	P-C	A
348	Kennedy Gulch at mouth nr Foxton, CO	S	T07S R70W	-	-	10-05-71	1100	8.0	8.5	275	-	A	-	P	C(?)
349	Long Gulch at mouth at Dome Rock, CO	S	T07S R70W	39 25 22	105 12 00	10-05-71	1145	9.0	8.5	350	-	P	-	P	C(?)
350	Bear Gulch at mouth nr Kessler, CO	S	T07S R69W	-	-	10-06-71	1145	-	-	-	NF	-	-	-	-
351	Deer C bl Rattlesnake Gulch nr Phillipsburg, CO	S	T06S R69W	-	-	10-05-71	1620	15.5	9.0	310	-	A	-	P-C	A
369	Cub C at mouth at Evergreen, CO	S	T05S R71W	-	-	10-05-71	1445	10.5	7.9	110	-	A	-	P-C	A
370	Turkey C nr Morrison, CO (06711000)	S	T05S R69W	-	-	10-05-71	1525	15.0	8.5	1000	-	A	-	P-C	A
371	Bear C tr No. 2 at mouth nr Kittredge, CO	S	T04S R70W	-	-	10-05-71	1325	-	-	-	NF	-	-	-	-
372	Cold Spring Gulch at mo nr Kittredge, CO	S	T04S R71W	-	-	10-05-71	1345	11.5	8.4	380	-	P	-	P-C	A
373	Swede Gulch at mouth at Kittredge, CO	S	T04S R71W	-	-	10-05-71	1405	9.0	8.8	460	-	C	-	P	A
374	Tucker Cl bl Crawford Gl nr Golden, CO	S	T03S R71W	-	-	10-06-71	0925	11.0	8.6	375	-	P-C	-	P-C	A
375	Guy Gulch bl Robinson Gulch nr Golden, CO	S	T03S R71W	-	-	10-06-71	0855	8.0	8.5	260	-	P	-	P	A
376	Elk C at mouth nr Golden, CO	S	T03S R71W	-	-	10-06-71	0725	5.0	8.4	350	-	P-C	-	P	A
377	Ralston C ab Ralston Re, CO	S	T02S R70W	-	-	10-06-71	1005	11.0	8.6	325	-	P	-	P-C	A
454A	Clear C bl N Clear C nr Hidden Valley, CO	S	T04S R72W	39 44 17	105 23 21	12-23-71	1245	0	8.2	340	TC OS YT ST	A	P-C	P	A
676	Clear C nr Golden, CO (06719500)	S	T03S R70W	39 45 02	105 14 54	12-23-71	1510	0	8.7	350	TC OS YT ST	-	-	-	-
			Larimer County												
584	N F Rabbit C ab Haystack Gl nr Livermore, CO	S	T01N R71W	40 51 10	105 22 50	10-13-71	1230	10.0	7.5	320	TC YT	P	A	P	P
585	Owl C at Owl Canyon, CO	S	T09N R70W	-	-	10-13-71	1125	-	-	-	NF	-	-	-	-
586	Manhattan C at mouth nr Rustic, CO	S	T09N R73W	-	-	10-13-71	0940	6.5	8.4	170	-	P	-	A	P
587	Mineral Springs Gl at mouth at Rustic, CO	S	T09N R73W	-	-	10-13-71	0915	-	-	-	NF	-	-	-	-

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations: Aquatic organisms: Fauna: Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Laboratory determinations: Trace elements, micrograms per liter: Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
PLATTE RIVER BASIN (Continued)																								
Gilpin County (Continued)																								
-	-	-	-	-	-	-	-	-	3	10	-	4	50	30	2	1500	0.4	2	0	1	0	-	15,000	280
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	P	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	A	A	A	-	0	0	-	1	3	20	3	67	.4	-	0	9	0	-	270	20
A	A	A	A	A	A	A	A	-	5	5	-	27	420	40,000	16	8000	.3	36	84	4	0	-	2900	320
Jackson County																								
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	C	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson County																								
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C+	A	A	P	A	A	damselfly: 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	0	-	1	1	40	2	20	-	-	3	-	0	-	20	32
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	P	C	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	P	C	A	A	A	damselfly: 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	1	P	A	P	A	A	A	fungal or bacterial slime: P-C	2	3	-	4	13	20	3	1800	.3	-	9	-	0	-	610	84
-	-	-	-	-	-	-	-	-	6	2	-	3	10	20	1	1500	.3	-	7	3	0	-	590	93
Larimer County																								
A	A	A	A	C	A	A	A	Edge- damselflies: P midges: C Bottom- midges: C	7	0	-	1	1	3200	0	770	-	-	1	-	0	-	20	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	A	A	A	A	damselflies: C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	PLATTE RIVER BASIN (Continued)														
	Park County														
241	S Platte R ab Elevenmile Cn Re nr Hartsel, CO (06695000)	S	T12S R73W	-	-	10-04-71	1100	6.5	8.6	740	-	A	-	P-C	A
326	Fourmile C ab Peart Upper D nr Fairplay, CO	S	T10S R78W	-	-	09-29-71	1415	6.5	8.0	270	-	P	-	P	A
327	High C tr at mouth nr Fairplay, CO	S	T10S R78W	-	-	09-29-71	1515	-	-	-	NF	-	-	-	-
328	Sheep C nr mouth nr Fairplay, CO	S	T11S R78W	-	-	09-30-71	1215	11.0	7.7	540	BS	A	-	P	C
329	Twelvemile C ab Cave C nr Fairplay, CO	S	T11S R78W	-	-	09-30-71	1145	8.5	8.5	255	-	A	A	A	A
330	M F South Platte R ab Trout C at Garo, CO	S	T11S R76W	-	-	09-30-71	1310	12.0	7.9	320	-	A	-	P-C	A
331	Fourmile C ab High C nr Garo, CO	S	T11S R76W	-	-	09-30-71	1330	13.5	7.9	460	-	P	-	P-C	A
337	Marksbury Gulch at mouth nr Tarryall, CO	S	T11S R72W	-	-	10-04-71	1230	13.0	8.9	840	-	P-C	-	C	A
338	Tarryall C tr ab unnamed Re nr Tarryall, CO	S	T11S R72W	-	-	10-04-71	1210	7.0	7.9	140	OS	P-C	-	P	A
339	Pulver Gulch at mouth nr Lake George, CO	S	T12S R71W	-	-	10-04-71	1140	-	-	-	NF	-	-	-	-
340	Tappan Gulch at mouth nr Lake George, CO	S	T12S R71W	-	-	10-04-71	1150	-	-	-	NF	-	-	-	-
346	Holmes Gulch nr mouth nr Crossons, CO	S	T08S R72W	-	-	10-05-71	1000	6.0	8.1	275	-	P	-	P	A
352	Michigan C at mouth nr Jefferson, CO	S	T09S R75W	-	-	10-01-71	0845	6.0	8.5	180	-	A	-	P	C(?)
353	Tarryall C ab Park Gulch nr Como, CO	S	T09S R75W	-	-	10-01-71	0800	5.0	8.2	225	WT VST	P	-	P-C	C(?)
354	Park Gulch ab Cline Re nr Como, CO	S	T09S R76W	-	-	09-30-71	1545	12.5	7.7	740	VST	P-C	A	P	A
355	Michigan C bl French C nr Jefferson, CO	S	T08S R76W	-	-	09-28-71	1330	12.0	7.1	120	-	A	A	P	C(?)
356	Jefferson C ab Jefferson, CO (06698000)	S	T07S R76W	-	-	09-28-71	1245	9.0	8.0	70	BS	A	P	P	A
357	N F S Platte R ab Beaver C nr Webster, CO	S	T06S R75W	39 28 32	105 46 17	09-28-71	1015	4.5	6.3	160	TC WT VST	A	A	P	A
358	Bruno Gulch nr mouth nr Grant, CO	S	T06S R75W	-	-	01-06-72	1330	0	8.2	75	-	A	-	A	P
359	Geneva C ab Duck C nr Grant, CO	S	T06S R75W	39 31 48	105 43 56	12-29-71	1435	0	5.2	210	8GC OTC	A	A	A	A
359A	Geneva C ab Callahan Gulch nr Grant, CO	S	T06S R74W	39 28 56	105 41 37	01-06-72	1415	0	7.9	100	-	A	-	A	A
360	Duck C at mouth nr Grant, CO	S	T06S R75W	-	-	12-29-71	1535	0	8.1	70	-	A	P-C	P-C	A
361	Sacramento C nr mouth nr Fairplay, CO	S	T09S R77W	39 13 38	106 02 33	09-29-71	0845	3.0	5.6	160	YT VST	A	A	A	A
362	Mosquito C at mouth at Alma. CO	S	T09S R78W	-	-	09-29-71	1245	5.0	7.8	250	ST	A	-	P-C	A
363	Buckskin C at mouth at Alma, CO	S	T09S R78W	-	-	09-29-71	1030	4.0	7.2	180	-	A	A	A	A
364	M F S Platte R ab Buckskin C nr Alma, CO	S	T09S R78W	39 17 40	106 03 54	09-29-71	1045	4.0	7.4	230	VST	A	A	P	P
365	Beaver C nr source nr Alma, CO	S	T09S R77W	-	-	09-29-71	1330	5.5	8.0	240	-	A	-	A	A
366	Trout C ab U.S. 285 nr Como, CO	S	T09S R76W	-	-	09-30-71	1030	9.5	8.6	160	WT VST	P-C	A	A	A
367	Tarryall C ab Silverheels C nr Como, CO	S	T08S R77W	-	-	09-28-71	1500	11.0	7.6	170	-	A	-	P-C	A
368	N Tarryall C at mouth nr Como, CO	S	T08S R77W	-	-	09-28-71	1430	10.0	7.8	155	-	A	P	P-C	A
413	M F S Platte R ab Platte Placer D nr Alma, CO	S	T08S R78W	-	-	09-29-71	1130	5.0	7.5	210	-	A	A	C+	A
	Teller County														
230	Trout C ab Rule C nr Woodland Park, CO	S	T11S R69W	-	-	10-04-71	1345	14.0	8.3	205	-	P	-	P-C	A
341	Turkey C ab Cheesman Lk nr Deckers, CO	S	T11S R70W	-	-	10-04-71	1635	9.0	8.3	180	-	P	-	P	A
342	Trail C nr mouth nr Westcreek, CO	S	T11S R70W	-	-	10-04-71	1550	10.0	8.2	155	-	P	-	A	A
344	Rule C at mouth nr Woodland Park, CO	S	T11S R69W	-	-	10-04-71	1415	10.5	7.7	155	-	P	-	P	A

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															Sulfate (SO_4), milligrams per liter
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	
									PLATTE RIVER BASIN (Continued)															
									Park County															
C	C	C	A	P(?)	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	C	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	-	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	P	P	P	A	fish observed in beaver ponds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	C	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	P	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	flatworms: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	P-C	A	1	A	fungal or bacterial slime: C	0	0	-	7	40	980	3	280	-	-	19	-	0	-	30	63
P	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	2	-	8	40	320	3	770	0.4	-	20	-	0	-	250	96
P	P	P-C	A	A	A	A	A	net-winged midges: P-C	0	0	-	2	2	10	2	120	.3	-	3	-	0	-	40	26
P-C	P-C	P	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	misc. dip-teran(?): C fungal or bacterial slime(?): P	0	0	-	0	1	70	1	40	-	-	0	-	0	-	40	11
P	P	P	A	A	A	A	A	misc. dip-teran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	A	A	A	-	0	0	-	0	2	80	1	50	-	0	2	-	0	-	0	15
C	C	C	C	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*	*	*	*	*	*	*	*	Edge-damselflies: C midges: P Bottom-midges: P oligochaetes: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	P(?)	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	P	P(?)	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	A	A	C	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Teller County															
C	C	C	A	A	P	C	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	P	A	A	damselfly: 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 5.—*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location				Date	Time	Field observations				Aquatic organisms: Flora			
		Principal meridian	Township and Range	Latitude	Longitude			Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Rooted aquatics	Diatoms	Green algae	Blue-green algae
	ARKANSAS RIVER BASIN														
	Baca County														
170	W Carrizo C at mouth nr Edler, CO	S	T34S R50W	-	-	11-04-71	1010	7.0	7.9	900	-	A	P-C	C	A
171	E Carrizo C at mouth nr Edler, CO	S	T34S R50W	-	-	11-04-71	0940	9.0	7.8	750	-	A	P-C	C	A
172	Carrizo C ab Colorado-Oklahoma State line	S	T35S R50W	37 01 46	102 58 02	11-04-71	1100	12.5	7.9	950	-	A	P-C	C	A
	Chaffee County														
1A	Chalk C ab N F Chalk C at St. Elmo, CO	S	T15S R80W	-	-	11-04-71	1230	0	7.6	105	-	A	C+	A	A
12	Grizzly Gulch at mouth at St. Elmo, CO	S	T15S R80W	38 42 20	106 20 16	11-04-71	1315	1.0	7.6	125	OS	A	P	A	A
13	Baldwin C at mouth nr St. Elmo, CO	S	T15S R80W	-	-	11-04-71	1435	.5	7.7	115	-	A	C	A	A
14	S Arkansas R ab Taylor Gl at Garfield, CO	NM	T50N R06E	-	-	10-29-71	1430	0	8.0	140	-	A	C	A	A
14A	Taylor Gulch at mouth at Garfield, CO	NM	T50N R06E	-	-	10-29-71	1500	-	-	-	NF	-	-	-	-
14B	Madonna Mine at Monarch, CO	NM	T50N R06E	38 32 11	106 18 46	07-19-72	1030	4.5	8.3	200	-	A	P	C	A
15	Green C at mouth nr Maysville, CO	NM	T49N R07E	38 31 35	106 09 19	10-29-71	1510	0	7.6	110	-	-	-	-	-
16	L Cochetopa C at mo nr Poncha Springs, CO	NM	T49N R08E	-	-	11-02-71	1600	2.0	8.2	165	-	A	P-C	P(?)	P
17	Poncha C ab Camp Rock Gulch nr Salida, CO	NM	T48N R08E	38 26 47	106 06 29	10-29-71	1640	0	7.7	130	-	-	-	-	C
21	Squaw C at mouth nr Poncha Springs, CO	NM	T50N R08E	-	-	10-29-71	0900	.5	8.2	390	-	A	P-C	A	A
22	Loggie Gulch at mouth at Salida, CO	NM	T49N R09E	-	-	10-29-71	0740	-	-	-	NF	-	-	-	-
28	M Cottonwood C ab Denny Gulch nr Buena Vista, CO	S	T14S R80W	-	-	10-15-71	1350	5.0	8.2	110	-	A	C	A	A
29	S Cottonwood C ab Fox Lk nr Buena Vista, CO	S	T14S R80W	-	-	11-05-71	0845	0	7.7	115	OS	A	C+	A	A
32	Trout C nr mouth nr Buena Vista, CO	S	T14S R78W	-	-	11-04-71	1540	5.5	8.5	460	-	A	C	P	A
33	Maxwell C nr mouth nr Buena Vista, CO	S	T14S R78W	-	-	11-09-71	1525	-	-	-	NF	-	-	-	-
34	Trout C ab Mushroom Gl nr Buena Vista, CO	S	T14S R77W	-	-	11-05-71	1300	14.0	8.9	380	-	C	P	P	A
36	Frenchman C at mouth nr Buena Vista, CO	S	T13S R79W	-	-	11-05-71	1120	.5	7.6	95	-	A	C+	A	A
37	Morrison C at mouth nr Buena Vista, CO	S	T12S R79W	-	-	11-05-71	1035	1.0	7.6	90	-	-	-	-	-
39	N F Clear C at mouth at Winfield, CO	S	T12S R81W	-	-	11-08-71	1245	0	7.7	135	-	A	P-C	P	A
40	S F Clear C at mouth at Winfield, CO	S	T12S R81W	-	-	11-08-71	1305	0	7.5	120	-	A	C	P	A
41	Lk F Clear C at mouth nr Winfield, CO	S	T12S R81W	-	-	11-08-71	1350	.5	7.7	140	-	A	P-C	P	A
294	W Columbine Gl at mo nr Buena Vista, CO	S	T14S R77W	-	-	11-05-71	1230	-	-	-	NF	-	-	-	-
322	Clear C ab Clear Creek Re, CO (07086500)	S	T12S R80W	-	-	11-08-71	1530	4.5	7.7	150	-	A	C	P	A
322A	Clear C bl Sheep Gulch at Vicksburg, CO	S	T12S R81W	-	-	11-08-71	1440	-	-	-	-	A	C	P	A
324	Low Pass Gulch at mouth at Granite, CO	S	T11S R79W	-	-	11-08-71	1620	0	7.7	95	-	A	C	P	P-C
	Custer County														
199	St. Charles R at San Isabel, CO (07107000)	S	T24S R69W	-	-	11-04-71	1540	1.0	8.1	80	-	A	P-C	P	A
200	Ophir C at mouth nr Beulah, CO	S	T23S R69W	-	-	11-04-71	1620	.5	8.0	120	-	A	P-C	P-C	A
201	Middle C ab Ophir C nr Beulah, CO	S	T23S R69W	-	-	11-04-71	1605	1.0	7.9	120	-	A	P-C	P	A
203	Oak C ab Ralph Gulch nr Ilse, CO	S	T21S R71W	-	-	11-08-71	1105	-	-	-	NF	-	-	-	-
204	Grape C tr at mouth nr Westcliffe, CO	S	T21S R72W	-	-	11-09-71	0840	-	-	-	NF	-	-	-	-
205	Chloride Gulch at mouth at Westcliffe, CO	S	T22S R72W	-	-	11-09-71	0925	-	-	-	NF	-	-	-	-
206	DeWeese Re tr nr mouth nr Westcliffe, CO	S	T21S R72W	-	-	11-09-71	0825	-	-	-	NF	-	-	-	-
207	Wilmer Gulch tr at mouth nr Rosita, CO	S	T23S R72W	-	-	11-09-71	1010	-	-	-	NF	-	-	-	-
208	Fourmile Gl tr nr mo nr Silver Cliff, CO	S	T22S R72W	-	-	11-09-71	0940	-	-	-	NF	-	-	-	-
209	N Hardscrabble C at mo nr Greenwood, CO	S	T21S R69W	-	-	11-04-71	1700	6.5	8.0	300	-	A	P-C	P	A
210	Grape C bl DeWeese Re, Co	S	T21S R72W	-	-	11-09-71	0845	3.0	8.0	385	-	A	P-C	P-C	A
213	Texas C ab Spruce C at Hillside, CO	NM	T46N R12E	-	-	10-28-71	1055	0	7.8	280	-	A	P-C	P-C	A
289	Grape C tr No. 2 at mo nr Westcliffe, CO	S	T21S R72W	-	-	11-09-71	0905	-	-	-	-	-	-	-	-
290	Grape C ab Taylor C nr Westcliffe, CO	S	T22S R73W	-	-	11-09-71	0800	0	8.1	375	-	A	P-C	P-C	A
	El Paso County														
224	Turkey C ab L Turkey C nr Ft. Carson, CO	S	T17S R67W	-	-	10-28-71	1450	-	-	-	NF	-	-	-	-
225	L Turkey C nr mouth nr Ft. Carson, CO	S	T16S R67W	-	-	10-28-71	1505	-	-	-	NF	-	-	-	-
226	L Fountain C ab unnamed re nr Ft. Carson, CO	S	T16S R67W	-	-	10-28-71	1520	-	-	-	NF	-	-	-	-
227	Rock C nr source nr Ft. Carson, CO	S	T15S R66W	-	-	10-28-71	1530	-	-	-	NF	-	-	-	-
228	Cheyenne C bl N Cheyenne C at Broadmoor, CO	S	T14S R67W	-	-	10-28-71	1545	8.0	7.8	120	-	A	-	P-C	A
229	Douglas C nr source nr Pikeview, CO	S	T13S R67W	-	-	10-06-71	1355	-	-	-	NF	-	-	-	-

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations — Aquatic organisms — Fauna / Miscellaneous

	Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous
ARKANSAS RIVER BASIN									
Baca County									
1	C	P	C	A	A	C	C	A	fish observed
2	A	P	P	A	A	A	A	A	fish observed
3	C	P	P	A	A	A	C	A	fish observed
Chaffee County									
4	P	A	P-C	A	A	A	A	A	-
5	P	P	A	A	A	A	A	A	-
6	P	A	P	A	A	A	A	A	net-winged midges: P
7	C	P	P	A	P	A	A	A	-
8	-	-	-	-	-	-	-	-	-
9	P	P	A	A	A	C	A	P	-
10	-	-	-	-	-	-	-	-	-
11	P	C	C	A	A	A	A	A	-
12	A	A	P	A	A	A	A	A	-
13	P	P	P	A	C	A	A	A	-
14	-	-	-	-	-	-	-	-	-
15	C	A	P	A	A	A	A	A	fungal or bacterial slime: P
16	P	P-C	P	A	A	A	A	A	-
17	P	C	C	A	A	A	A	A	-
18	-	-	-	-	-	-	-	-	-
19	A	C	P	A	A	A	A	A	-
20	A	P	C	A	A	A	A	A	-
21	-	-	-	-	-	-	-	-	-
22	P	P	P	A	A	P	A	A	-
23	P	P	P	A	A	A	A	A	-
24	P	P	P	A	P	A	A	A	-
25	-	-	-	-	-	-	-	-	-
26	C	P	P	A	A	A	A	A	-
27	C	P	P	A	A	A	A	A	-
28	P	P	P	A	A	A	A	A	-
Custer County									
29	C	C	C	A	A	A	A	A	-
30	C	C	C	A	A	A	A	A	-
31	C	C	C	A	A	A	A	A	-
32	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-
38	C	C	C	A	A	A	C	A	-
39	C	C	C+	A	A	A	A	A	-
40	C	C	C	A	A	A	A	A	-
41	-	-	-	-	-	-	-	-	-
42	C	C	C	A	A	A	A	A	-
El Paso County									
43	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-
47	P	P	P	A	A	A	A	A	-
48	-	-	-	-	-	-	-	-	-

Laboratory determinations — Trace elements, micrograms per liter; Sulfate, milligrams per liter

	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
ARKANSAS RIVER BASIN																
Baca County																
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	0	0	-	0	1	20	2	0	0.0	-	3	-	0	-	10	270
Chaffee County																
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	2	0	-	0	3	10	3	100	.3	-	2	-	0	-	20	45
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	1	0	-	1	1	10	1	0	.0	-	2	-	0	-	20	4.0
10	0	0	-	1	1	70	2	120	.4	-	4	-	0	-	20	3.2
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	0	0	-	0	2	220	2	210	.3	-	3	-	0	-	0	4.3
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Custer County																
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
El Paso County																
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.—*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	ARKANSAS RIVER BASIN (Continued)														
	Fremont County														
25	Steer C nr mouth nr Howard, CO	NM	T51N R10E	-	-	11-01-71	1545	-	-	-	NF	-	-	-	-
26	Willow C nr mouth nr Howard, CO	NM	T41N R10E	-	-	11-01-71	1610	-	-	-	NF	-	-	-	-
27	Badger C at mouth nr Howard, CO	NM	T49N R10E	-	-	11-01-71	1200	-	-	-	NF	-	-	-	-
211	Grape C ab Bear Gulch nr Canon City, CO	S	T20S R71W	-	-	11-08-71	1145	2.5	7.8	400	ST	A	P-C	P-C	A
212	Pine Gl ab W Pierce Gl nr Canon City, CO	S	T20S R72W	38 20 42	105 23 47	11-08-71	1425	8.0	7.9	850	-	C+	P-C	P	A
214	Bernard C at mouth at Cotopaxi, CO	NM	T48N R12E	38 22 33	105 41 17	11-01-71	1150	11.0	7.9	950	-	A	P-C	P-C	A
215	Fernleaf Gulch at mouth nr Cotopaxi, CO	NM	T48N R12E	-	-	11-01-71	1115	-	-	-	NF	-	-	-	-
216	Texas C nr mouth nr Texas Creek, CO	NM	T48N R12E	-	-	11-01-71	1100	-	-	-	NF	-	-	-	-
217	Volcano Gulch at mouth nr Canon City, CO	S	T19S R71W	-	-	10-29-71	0930	-	-	-	NF	-	-	-	-
218	Grape C ab Volcano Gl nr Canon City, CO	S	T19S R71W	-	-	10-29-71	0910	1.0	7.7	350	-	A	P-C	P-C	A
219	Grape C tr at mouth nr Canon City, CO	S	T19S R71W	-	-	10-29-71	0840	-	-	-	NF	-	-	-	-
220	Red Gulch ab Dirty Gulch nr Cotopaxi, CO	NM	T49N R11E	-	-	11-01-71	1230	-	-	-	NF	-	-	-	-
221	Smith Gulch at mouth nr Parkdale, CO	S	T16S R72W	-	-	10-28-71	1145	-	-	-	NF	-	-	-	-
222	Currant C ab Smith Gulch nr Parkdale, CO	S	T16S R72W	-	-	10-28-71	1150	7.0	7.7	550	-	A	P-C	P-C	A
223	Currant C ab Cottonwood C nr Parkdale, CO	S	T17S R72W	-	-	10-28-71	1215	7.5	7.7	550	-	A	P-C	P-C	A
236	Milsap C nr mouth nr Victor, CO	S	T17S R70W	-	-	10-28-71	1330	-	-	-	NF	-	-	-	-
237	Eightmile C nr source nr Victor, CO	S	T16S R69W	-	-	10-27-71	1215	9.0	7.7	220	-	A	P-C	P-C	A
288	Copper Gulch at mouth at Parkdale, CO	S	T18S R71W	-	-	10-29-71	0950	-	-	-	NF	-	-	-	-
	Huerfano County														
166	Echo C at mouth nr La Veta, CO	S	T30S R68W	-	-	11-03-71	1510	7.5	7.9	120	-	A	P-C	P	A
167	School C ab Echo D nr La Veta, CO	S	T30S R68W	-	-	11-03-71	1540	-	-	-	NF	-	-	-	-
179	Yellowstone C bl S F nr Badito, CO	S	T27S R69W	-	-	11-09-71	1345	-	-	-	NF	-	-	-	-
180	S Abeyta C nr mouth nr La Veta, CO	S	T29S R69W	-	-	11-03-71	1410	4.0	8.0	260	-	A	P-C	P	A
181	Manzanares C at mouth nr Red Wing, CO	S	T27S R71W	-	-	11-09-71	1300	-	-	-	NF	-	-	-	-
182	Stanley C at mouth nr Red Wing, CO	S	T27S R71W	-	-	11-09-71	1205	-	-	-	NF	-	-	-	-
183	Martin C at mouth nr Red Wing, CO	S	T27S R71W	37 43 22	105 16 47	11-09-71	1120	6.0	7.8	950	-	A	P-C	P-C	A
184	May C bl N May C nr Red Wing, CO	S	T27S R72W	-	-	11-09-71	1215	6.0	-	220	-	A	P-C	C	A
291	Middle C bl Oak C nr La Veta, CO	S	T29S R68W	37 31 08	105 03 06	11-03-71	1425	6.0	7.4	1300	OS	A	P-C	C	A
	Lake County														
315	S F Lake C at mouth nr Twin Lakes, CO	S	T11S R82W	39 04 02	106 30 09	11-09-71	0845	0	5.0	200	TC OS YT ST	A	A	A	A
316	N F Lake C at mouth nr Twin Lakes, CO	S	T11S R82W	-	-	11-09-71	1000	0	7.8	90	-	A	P	P	A
318	Echo C at mouth nr Twin Lakes, CO	S	T11S R81W	-	-	11-09-71	1150	0	7.7	140	-	A	P	P	A
321	Lake C ab Twin Lakes Re, CO (07084500)	S	T11S R81W	-	-	11-08-71	1705	0	7.6	140	-	A	P	-	A
321A	Lake C bl Crystal Lake C nr Twin Lakes, CO	S	T11S R81W	39 04 14	106 27 05	11-09-71	1225	0	7.8	130	TC YT ST	-	-	-	-
321B	Lake C at State Hwy 82 bl Twin Lakes Re, CO	S	T11S R80W	-	-	11-09-71	1355	-	-	-	-	A	C	P	A
325	Big Union C bl L Union C nr Malta, CO	S	T10S R80W	-	-	01-27-72	0900	0	8.4	340	-	-	-	-	-
623	Empire Gulch nr mouth nr Malta, CO	S	T10S R80W	-	-	01-27-72	0935	0	7.5	245	BS	A	-	A	P
624	Thompson Gulch at mouth nr Malta, CO	S	T10S R80W	-	-	01-27-72	1000	-	-	-	NF	-	-	-	-
625	Iowa Gulch at mouth nr Malta, CO	S	T10S R80W	-	-	01-27-72	1010	-	-	-	NF	-	-	-	-
626	California Gulch at Malta, CO (07081800)	S	T09S R80W	39 13 21	106 21 14	01-27-72	1030	1.0	7.0	950	OC TC OT T	A	A	A	A
627	California Gl ab stp outfall at Leadville, CO	S	T09S R80W	39 14 20	106 18 04	01-27-72	1215	1.0	6.3	1500	BOC OC OS OT ST	A	A	A	A
628	Yak Tunnel nr Leadville, CO	S	T09S R80W	39 14 09	106 16 13	01-27-72	1320	8.0	4.9	1500	OC OT ST	A	A	A	A
628A	California Gulch ab Yak Tunnel nr Leadville, CO	S	T09S R79W	-	-	01-27-72	1300	-	-	-	NF OS	-	-	-	-
629	E F Arkansas R nr Leadville, CO (07079500)	S	T09S R80W	39 15 35	106 20 24	01-26-72	1420	0	7.7	400	TC YT	A	-	A	A
630	E F Arkansas R at State Hwy 91 nr Leadville, CO	S	T09S R80W	-	-	01-27-72	1600	0	7.2	230	-	-	-	-	-
631	Evans Gulch at Leadville, CO	S	T09S R80W	-	-	01-27-72	1510	-	-	-	NF OS	-	-	-	-

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations: Aquatic organisms: Fauna									Laboratory determinations: Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									ARKANSAS RIVER BASIN (Continued)															
									Fremont County															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	C	C	A	-	2	0	-	1	0	10	2	10	1.2	12	0	7	0	-	20	57
C	C	C	A	A	A	A	A	-	0	0	-	0	20	10	3	0	.1	-	7	-	0	-	20	63
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C+	A	A	C	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Huerfano County															
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	0	.0	0	0	1	20	1	20	.2	-	3	-	0	0.3	30	60
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	P	A	flatworms(?): P	3	0	0	1	1	40	2	180	.4	-	0	-	0	.8	20	370
									Lake County															
A	A	A	A	A	A	A	A	-	0	3	-	10	110	410	6	120	.3	0	19	-	0	-	70	87
P	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P-C	P(?)	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	2	0	-	1	6	10	1	60	.3	3	7	-	0	-	10	30
A	P-C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P-C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	fungal or bacterial slime: P	5	9	-	15	34	620	2	14,000	.3	-	12	11	0	-	28,000	450
A	A	A	A	A	A	A	A	-	2	160	-	29	690	30,000	6	30,000	.3	-	60	0	0	-	60,000	930
A	A	A	A	A	A	A	A	fungal or bacterial slime: P	8	150	-	27	900	45,000	8	26,000	.3	32	68	16	0	-	53,000	960
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	A	A	A	A	crane flies(?):P	8	2	-	1	1	10	3	600	.3	-	0	5	0	-	1200	85
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	ARKANSAS RIVER BASIN (Continued)														
	Lake County (Continued)														
631A	Leadville Drain at Leadville, CO (07079200)	S	T09S R80W	39 16 29	106 17 15	01-27-72	1535	6.0	7.1	800	OC OS OT	A	A	P-C	A
632	Birdseye Gulch at mouth nr Climax, CO	S	T08S R79W	-	-	01-28-72	0945	-	-	-	NF	-	-	-	-
633	E F Arkansas R bl Climax, CO	S	T08S R79W	39 19 46	106 13 04	01-28-72	1050	0	7.2	240	-	A	P	P	A
635	E F Arkansas R ab Birdseye Gulch nr Climax, CO	S	T08S R79W	-	-	01-28-72	0930	-	-	-	NF	-	-	-	-
636	Buckeye Gulch at mouth nr Climax, CO	S	T08S R79W	-	-	01-27-72	1640	-	-	-	NF	-	-	-	-
637	Lake Fork bl Bear Lake C nr Malta, CO	S	T09S R81W	-	-	01-26-72	1035	0	7.2	60	-	A	C+	A	-
638	Lake Fork bl Mill C nr Malta, CO	S	T09S R81W	-	-	01-26-72	0940	0	-	<50	-	A	C	A	A
638A	Lake Fork tr at mouth nr Malta, CO	S	T09S R81W	-	-	01-26-72	1020	0	-	50	-	-	-	-	-
639	Busk C at mouth nr Malta, CO	S	T09S R81W	39 16 34	106 26 11	01-26-72	1000	0	6.8	60	-	A	-	A	A
640	Tennessee C bl Thayer Gl nr Leadville, CO	S	T08S R80W	39 21 07	106 19 01	01-26-72	1545	.5	6.6	100	-	A	-	C	P-C
641	W Tennessee C at mouth nr Leadville, CO	S	T08S R80W	-	-	01-26-72	1650	0	6.4	60	-	-	-	-	-
643	E Tennessee C nr mouth nr Leadville, CO	S	T08S R80W	-	-	01-27-72	1545	0	7.2	150	-	A	C	A	P
645	St. Kevin Gulch at mouth nr Leadville, CO	S	T09S R80W	39 17 27	106 21 58	01-26-72	1230	0	3.6	350	OC YT	A	A	P-C	A
646	Temple Gulch at mouth nr Leadville, CO	S	T08S R80W	-	-	01-26-72	1305	-	-	-	NF	-	-	-	-
655	Lake Fork bl Colorado Gulch nr Malta, CO	S	T09S R80W	-	-	01-27-72	1115	1.0	7.9	80	BS	A	C	P	A
656	Gleason Gulch at mouth nr Leadville, CO	S	T09S R80W	39 17 50	106 21 49	01-26-72	1245	0	7.2	190	-	-	-	-	-
	Las Animas County														
168	S F Trujillo C tr at mouth nr Aguilar, CO	S	T31S R66W	-	-	11-03-71	1655	-	-	-	NF	-	-	-	-
169	S F Trujillo C ab unnamed tr nr Aguilar, CO	S	T31S R66W	-	-	11-03-71	1710	-	-	-	NF	-	-	-	-
	Park County														
242	Thirtyone Mile C at mouth nr Guffey, CO	S	T15S R73W	-	-	10-28-71	1110	8.5	7.8	650	-	A	P-C	P-C	A
243	Currant C ab Thirtyone Mile C nr Guffey, CO	S	T15S R73W	-	-	10-28-71	1050	8.0	7.7	500	-	A	P-C	P-C	A
244	Freshwater C at mouth nr Guffey, CO	S	T15S R73W	-	-	10-28-71	1130	-	-	-	NF	-	-	-	-
	Teller County														
231	Oil C at mouth nr Midland, CO	S	T14S R70W	-	-	10-28-71	0835	1.0	7.8	80	-	A	P-C	P-C	A
232	Barnard C at mouth nr Cripple Creek, CO	S	T15S R70W	-	-	10-28-71	1000	2.5	7.8	200	-	A	P-C	P	A
233	Long Hungry Gulch at mouth nr Victor, CO	S	T16S R70W	-	-	10-27-71	1450	11.5	7.6	300	-	A	P-C	P-C	A
234	Cripple C at mouth nr Victor, CO	S	T16S R70W	38 39 59	105 13 38	10-27-71	1515	10.0	7.6	600	-	A	P-C	P	A
235	Wilson C at mouth nr Victor, CO	S	T16S R70W	38 39 19	105 12 39	10-27-71	1350	13.0	7.9	640	-	A	P-C	C	A
238	W Beaver C ab Willow C nr Goldfield, CO	S	T15S R69W	-	-	10-27-71	1100	1.0	7.9	80	-	A	P-C	P-C	A
239	M Beaver C nr mouth nr Goldfield, CO	S	T15S R68W	-	-	10-27-71	1030	3.0	7.8	65	-	A	P-C	P-C	A
240	E Beaver C bl Penrose-Rosemont Re, CO	S	T15S R68W	-	-	10-27-71	0920	3.0	8.0	80	-	A	P-C	P-C	A
286	Fourmile C ab Oil C nr Midland, CO	S	T14S R70W	-	-	10-28-71	0810	1.0	7.7	75	-	A	P-C	P	A
287	Willow C at mouth nr Goldfield, CO	S	T15S R69W	-	-	10-27-71	1110	-	-	-	NF	-	-	-	-
333	Fourmile C ab Cripple C nr Victor, CO	S	T16S R70W	-	-	10-27-71	1540	10.0	7.8	300	-	A	P-C	P-C	A
334	Cripple C ab Roosevelt Tunnel nr Victor, CO	S	T16S R70W	-	-	10-27-71	1625	7.0	7.6	550	-	A	P-C	P	A
334A	Roosevelt Tunnel nr Victor, CO	S	T16S R70W	38 41 28	105 12 21	10-27-71	1615	4.5	8.2	1500	-	-	-	-	-
335	Carlton Tunnel nr Victor, CO	S	T16S R70W	38 39 46	105 13 13	10-27-71	1430	22.0	7.4	2100	OC GT ST	-	-	-	-
336	Fourmile C ab Wilson C nr Victor, CO	S	T16S R70W	38 38 57	105 13 09	10-27-71	1400	15.0	7.7	1000	ST	-	-	-	-

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
ARKANSAS RIVER BASIN (Continued)																								
Lake County (Continued)																								
A	A	A	A	A	A	A	A	fungal or bacterial slime: P	0	15	-	3	2	100	0	3000	0.4	-	4	14	0	-	6500	340
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	10	1	-	1	4	20	1	140	.3	59	2	17	0	-	50	60
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	A	A	A	A	A	A	-	4	0	-	0	1	80	1	29	.4	-	0	7	0	-	0	3.0
A	P	A	A	P	A	A	A	-	10	1	-	0	5	20	1	0	.3	-	1	24	0	-	50	6.5
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	3	60	-	9	120	1800	19	6200	.3	3	20	4	0	-	11,000	130
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P-C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	3	0	-	0	1	30	1	160	.3	1	0	1	0	-	350	58
Las Animas County																								
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Park County																								
A	P	A	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Teller County																								
C	C	C	A	A	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	C	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	C	A	A	-	0	1	-	1	3	20	5	410	.4	-	8	3	0	-	50	250
C	P	C	A	A	A	A	A	-	0	0	-	0	1	0	1	0	.3	-	0	4	0	-	30	190
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	2	0	-	0	1	20	1	50	.3	-	5	3	0	-	50	700
-	-	-	-	-	-	-	-	-	0	0	-	2	1	20	1	1200	.3	-	6	8	0	-	40	1300
-	-	-	-	-	-	-	-	-	0	0	-	1	0	20	2	200	.4	-	1	4	0	-	40	430

Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location				Date	Time	Field observations				Aquatic organisms			
												Flora			
		Principal meridian	Township and Range	Latitude	Longitude			Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Rooted aquatics	Diatoms	Green algae	Blue-green algae
	RIO GRANDE BASIN														
	Alamosa County														
177	Holbrook C bl Lk Como nr Blanca, CO	S	T28S R73W	-	-	11-03-71	0830	-	-	-	NF	-	-	-	-
178	S Zapata C nr mouth nr Blanca, CO	S	T28S R73W	-	-	11-03-71	0935	-	-	-	NF	-	-	-	-
	Conejos County														
156	Iron C nr mouth nr Jasper, CO	NM	T36N R04E	37 22 53	106 36 08	10-05-71	1715	4.0	4.9	180	OS GT ST	A	A	A	A
157	Prospect C at mouth nr Jasper, CO	NM	T36N R03E	-	-	10-05-71	1745	2.5	7.8	80	-	A	P-C	P	A
158	Conejos R ab Platoro Re nr Platoro, CO	NM	T35N R03E	-	-	10-05-71	1635	9.5	7.8	45	-	A	P-C	P	A
159	Adams F Conejos R at mouth nr Platoro, CO	NM	T36N R03E	-	-	10-05-71	1620	7.0	7.9	55	-	A	P-C	P	A
160	Alamosa C ab Wightman F nr Jasper, CO	NM	T36N R04E	37 24 04	106 31 26	10-05-71	1530	9.0	6.0	210	OC RS ST	A	A	A	A
266	Treasure C ab Prospect C nr Jasper, CO	NM	T36N R03E	-	-	10-05-71	1800	4.0	7.8	80	-	A	P-C	P	A
	Costilla County														
165	El Poso C at mouth nr Chama, CO	S	T33S R71W	-	-	11-03-71	1100	.5	7.6	180	-	A	P-C	P	A
173	Wagon C at mouth nr Russell, CO	S	T29S R71W	37 30 55	105 18 10	11-03-71	1230	1.0	8.2	500	GT	A	P-C	P	A
174	Malo Vega C at mouth nr Russell, CO	S	T29S R71W	-	-	11-03-71	1305	-	-	-	NF	-	-	-	-
175	Placer C at mouth at Russell, CO	S	T28S R71W	-	-	11-03-71	1320	2.0	8.1	190	-	A	P-C	P	A
176	Sangre de Cristo C ab Placer C at Russell, CO	S	T28S R71W	-	-	11-03-71	1330	2.0	7.9	250	-	A	P-C	P	A
	Mineral County														
136	Rat C at mouth nr Creede, CO	NM	T42N R01W	-	-	09-28-71	0945	5.0	8.1	85	-	A	P-C	P-C	A
137	W Willow C at mouth at North Creede, CO	NM	T42N R01W	37 52 02	106 55 34	09-28-71	1250	9.0	7.7	190	-	A	P-C	P-C	A
138	E Willow C at mouth at North Creede, CO	NM	T42N R01E	37 51 57	106 55 19	09-28-71	1215	9.0	7.9	70	GT	A	P-C	P	A
139	Shallow C at mouth nr Creede, CO	NM	T41N R01W	-	-	09-28-71	0910	8.0	8.1	65	-	A	P-C	C	A
140	Miners C at mouth nr Creede, CO	NM	T42N R01E	37 50 37	106 57 47	09-28-71	1015	5.5	8.1	65	-	A	P-C	P-C	A
141	Willow C di at mouth nr Creede, CO	NM	T41N R01E	37 49 23	106 54 38	09-28-71	1420	13.0	7.6	180	-	A	A	C	A
142	Dry Gulch at mouth nr Creede, CO	NM	T41N R01E	-	-	09-28-71	1530	-	-	-	NF	-	-	-	-
145	Lime C ab unnamed tr at Spar City, CO	NM	T40N R01W	-	-	09-28-71	0830	5.5	7.9	110	-	A	P-C	C	A
284	Willow C di No. 2 at mouth nr Creede, CO	NM	T41N R01E	37 49 23	106 54 32	09-28-71	1425	15.0	7.9	120	-	-	-	C	-
	Rio Grande County														
155	Wightman F Alamosa C at mo nr Jasper, CO	NM	T37N R04E	37 24 15	106 31 16	10-05-71	1500	7.0	6.6	290	OC RS GT ST	A	P(?)	A	A
161	Alamosa C ab Castleman Gl nr Jasper, CO	NM	T37N R05E	37 24 18	106 27 06	10-05-71	1420	10.0	7.4	280	OC RS BT	A	A	P	A
	Saguache County														
61	Kerber C nr mouth at Villa Grove, CO	NM	T46N R09E	-	-	11-03-71	1420	4.5	7.8	505	TC ST	A	P-C	P-C	A
62	Cottonwood C at mouth nr Villa Grove, CO	NM	T46N R09E	-	-	11-03-71	1410	-	-	-	NF	-	-	-	-
63	L Kerber C nr mouth nr Bonanza, CO	NM	T46N R08E	-	-	11-03-71	1350	-	-	-	NF	-	-	-	-
64	Brewery C at mouth nr Bonanza, CO	NM	T46N R07E	-	-	11-03-71	0915	0	8.0	135	-	A	C	A	P-C
65	Kerber C ab Brewery C nr Bonanza, CO	NM	T47N R07E	38 16 38	106 08 56	11-03-71	0800	0	6.9	415	OTC YT ST	A	A	A	A
65A	Mosquito C at mouth nr Bonanza, CO	NM	T47N R07E	-	-	10-28-71	1105	2.0	7.8	85	-	A	P-C	P(?)	C
65B	Kerber C ab Mosquito C nr Bonanza, CO	NM	T47N R07E	-	-	10-28-71	1125	2.5	7.8	105	-	A	C	P(?)	P-C

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Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
RIO GRANDE BASIN																								
Alamosa County																								
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conejos County																								
A	A	A	A	A	A	A	A	-	0	0	-	8	30	1300	20	410	0.3	-	10	-	0	-	30	69
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	0	-	0	680	3300	40	430	.1	-	20	-	0	-	80	80
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Costilla County																								
C+	C+	C+	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	8	0	-	0	1	30	1	50	.0	-	0	-	0	-	30	53
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mineral County																								
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	A	A	A	A	-	0	15	-	0	5	30	33	30	.2	-	3	-	0	-	2200	56
P	P	C	A	A	A	A	A	-	3	3	-	1	3	30	27	30	.2	-	4	-	0	-	770	6.5
P	P	P	A	A	P	A	A	misc. dipteran (?): P fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	1	0	-	1	2	20	2	40	.3	-	0	-	0	-	40	3.8
A	A	P	A	A	A	A	C	-	0	18	-	0	5	40	32	200	.1	-	2	-	0	-	2200	51
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C+	C+	C+	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	1	5	-	1	20	10	21	130	4.5	-	1	-	0	-	370	30
Rio Grande County																								
A	A	A	A	A	A	A	A	-	0	0	-	10	470	20	20	640	.3	-	8	-	0	-	540	110
A	A	P(?)	A	A	A	A	A	-	3	.1	-	8	90	2500	3	400	.1	-	10	-	0	-	110	110
Saguache County																								
A	P	P-C	A	P	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	9	60	-	10	630	250	1	8900	.3	-	0	-	0	-	13,000	190
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 5.--*Chemical and biological quality of surface water at sites sampled.*

Station number	Station name	Location				Date	Time	Field observations				Aquatic organisms: Flora			
		Principal meridian	Township and Range	Latitude	Longitude			Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Rooted aquatics	Diatoms	Green algae	Blue-green algae
	RIO GRANDE BASIN (Continued)														
	Saguache County (Continued)														
65C	Squirrel C bl Sosthenes Gl nr Bonanza, CO	NM	T47N R07E	-	-	10-28-71	1220	4.0	8.2	300	-	A	P-C	P-C	A
65D	Squirrel C at mouth nr Bonanza, CO	NM	T47N R07E	38 18 35	106 08 40	10-28-71	1320	7.5	5.4	710	OC YT ST	A	A	A	A
65E	Kerber C ab Squirrel C nr Bonanza, CO	NM	T47N R07E	-	-	10-28-71	1430	4.0	7.9	115	-	A	C(?)	P	A
65F	Rawley Gulch at mouth nr Bonanza, CO	NM	T47N R07E	38 18 25	106 08 45	10-28-71	1450	3.5	4.0	660	OS	A	A	P	A
65G	Copper Gulch at mouth at Bonanza, CO	NM	T47N R07E	38 17 35	106 08 30	10-28-71	1545	4.0	7.3	280	BS	A	C	P	A
65H	Kerber C ab Copper Gulch at Bonanza, CO	NM	T47N R07E	-	-	10-28-71	1640	-	-	-	TC RS YT ST	A	A	P	A
66	Kerber C ab L Kerber C nr Bonanza, CO	NM	T46N R08E	38 12 54	106 04 45	11-04-71	0825	0	6.6	455	-	A	A	A	A
66A	Greenback Gulch at mouth nr Bonanza, CO	NM	T46N R08E	38 15 03	106 07 24	11-03-71	1250	6.0	7.4	250	TC	A	P	P	A
67	Clover C at mouth nr Villa Grove, CO	NM	T48N R08E	-	-	11-02-71	1645	-	-	-	NF	-	-	-	-
68	Alder C at mouth nr Villa Grove, CO	NM	T48N R08E	38 22 12	106 02 24	11-02-71	1650	1.0	8.0	220	-	A	C	A	A
69	Spring C at mouth nr Villa Grove, CO	NM	T47N R08E	-	-	11-02-71	1715	-	-	-	NF	-	-	-	-
74	Mill C at mouth nr Saguache, CO	NM	T45N R06E	-	-	10-28-71	0805	-	-	-	NF	-	-	-	-
75	Laughlin Gulch nr mouth nr Saguache, CO	NM	T45N R06E	-	-	10-28-71	0905	-	-	-	NF	-	-	-	-
147	Embargo C ab Baughman C nr Granger, CO	NM	T41N R04E	-	-	09-28-71	1715	11.5	7.9	300	-	A	P-C	C	A
148	Seitz C at mouth nr Granger, CO	NM	T41N R04E	-	-	09-28-71	1740	-	-	-	NF	-	-	-	-
149	Carnero C nr mouth nr La Garita, CO	NM	T42N R06E	-	-	10-06-71	0925	5.0	7.4	210	-	A	P-C	P-C	A
150	Biedell C nr mouth nr La Garita, CO	NM	T42N R06E	-	-	10-06-71	1010	-	-	-	NF	-	-	-	-
151	Sanderson Gl tr nr mouth nr La Garita, CO	NM	T43N R07E	-	-	10-06-71	1030	-	-	-	NF	-	-	-	-
152	Cottonwood C nr mouth nr La Garita, CO	NM	T43N R06E	-	-	10-06-71	1045	-	-	-	NF	-	-	-	-
186	N Crestone C nr mouth at Crestone, CO	NM	T43N R11E	-	-	11-02-71	1245	3.0	7.9	120	-	A	P-C	C+	A
187	Willow C nr Crestone, CO (08228500)	NM	T43N R12E	-	-	11-02-71	1345	2.0	7.9	80	-	A	P-C	P-C	A
188	Spanish C nr Crestone, CO (08229000)	NM	T43N R12E	-	-	11-02-71	1400	1.5	7.9	85	-	A	P-C	P	A
189	Cottonwood C tr nr Crestone, CO	NM	T43N R12E	-	-	11-02-71	1410	-	-	-	NF	-	-	-	-
190	Cottonwood C nr Crestone, CO (08229500)	NM	T43N R12E	-	-	11-02-71	1420	1.0	7.0	90	-	A	P-C	P	A
191	San Luis C tr nr Valley View Hot Spgs, CO	NM	T45N R11E	-	-	11-02-71	1045	-	-	-	NF	-	-	-	-
192	Cotton C nr Mineral Hot Springs, CO (08226700)	NM	T45N R11E	-	-	11-02-71	1020	.5	7.7	340	-	A	P-C	P-C	A
193	Major C nr mo nr Valley View Hot Spgs, CO	NM	T45N R11E	-	-	11-02-71	0930	3.0	7.8	500	-	A	P-C	P-C	A
194	Garner C nr Valley View Hot Springs, CO	NM	T45N R11E	38 10 34	105 48 14	11-02-71	0900	1.0	7.7	500	-	A	P-C	P-C	A
195	Hot Springs Cn C at Valley View Hot Springs, CO	NM	T46N R11E	-	-	11-02-71	0845	-	-	-	NF	-	-	-	-
196	Black Cn C nr Valley View Hot Springs, CO	NM	T46N R10E	-	-	11-02-71	0815	-	-	-	NF	-	-	-	-
197	Rasberry C ab Ferguson C nr Villa Grove, CO	NM	T47N R09E	-	-	11-03-71	1545	-	-	-	NF	-	-	-	-
198	Rasberry C di nr mouth nr Villa Grove, CO	NM	T47N R09E	-	-	11-03-71	1605	6.5	7.9	105	-	A	P	A	A
285	Baughman C ab Seitz C nr Granger, CO	NM	T41N R04E	-	-	10-28-71	1730	-	-	-	NF	-	-	-	-
292	S Crestone C nr Crestone, CO (08228000)	NM	T43N R12E	-	-	11-02-71	1330	4.0	7.9	80	-	A	P-C	P-C	A
293	Orient Cn C at Valley View Hot Spgs, CO	NM	T46N R10E	-	-	11-02-71	0800	-	-	-	NF	-	-	-	-

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Field observations: Aquatic organisms: Fauna: Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Laboratory determinations: Trace elements, micrograms per liter: Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									RIO GRANDE BASIN (Continued)															
									Saguacne County (Continued)															
A	C	C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	130	-	30	2400	6600	10	22,000	0.3	-	23	-	0	-	28,000	370
P	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	2	120	-	10	3700	120	80	17,000	.2	-	35	-	0	-	27,000	370
A	A	A	A	1	A	A	A	-	0	3	-	0	20	20	1	530	.3	-	6	-	0	-	1200	120
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	10	30	-	6	120	340	1	7400	.3	2	8	-	0	-	9000	220
A	A	A	A	A	A	A	A	-	1	0	-	3	3	0	1	60	.3	0	5	-	0	-	130	89
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	C	A	A	A	A	A	-	1	0	-	0	3	0	1	10	.2	-	4	-	0	-	40	64
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	C	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	C	-	0	0	-	1	4	10	2	0	.4	11	1	-	0	-	20	140
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	Field observations: pH	Field observations: Specific conductance, micromhos per centimeter at 25°C	Field observations: Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Aquatic organisms, Flora: Diatoms	Aquatic organisms, Flora: Green algae	Aquatic organisms, Flora: Blue-green algae
				COLORADO RIVER BASIN											
				Dolores County											
104	W Dolores R nr Dunton, CO (09165500)	NM	T41N R11W	-	-	09-21-71	1705	9.0	7.7	290	-	-	P-C	P	A
105A	Dolores R ab Sulphur C at Rico, CO	NM	T40N R11W	-	-	07-18-72	1010	14.0	7.5	380	OS	A	P	P	A
105E	Silver C at mouth at Rico, CO	NM	T40N R11W	-	-	07-18-72	1110	15.0	8.3	700	-	A	P	P	A
125	Barlow C at mouth nr Coke Oven, CO	NM	T41N R10W	37 46 08	107 58 48	09-22-71	0935	3.5	8.1	180	-	A	P-C	P-C	A
126	Dolores R ab Snow Spur C nr Coke Oven, CO	NM	T41N R10W	37 46 45	107 56 34	09-22-71	0840	1.5	7.9	280	OS	A	P-C	A	A
127	Snow Spur C at mouth nr Coke Oven, CO	NM	T41N R10W	-	-	09-22-71	0830	.5	8.4	240	-	A	P-C	P	A
				Eagle County											
513	E F Eagle R nr mouth nr Camp Hale, CO	S	T07S R80W	-	-	11-23-71	1100	1.0	7.4	325	-	A	P-C	P-C	A
514	Mitchell C at mouth nr Camp Hale, CO	S	T07S R80W	-	-	11-23-71	1125	0	7.5	90	-	-	-	-	-
515	Homestake C nr Red Cliff, CO (09064500)	S	T07S R80W	-	-	11-23-71	1000	0	7.5	60	-	A	P-C	P-C	A
518	Two Elk C at mouth nr Minturn, CO	S	T06S R81W	-	-	12-14-71	1300	0	8.4	350	-	A	P-C	P-C	A
519	Turkey C at mouth at Red Cliff, CO	S	T06S R80W	-	-	11-23-71	0920	0	7.5	90	-	A	P-C	P-C	A
520	Cross C at mouth nr Minturn, CO	S	T05S R81W	39 34 13	106 24 23	11-23-71	0830	1.0	7.4	360	OS	A	P-C	P	A
521	E Brush C at Yeoman Park nr Eagle, CO (09067700)	S	T06S R83W	39 30 15	106 40 39	11-22-71	1455	0	7.2	480	-	-	-	-	-
522	W Lake C ab Casteel C nr Edwards, CO	S	T05S R82W	-	-	11-22-71	1635	0	7.4	300	-	A	P-C	P-C	A
524	Trail Gulch at mouth nr Eagle, CO	S	T05S R84W	-	-	11-22-71	1320	-	-	-	NF	-	-	-	-
525	Salt C ab Trail Gulch nr Eagle, CO	S	T05S R84W	39 35 58	106 45 22	11-22-71	1330	3.0	6.7	2200	-	A	P-C	P-C	A
526	Bruce C at mouth nr Eagle, CO	S	T05S R84W	-	-	11-22-71	1355	-	-	-	NF	-	-	-	-
527	Frost C at mouth nr Eagle, CO	S	T05S R84W	-	-	11-22-71	1405	-	-	-	NF	-	-	-	-
529	Colorado R tr at mouth nr McCoy, CO	S	T02S R83W	39 54 10	106 42 10	10-20-71	1330	6.0	8.2	750	-	A	P-C	P	A
				Garfield County											
534	Butler C ab M Rifle C nr Rifle, CO	S	T04S R92W	-	-	10-20-71	0800	6.0	7.9	325	-	A	P-C	C	A
535	M Rifle C ab Butler C nr Rifle, CO	S	T04S R93W	-	-	10-20-71	0745	-	-	-	NF	-	-	-	-
536	E Rifle C ab Dry Rifle C nr Rifle, CO	S	T05S R92W	39 38 21	107 42 59	10-20-71	0910	8.0	8.1	600	ST	A	P-C	P	A
537	W Elk C ab W Elk Re nr New Castle, CO	S	T04S R91W	39 40 58	107 39 19	10-20-71	1005	3.5	8.1	1000	-	A	P-C	P-C	A
				Grand County											
471	Williams Fork ab Darling C nr Leal, CO (09035700)	S	T03S R77W	-	-	01-20-72	1300	0	7.3	85	-	-	-	-	-
530	Sheephorn C at mouth at Radium, CO	S	T01S R82W	-	-	10-20-71	1620	6.0	8.1	650	-	A	P-C	P-C	A
570	Baker Gulch nr mouth nr Grand Lake, CO	S	T05N R76W	-	-	10-21-71	1300	2.0	8.0	90	-	A	A	P-C	A
571	Bowen Gulch at mouth nr Grand Lake, CO	S	T04N R76W	-	-	10-21-71	1335	1.0	7.9	95	-	A	P-C	P	A
573	Roaring Fork ab Lk Granby, CO (09016000)	S	T02N R75W	-	-	10-21-71	1740	2.0	8.1	40	-	A	P-C	P	A
574	Hell Canyon C at mouth nr Grand Lake, CO	S	T02N R74W	-	-	10-21-71	1510	2.0	7.8	50	-	A	P-C	A	A
575	Arapaho C ab Mill C nr Grand Lake, CO	S	T02N R74W	-	-	10-21-71	1410	2.0	7.9	60	-	A	P-C	A	A
576	Corral C at mouth at Parshall, CO	S	T01N R79W	-	-	10-21-71	1025	2.5	8.1	240	-	A	P-C	P	A
577	Rock C ab unnamed re nr Parshall, CO	S	T01N R79W	-	-	10-21-71	1000	5.0	8.2	540	ST	A	P-C	P-C	A
578	Sulphur Gulch at mouth at Troublesome, CO	S	T01N R79W	40 03 54	106 16 54	10-21-71	0910	1.0	-	2400	T	A	A	C+	P(?)
580	Elliott C at mouth nr Kremmling, CO	S	T01N R80W	-	-	10-21-71	0800	-	-	-	NF	-	-	-	-
581	Muddy C ab Horse Gulch nr Kremmling, CO	S	T01N R80W	40 04 23	106 22 32	10-21-71	0825	3.0	7.9	1300	T	-	-	-	-
582	Horse Gulch at mouth nr Kremmling, CO	S	T01N R80W	-	-	10-21-71	0815	-	-	-	NF	-	-	-	-
663	Williams Fork ab Keyser C nr Leal, CO	S	T02S R78W	39 53 39	106 05 33	01-20-72	1415	0	7.7	90	-	A	C	A	P
				Gunnison County											
4	M Quartz C ab S Quartz C nr Pitkin, CO	NM	T50N R04E	38 36 10	106 28 00	10-08-71	0820	3.0	7.6	100	-	A	C	P	A
5	Tomichi C ab Spring C at Whitepine, CO	NM	T49N R05E	-	-	10-11-71	1335	9.0	8.3	560	-	A	C	A	A
6	No Name C nr mouth nr Whitepine, CO	NM	T49N R05E	-	-	10-11-71	1430	7.0	8.4	165	-	A	C	P	A
7	N Quartz C at mouth nr Pitkin, CO	NM	T50N R04E	-	-	10-08-71	0950	3.0	8.5	205	-	A	C	A	P
8	W Willow C ab Slaughterhouse C at Tincup, CO	S	T15S R81W	-	-	10-14-71	1605	8.5	8.2	135	-	A	P-C	P-C	A
8A	Willow C ab Cow C nr Taylor Park, CO	S	T14S R82W	-	-	10-14-71	1710	-	-	-	-	A	C	A	A
9	Gold C at mouth at Ohio, CO	NM	T50N R03E	-	-	10-08-71	0705	3.5	8.3	145	-	A	P-C	P-C	A
10A	Hot Springs C ab Waunita Hot Springs, CO	NM	T49N R04E	-	-	10-08-71	1205	10.0	8.1	190	-	A	P-C	P	A

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Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															Sulfate (SO_4), milligrams per liter
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	
													COLORADO RIVER BASIN											
													Dolores County											
C	C	C	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0.1	-	-
P	C	P	A	A	A	A	A	-	0	0	-	1	0	20	4	10	0.2	-	0	-	0	-	30	56
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
													Eagle County											
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	A	A	A	A	-	0	15	-	3	4	460	2	12,000	.2	-	4	-	0	-	4500	270
-	-	-	-	-	-	-	-	-	0	0	-	1	3	20	2	14	.4	-	0	-	0	-	30	250
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	C	A	A	A	C	P	-	5	0	0	2	2	10	7	14	.2	-	3	-	2	3.1	20	140
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	A	-	4	0	-	0	3	30	3	100	.3	0	2	-	0	-	0	98
													Garfield County											
C+	C+	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	-	0	0	0	0	1	10	0	30	.3	-	1	4	0	.1	0	110
A	P	P	A	A	A	A	A	-	10	0	0	1	0	50	0	10	.3	-	0	4	0	.4	30	370
													Grand County											
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C+	C+	C+	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	3	0	0	0	3	620	2	130	.3	-	3	-	0	5.8	0	390
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	0	0	-	0	2	20	1	30	.3	-	4	-	0	-	0	580
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	P	A	A	A	A	A	fungal or bacterial slime: P	1	0	-	0	1	30	0	36	.3	7	0	-	0	-	0	5.7
													Gunnison County											
A	C	P	A	A	P(?)	A	A	fish observed fungal or bacterial slime: P	1	0	-	1	0	90	1	30	.3	-	0	-	0	-	20	6.8
C	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 5.—*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Gunnison County (Continued)														
10B	Hot Springs C bl Waunita Hot Springs, CO	NM	T49N R04E	38 30 45	106 32 03	10-08-71	1300	16.0	8.8	580	YT ST	C	P-C	P	A
11	Quartz C ab Gold C at Ohio, CO	NM	T50N R03E	-	-	10-08-71	1030	7.0	8.4	195	-	A	C	A	A
18	Lottis C at mouth nr Taylor Park, CO	S	T15S R83W	-	-	10-15-71	0725	1.0	7.9	110	-	A	C	A	A
30	Sanford C tr nr mouth nr Tincup, CO	S	T14S R81W	38 47 17	106 28 57	10-14-71	1515	3.5	8.3	135	-	A	P	P	P
31	Sanford C ab unnamed tr nr Tincup, CO	S	T14S R81W	-	-	10-14-71	1635	5.5	8.2	110	-	A	C	A	A
38	Texas C nr mouth nr Taylor Park, CO	S	T14S R82W	-	-	10-15-71	1135	6.0	8.3	90	-	A	C	A	A
42A	Spring C ab Spring C Re nr Almont, CO	S	T13S R83W	-	-	10-14-71	1125	6.0	8.5	240	-	A	C	P	A
42B	Rocky Bk ab Wheelbarrow Gulch nr Almont, CO	S	T14S R83W	-	-	10-14-71	1200	5.5	8.8	280	-	A	C+	A	C
43	Deadmans Gulch at mouth nr Almont, CO	S	T14S R84W	-	-	10-14-71	1250	8.5	8.9	285	-	A	C	A	A
44	Taylor R bl Red Mountain C nr Taylor Park, CO	S	T13S R82W	-	-	10-15-71	1005	4.0	7.8	115	-	A	C	P	A
44A	Red Mountain C at mouth nr Taylor Park, CO	S	T13S R82W	-	-	10-15-71	1025	-	-	-	-	A	C	A	A
44B	Trail C at mouth nr Taylor Park, CO	S	T13S R83W	-	-	10-15-71	1040	3.5	8.0	75	-	A	C	P-C	C
46	Italian C at mouth nr Taylor Park, CO	S	T13S R83W	-	-	10-15-71	0935	3.5	8.0	140	-	A	C	P	A
47	Taylor R ab Bowman C nr Taylor Park, CO	S	T12S R83W	-	-	10-15-71	0900	1.5	8.5	220	-	A	C	A	A
48	Cement C ab Waterfall C nr Crested Butte, CO	S	T13S R84W	-	-	10-14-71	0820	.5	8.3	370	-	A	C	P	A
48A	Walrod Gulch at mouth nr Crested Butte, CO	S	T14S R85W	-	-	10-14-71	0855	-	-	-	-	A	C	A	A
49	Copper C at mouth at Gothic, CO	S	T13S R86W	-	-	10-13-71	1235	4.0	8.4	260	-	A	C	A	A
50A	East R tr at mouth nr Gothic, CO	S	T13S R85W	-	-	10-13-71	1620	8.5	8.6	320	-	A	C	A	A
51	Deer C at mouth nr Gothic, CO	S	T13S R85W	-	-	10-13-71	1630	-	-	-	-	A	C	A	A
52	Brush C at mouth nr Gothic, CO	S	T13S R85W	-	-	10-13-71	1455	8.5	8.7	305	-	A	C	A	A
53	Coal C ab Wildcat C nr Crested Butte, CO	S	T14S R86W	38 52 08	107 00 40	10-12-71	1600	7.0	7.2	260	TC YT	A	A	A	A
53A	Coal Creek ab Splains Gulch nr Crested Butte, CO	S	T14S R87W	-	-	10-12-71	1705	8.0	7.8	190	-	A	C	A	A
53B	Coal C at mouth at Crested Butte, CO	S	T13S R86W	-	-	10-13-71	0645	1.0	7.7	265	TC YT	A	A	A	A
54	Ruby Anthracite C bl Bracken nr Oliver, CO	S	T14S R87W	-	-	10-12-71	1225	9.5	8.1	155	VST	A	C	P	P
55	Oh-Be-Joyful C at mo nr Crested Butte, CO	S	T13S R86W	38 54 37	107 01 56	10-13-71	0815	1.0	7.4	85	OS	A	P-C	A	A
56	Slate R ab Oh-Be-Joyful C nr Crested Butte, CO	S	T13S R86W	-	-	10-13-71	0920	4.0	7.9	150	-	A	P-C	C	A
56B	Slate R ab Peanut Lk nr Crested Butte, CO	S	T13S R86W	-	-	10-13-71	1035	6.0	7.6	200	RC	A	P-C	P-C	P-C
56C	Slate R bl Coal C at Crested Butte, CO	S	T13S R86W	-	-	10-13-71	1720	-	-	-	TC	P	C	A	A
56D	Slate R ab Baxter Gulch nr Crested Butte, CO	S	T14S R86W	-	-	10-13-71	1745	-	-	-	-	P	C	P	A
56E	Slate R at mouth nr Crested Butte, CO	S	T14S R85W	-	-	10-14-71	0720	-	-	-	-	A	P	C	A
57A	Anthracite C bl Munsey C nr Oliver, CO	S	T13S R88W	-	-	10-12-71	1405	10.0	8.5	160	-	A	C	A	A
58	East R ab Copper C at Gothic, CO	S	T12S R86W	-	-	10-13-71	1155	8.0	8.5	285	-	A	P-C	P-C	A
59	Soap C at Soap C Campground nr Sapinero, CO	NM	T50N R04W	-	-	10-05-71	1010	5.5	8.4	150	-	A	C	A	P
60	Curecanti C nr Sapinero, CO (09125000)	NM	T49N R05W	-	-	10-05-71	0745	2.0	8.0	105	-	-	C	P-C	A
70	Ohio C at mouth nr Gunnison, CO	NM	T50N R01W	-	-	10-12-71	0720	4.0	8.3	275	-	P	C	P	P
71	Mill C at mouth nr Baldwin, CO	S	T15S R86W	-	-	10-12-71	0850	3.0	8.0	240	-	A	C	A	P
73	Carbon C at mouth nr Baldwin, CO	S	T15S R86W	-	-	10-12-71	0930	5.0	8.0	115	-	A	P-C	P-C	P
81	Cochetopa C at mouth nr Gunnison, CO	NM	T49N R02E	-	-	10-07-71	1200	9.0	8.6	200	YT ST	A	C	P	A
82	Long Gulch bl Dutch Gulch nr Gunnison, CO	NM	T49N R02E	-	-	10-07-71	1115	-	-	-	NF	-	-	-	-
83	Chance Gulch nr mouth nr Gunnison, CO	NM	T49N R01E	-	-	10-07-71	1030	-	-	-	NF	-	-	-	-
85	Gold Basin C bl Saguache-Gunnison Co. line, CO	NM	T48N R01W	-	-	10-07-71	0825	-	-	-	NF	-	-	-	-
87	Cebolla C ab Road Beaver C nr Powderhorn, CO	NM	T46N R02W	-	-	10-06-71	1310	10.5	8.0	135	VT	A	C	A	P
89	Corral C at mouth nr Gunnison, CO	NM	T48N R02W	-	-	10-06-71	1740	9.5	8.1	530	-	A	P-C	P-C	A
90	Willow C ab Corral C nr Gunnison, CO	NM	T48N R02W	38 23 01	107 02 48	10-06-71	1700	12.5	8.6	415	-	A	P-C	P-C	A
93	Lk F Gunnison R at mouth nr Sapinero, CO	NM	T48N R03W	38 23 42	107 14 37	10-05-71	1425	9.5	8.6	175	-	A	P-C	A	A
95	Powderhorn C at mouth at Powderhorn, CO	NM	T47N R02W	-	-	10-06-71	0900	4.0	7.7	115	-	A	P-C	P-C	P
96	Cebolla C ab Powderhorn C at Powderhorn, CO	NM	T46N R02W	-	-	10-06-71	1000	7.0	8.0	130	ST	A	P-C	P	C
96A	Cebolla C seep at Powderhorn, CO	NM	T46N R02W	38 16 30	107 05 34	10-06-71	1110	15.0	7.7	480	YT	P	-	-	-
99	Red C at mouth nr Sapinero, CO	NM	T49N R03W	-	-	10-06-71	0645	2.5	7.5	125	-	A	C	A	P

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations: Aquatic organisms: Fauna: Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Laboratory determinations: Trace elements, micrograms per liter: Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									Gunnison County (Continued)															
P	A	C	A	A	A	P	A	-	2	0	-	1	1	150	1	60	0.3	-	1	-	0	-	20	130
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	0	-	0	1	10	1	0	.3	0	2	-	0	-	0	7.8
A	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	P	A	A	A	A	A	fungal or bacterial slime: P-C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	C	A	A	A	A	C	water mites: P oligochaetes: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	P	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	1	110	-	10	120	80	8	120	.2	-	15	-	0	-	11,000	100
P	P	P	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	A	A	A	A	A	A	-	0	2	-	1	10	20	5	30	.3	-	1	-	0	-	300	13
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	A	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	1	P	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	net-winged midges: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	fungal or bacterial slime (?): P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	P	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	P	A	P	A	-	1	0	-	0	1	40	2	20	.1	-	5	6	0	-	20	7.3
P	A	P	A	A	A	A	A	-	0	0	-	0	2	10	2	0	.3	-	1	-	0	-	40	36
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*	*	*	*	*	*	*	*	Edge-mayflies: C	1	0	-	1	1	100	1	530	.3	-	1	-	0	-	30	34
A	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	Field observations: pH	Field observations: Specific conductance, micromhos per centimeter at 25°C	Field observations: Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Aquatic organisms, Flora: Diatoms	Aquatic organisms, Flora: Green algae	Aquatic organisms, Flora: Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Gunnison County (Continued)														
295	N F Crystal R at mouth at Crystal, CO	S	T11S R87W	39 03 35	107 06 09	11-11-71	0935	2.0	6.9	750	-	A	P-C	P	A
296	S F Crystal R at mouth at Crystal, CO	S	T11S R87W	39 03 31	107 06 09	11-11-71	1000	1.0	7.4	550	-	A	P-C	P	A
297	Crystal R ab Yule C at Marble, CO	S	T11S R88W	-	-	11-11-71	1125	2.0	7.6	650	-	A	P-C	P	A
298	Yule C at mouth at Marble, CO	NM	T11S R88W	-	-	11-11-71	1110	2.5	7.4	180	-	A	P-C	A	A
	Hinsdale County														
128	Lake Fork at Lake City, CO (09123500)	NM	T44N R04W	-	-	09-27-71	1630	13.0	7.9	150	-	A	P-C	P-C	A
129	Henson C at mouth at Lake City, CO	NM	T44N R04W	38 01 33	107 19 00	09-27-71	1550	8.5	7.5	180	-	A	P-C	P	A
130	N F Henson C at mouth nr Lake City, CO	NM	T43N R06W	-	-	09-27-71	1325	8.5	7.8	220	-	A	P-C	P-C	A
131	Henson C ab N F nr Lake City, CO	NM	T43N R06W	-	-	09-27-71	1400	10.5	7.7	180	-	A	P-C	P	A
132	Lake Fork ab Cooper C nr Sherman, CO	NM	T43N R05W	-	-	09-24-71	1205	10.5	7.9	160	-	A	P-C	P-C	A
133	Cooper C at mouth nr Sherman, CO	NM	T43N R05W	37 56 35	107 28 08	09-24-71	1130	4.0	4.9	180	-	A	P	A	A
134	Silver C at mouth nr Sherman, CO	NM	T42N R05W	37 56 08	107 27 30	09-24-71	1230	6.5	5.8	190	TC	A	A	A	A
135	Cottonwood C ab Cataract Gulch at Sherman, CO	NM	T42N R05W	-	-	09-24-71	1330	7.0	-	140	-	A	P-C	P	A
	La Plata County														
110	La Plata R ab Deadwood C nr Mayday, CO	NM	T36N R11W	37 20 25	108 03 56	09-29-71	1520	7.0	7.7	160	-	A	P-C	P	A
111	Deadwood C at mouth nr Mayday, CO	NM	T36N R11W	-	-	09-29-71	1500	-	-	-	NF	-	-	-	-
112	Lightner C bl Coal Gulch nr Durango, CO	NM	T35N R10W	-	-	09-30-71	1135	12.0	8.0	450	VT	A	P-C	C	A
113	Junction C bl Quinn C nr Durango, CO	NM	T36N R10W	-	-	09-30-71	1250	11.5	8.5	300	ST	A	P-C	C	A
114	Los Pinos R ab East C nr Bayfield, CO	NM	T36N R06W	-	-	09-29-71	0950	6.0	7.3	120	-	A	P-C	P-C	A
124	Hermosa C ab E F nr Hermosa, CO	NM	T39N R10W	-	-	09-30-71	1500	10.0	8.2	250	-	A	P-C	P	A
202	La Plata R ab Lewis C nr Mayday, CO	NM	T36N R11W	-	-	09-29-71	1610	4.0	7.6	160	-	A	P-C	P	A
	Mesa County														
162	West C nr mouth nr Gateway, CO	S	T15S R102W	38 46 13	108 49 04	10-08-71	1125	13.0	8.2	500	-	A	P-C	C	A
163	West C nr source nr Gateway, CO	S	T15S R101W	-	-	10-08-71	1200	12.5	8.2	480	-	A	P-C	C	A
164	East C nr source nr Whitewater, CO	S	T14S R100W	-	-	10-08-71	1215	-	-	-	NF	-	-	-	-
594	Salt C at mouth nr Gateway, CO	NM	T50N R18W	-	-	10-08-71	1010	-	-	-	NF	-	-	-	-
611	Lumsden Canyon C at mouth at Gateway,CO	NM	T51N R19W	-	-	10-08-71	1040	-	-	-	NF	-	-	-	-
612	John Brown C at mouth at Gateway, CO	NM	T51N R19W	-	-	10-08-71	1035	-	-	-	NF	-	-	-	-
613	Cottonwood Canyon C at mouth nr Gateway, CO	NM	T50N R19W	-	-	10-08-71	1020	-	-	-	NF	-	-	-	-
614	Larsen Canyon C at mouth nr Gateway, CO	NM	T51N R19W	-	-	10-08-71	1030	-	-	-	NF	-	-	-	-
615	Dolores R tr at mouth nr Gateway, CO	NM	T50N R19W	-	-	10-08-71	1025	-	-	-	NF	-	-	-	-
616	Bull Canyon C at mouth nr Gateway, CO	NM	T50N R19W	-	-	10-08-71	1015	-	-	-	NF	-	-	-	-
617	Calamity C at mouth nr Gateway, CO	NM	T49N R18W	-	-	10-08-71	0820	-	-	-	NF	-	-	-	-
618	Blue C ab Calamity C nr Gateway, CO	NM	T49N R18W	-	-	10-08-71	0830	8.0	8.1	475	-	A	P-C	P	A
	Mineral County														
153	E F San Juan R ab Quartz C nr Pagosa Spgs, CO	NM	T37N R02E	-	-	10-05-71	0945	6.0	8.1	180	-	A	P-C	P-C	A
	Moffat County														
539	Johnson Draw ab unnamed tr nr Skull Creek, CO	S	T06N R101W	-	-	10-19-71	0830	-	-	-	NF	-	-	-	-
540	Johnson Draw tr nr Skull Creek, CO	S	T06N R101W	-	-	10-19-71	0835	-	-	-	NF	-	-	-	-
541	Johnson Draw tr No. 2 nr Skull Creek, CO	S	T06N R101W	-	-	10-19-71	0840	-	-	-	NF	-	-	-	-
542	Wolf C bl Wolf C Spring nr Massadona, CO	S	T04N R100W	-	-	10-18-71	1110	-	-	-	NF	-	-	-	-
545	House Gulch nr Great Divide, CO	S	T10N R92W	-	-	10-18-71	1715	-	-	-	NF	-	-	-	-
546	Lay C nr source nr Great Divide, CO	S	T09N R93W	-	-	10-18-71	1540	-	-	-	NF	-	-	-	-
547	Scandinavian Gl nr source nr Great Divide, CO	S	T11N R93W	-	-	10-18-71	1630	-	-	-	NF	-	-	-	-
548	Bighole Gulch nr source at Great Divide, CO	S	T10N R93W	-	-	10-18-71	1610	-	-	-	NF	-	-	-	-
650	Johnson Canyon C tr nr Skull Creek, CO	S	T06N R101W	-	-	10-19-71	0840	-	-	-	NF	-	-	-	-
651	Johnson C Canyon C tr No. 2 nr Skull Creek, CO	S	T06N R101W	-	-	10-19-71	0845	-	-	-	NF	-	-	-	-
652	Johnson Canyon C nr Skull Creek, CO	S	T06N R101W	-	-	10-19-71	0850	-	-	-	NF	-	-	-	-

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations: Aquatic organisms: Fauna									Laboratory determinations: Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									Gunnison County (Continued)															
C	C	C	A	A	A	A	A	-	0	0	-	0	0	0	3	0	0.1	-	2	-	0	-	20	290
C	C	C	A	A	A	A	A	-	0	0	-	0	2	0	5	0	.1	-	5	-	0	-	30	190
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Hinsdale County															
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	A	A	A	A	-	1	0	-	1	4	10	1	40	.3	-	1	-	0	-	70	45
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	3	0	-	1	4	40	3	670	.5	-	4	-	0	-	160	64
A	A	A	A	A	A	A	A	-	2	1	-	1	6	10	2	380	.1	-	4	-	0	-	110	71
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									La Plata County															
C	C	C	A	A	A	A	A	-	0	0	0	0	1	0	2	20	.3	-	0	4	0	0.1	40	22
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	P	C	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C+	C+	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Mesa County															
C	C	P	A	A	A	C	P	-	0	0	-	1	2	190	0	80	.3	-	0	-	0	-	30	6.0
C	C	C	A	A	A	C	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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									Mineral County															
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Moffat County															
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Station number	Station name	Location				Date	Time	Field observations				Aquatic organisms			
												Flora			
		Principal meridian	Township and Range	Latitude	Longitude			Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Rooted aquatics	Diatoms	Green algae	Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Montezuma County														
105	Dolores R bl Rico, CO (09165000)	NM	T39N R11W	37 38 20	108 03 35	09-21-71	1455	14.5	7.9	425	OS	A	P-C	P	A
106	Dolores R ab Taylor C nr Stoner, CO	NM	T38N R12W	-	-	09-21-71	1340	11.0	8.1	400	OS	A	P-C	P-C	A
107	Bear C at mouth nr Stoner, CO	NM	T38N R12W	-	-	09-21-71	1415	11.0	7.6	240	-	A	P-C	P	A
108	W Mancos R bl Bob C nr Mancos, CO	NM	T37N R12W	-	-	09-30-71	0930	4.0	7.8	150	ST	A	P-C	P	A
109	E Mancos R nr Mancos, CO (09369000)	NM	T36N R13W	-	-	09-29-71	1310	8.5	7.7	300	-	A	P-C	P	A
122	Tozer Canyon C at mouth nr Cortez, CO	NM	T36N R18W	-	-	10-06-71	1550	-	-	-	NF	-	-	-	-
123	Rock C at mouth nr Cortez, CO	NM	T36N R18W	38 20 15	108 50 02	10-06-71	1600	12.0	8.3	2700	T	A	A	P	A
	Montrose County														
590	W Paradox C tr nr mouth nr Bedrock, CO	NM	T47N R19W	-	-	10-07-71	1335	-	-	-	NF	-	-	-	-
592	Sunrise Canyon C nr mouth nr Paradox, CO	NM	T48N R19W	-	-	10-07-71	1400	-	-	-	NF	-	-	-	-
593	Roc C at mouth nr Uravan, CO	NM	T48N R18W	38 27 14	108 51 49	10-08-71	0940	10.0	7.9	2900	-	-	-	-	-
604	Dolores R at Bedrock, CO (09169500)	NM	T47N R18W	-	-	10-07-71	1300	17.0	7.8	1800	ST	A	A	A	A
607	Saucer Basin C at mouth nr Uravan, CO	NM	T48N R18W	-	-	10-07-71	1430	-	-	-	NF	-	-	-	-
608	Hieroglyphic Canyon C at mouth at Uravan, CO	NM	T48N R17W	-	-	10-07-71	1500	-	-	-	NF	-	-	-	-
609	San Miguel R tr at mouth nr Uravan, CO	NM	T47N R17W	-	-	10-07-71	1515	-	-	-	NF	-	-	-	-
610	San Miguel R tr No. 2 at mouth nr Uravan, CO	NM	T47N R16W	-	-	10-07-71	1520	-	-	-	NF	-	-	-	-
619	Mesa C ab S F nr Uravan, CO	NM	T49N R17W	-	-	10-08-71	0630	-	-	-	NF	-	-	-	-
620	S F Mesa C nr mouth nr Uravan, CO	NM	T48N R17W	-	-	10-08-71	0645	-	-	-	NF	-	-	-	-
621	Atkinson C at mouth nr Uravan, CO	NM	T48N R17W	38 23 12	108 45 25	10-07-71	1445	19.0	8.3	750	ST	A	P-C	C	A
622	Tabeguache C at mouth nr Uravan, CO	NM	T47N R17W	-	-	10-07-71	1505	-	-	-	NF	-	-	-	-
647	San Miguel R tr No. 3 at mouth nr Uravan, CO	NM	T47N R17W	-	-	10-07-71	1510	-	-	-	NF	-	-	-	-
648	Mesa C at mouth nr Uravan, CO	NM	T48N R18W	-	-	10-07-71	1645	-	-	-	NF	-	-	-	-
649	Dolores R ab Mesa C nr Uravan, CO	NM	T48N R18W	38 26 13	108 50 18	10-07-71	1615	15.0	8.1	3600	ST	A	A	P	A
	Ouray County														
258	Red Mountain C ab Crystal Lk nr Ironton, CO	NM	T43N R07W	37 57 32	107 39 40	09-23-71	1420	10.5	3.8	1000	OC OS OT VT	A	A	P	A
259	Uncompahgre R ab Red Mountain C nr Ouray, CO	NM	T43N R07W	37 59 16	107 38 54	09-23-71	1530	5.5	7.1	275	-	A	P	A	A
260	Canyon C at Ouray, CO (09145500)	NM	T44N R08W	38 01 11	107 40 34	09-23-71	1635	9.0	7.4	500	ST	A	A	A	A
261	Oak C at mouth at Ouray, CO	NM	T44N R07W	-	-	09-23-71	1610	4.5	7.8	120	-	A	A	A	A
262	Corbett C at mouth nr Ouray, CO	NM	T44N R08W	38 03 09	107 41 27	09-22-71	1445	6.0	7.4	240	-	A	A	A	A
263	Dexter C at mouth nr Ouray, CO	NM	T44N R08W	-	-	09-22-71	1620	7.0	7.9	350	-	A	P-C	P	A
264	Uncompahgre R ab Cutler C nr Ouray, CO	NM	T44N R08W	38 04 48	107 42 08	09-22-71	1640	11.0	8.2	600	GT VT	A	A	A	A
265	Cow C ab Nate C nr Ridgeway, CO	NM	T45N R07W	-	-	10-01-71	1245	11.5	7.8	260	-	A	P-C	C	A
267	Cutler C at mouth at Ouray, CO	NM	T44N R08W	-	-	09-22-71	1710	-	-	-	NF	-	-	-	-
268	Coal C at mouth nr Ouray, CO	NM	T45N R08W	-	-	09-22-71	1740	6.5	8.1	220	ST	A	A	A	A
269	Beaver C nr Ridgeway, CO (09146550)	NM	T45N R09W	-	-	09-23-71	1250	8.0	8.3	340	ST	A	P-C	P	A
270	E F Dallas C ab Beaver C nr Ridgeway, CO	NM	T45N R09W	-	-	09-23-71	1305	7.0	8.5	180	-	A	P-C	P	A
271	W F Dallas C at mouth nr Ridgeway, CO	NM	T45N R09W	-	-	09-23-71	1200	8.0	8.2	325	ST	A	P-C	P-C	A
	Pitkin County														
299	W Maroon C at mouth nr Aspen, CO	S	T11S R85W	39 06 18	106 55 26	11-11-71	1535	5.0	8.2	320	-	A	P-C	P	A
300	E Maroon C at mouth nr Aspen, CO	S	T11S R85W	39 06 11	106 54 51	11-11-71	1520	6.0	7.5	850	-	A	P-C	P	A
301	Conundrum C at mouth nr Aspen, CO	S	T11S R85W	39 07 30	106 50 53	11-12-71	1000	3.0	7.4	500	-	A	P-C	P	A
302	Pine C at mouth nr Aspen, CO	S	T12S R84W	-	-	11-12-71	0900	3.0	7.4	280	-	A	P-C	P-C	A
303	Castle C ab Pine C nr Aspen, CO	S	T12S R84W	39 01 37	106 48 21	11-12-71	0825	0	7.2	350	-	A	P-C	P	A
304	Express C at mouth nr Aspen, CO	S	T11S R84W	-	-	11-12-71	0925	1.0	7.5	220	-	A	P-C	P	A
305	Difficult C at mouth nr Aspen, CO	S	T10S R84W	-	-	11-12-71	1425	1.0	7.5	80	-	A	P-C	P-C	A
306	Lincoln C at mouth nr Aspen, CO	S	T11S R83W	-	-	11-12-71	1335	0	7.5	120	-	A	P-C	P	A
307	Roaring Fork ab Lincoln C nr Aspen, CO	S	T11S R83W	-	-	11-12-71	1345	0	7.5	60	-	A	P-C	P	A
308	Willow C at mouth nr Aspen, CO	S	T10S R85W	-	-	11-11-71	1445	2.5	7.6	220	-	A	P-C	P-C	A
309	Hunter C at Aspen, CO (09074500)	S	T10S R84W	-	-	11-12-71	1510	5.0	7.4	110	-	A	P-C	P-C	A
310	Roaring Fork ab stp outfall at Aspen, CO	S	T10S R84W	-	-	11-12-71	1520	4.5	7.5	150	-	A	P-C	C	A
311	Castle C at mouth at Aspen, CO	S	T10S R85W	39 11 43	106 49 58	11-12-71	1535	5.0	7.8	480	-	A	P-C	P-C	A

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to determine the effect of metal mining in Colorado, 1971-72—Continued

Field observations: Aquatic organisms: Fauna: Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Laboratory determinations: Trace elements, micrograms per liter: Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									Montezuma County															
A	C	P	A	A	A	A	A	-	0	1	-	1	4	40	2	250	0.4	-	0	8	0	-	120	110
C	C	C	A	A	A	A	A	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	1	0	-	1	2	20	0	70	.4	-	5	-	0	-	30	1600
									Montrose County															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	A	A	A	A	-	2	0	-	1	1	20	1	0	.4	-	1	0	0	-	20	120
A	P(?)	A	A	A	A	A	P	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	C	A	A	A	A	A	A	-	-	-	0	-	-	-	-	-	-	-	-	7	-	29	-	-
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A	A	A	A	1(?)	A	A	A	-	-	-	0	-	-	-	-	-	-	-	-	8	-	12	-	-
									Ouray County															
A	A	A	A	A	A	A	A	-	0	14	-	53	1200	11,000	10	2600	.4	19	4	4	0	-	2600	540
A	P	P	A	A	A	A	A	-	2	1	-	0	5	20	3	0	.7	-	4	8	0	-	110	82
A	A	A	A	A	A	A	A	-	0	1	-	0	2	0	5	100	.0	-	1	2	0	-	130	210
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	1	0	-	0	0	10	1	10	.3	-	0	-	0	-	20	34
C	C	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	1	-	6	20	0	1	430	.3	16	8	-	0	-	120	270
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Pitkin County															
C	C	C	A	A	A	A	C	-	2	0	-	0	1	0	3	0	.3	-	0	-	0	-	20	75
A	P	C	A	A	A	A	A	-	0	0	-	1	0	0	1	0	.3	9	0	-	0	-	10	400
C	C	C	A	A	A	A	A	-	2	0	-	0	3	0	2	0	.1	2	1	-	0	-	20	160
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	1	0	-	0	1	0	0	0	.4	-	0	-	0	-	10	97
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C+	C+	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	7	0	-	1	0	0	1	80	.4	-	1	-	0	-	10	130

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Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Pitkin County (Continued)														
312	Maroon C at mouth at Aspen, CO	S	T10S R85W	39 12 05	106 50 56	11-12-71	1600	5.5	7.7	550	-	A	P-C	P-C	A
313	Woody C ab Casaday C nr Aspen, CO	S	T09S R84W	-	-	11-12-71	1145	2.5	7.3	280	-	A	P-C	P	A
314	Crystal R ab Avalanche C nr Redstone, CO (09081600)	S	T09S R88W	-	-	11-11-71	1245	5.0	7.4	650	-	A	P-C	P	A
	Rio Blanco County														
532	S F White R bl Swede C nr Buford, CO	S	T01S R91W	-	-	10-19-71	1620	4.0	7.8	300	-	A	P-C	P	A
543	Coal C bl Ninemile Draw nr Meeker, CO	S	T02N R92W	-	-	10-19-71	1420	7.0	7.8	450	-	A	P-C	P-C	A
544	Fawn C at mouth nr Buford, CO	S	T01N R90W	-	-	10-19-71	1535	6.0	7.8	400	-	A	P-C	P-C	A
	Routt County														
549	Trull C at mouth nr Milner, CO	S	T07N R85W	-	-	10-'5-71	0650	6.5	7.7	750	-	P	A	C	A
550	Dry Gulch at mouth nr Milner, CO	S	T07N R85W	-	-	10-15-71	0715	-	-	-	NF	-	-	-	-
551	Willow C at mouth nr Clark, CO	S	T09N R85W	-	-	IO 14-71	1645	8.0	8.6	145	-	A	P(?)	P	A
552	Red C nr mouth nr Hahns Peak, CO	S	T09N R85W	-	-	10-14-71	1720	9.0	8.4	100	-	P	A	C	A
555	Lorson C at mouth nr Hahns Peak, CO	S	T10N R86W	-	-	10-18-71	1240	3.0	8.3	65	-	A	P-C	P-C	A
556	Willow C tr at mouth nr Hahns Peak, CO	S	T10N R86W	-	-	10-14-71	1510	-	-	-	NF	-	-	-	-
557	Beaver C at mouth nr Hahns Peak, CO	S	T09N R85W	-	-	10-14-71	1610	9.0	8.0	135	-	P-C	A	P-C	A
557A	Willow C ab Beaver C nr Hahns Peak, CO	S	T09N R85W	-	-	10-14-71	1235	8.5	8.3	140	VST	A	P(?)	C	A
558	Independence C bl Summit C nr Columbine, CO	S	T11N R85W	-	-	10-14-71	1320	6.5	7.4	210	VST	P	P(?)	P	A
559	King Solomon C nr Columbine, CO (09251400)	S	T11N R85W	-	-	10-14-71	1345	7.0	8.3	165	-	A	P(?)	P	P
560	Whiskey C ab Whiskey Park nr Columbine, CO	S	T12N R85W	-	-	10-14-71	1420	5.0	8.2	<50	-	A	P(?)	C(?)	A
653	Ways Gulch at mouth at Hahns Peak, CO	S	T10N R85W	-	-	10-14-71	1555	-	-	-	NF	-	-	-	-
654	Dutch C at mouth nr Hahns Peak, CO	S	T10N R86W	-	-	10-14-71	1535	-	-	-	NF	-	-	-	-
	Saguache County														
76	Archuleta C ab Los C nr Gunnison, CO	NM	T45N R02E	-	-	10-07-71	1555	-	-	-	NF	-	-	-	-
77	Razor C ab Vouga Re nr Doyleville, CO	NM	T47N R03E	-	-	10-11-71	1725	9.0	8.0	165	-	A	P-C	A	P
78	Cochetopa C ab Rock C nr Gunnison, CO	NM	T47N R02E	38 18 55	106 45 52	10-07-71	1420	11.0	8.9	240	YT ST	A	C	A	P
79	Cochetopa C at Saguache-Gunnison County line, CO	NM	T48N R02E	-	-	10-07-71	1300	11.0	8.6	190	YT ST	A	C	A	A
	San Juan County														
120	Sultan C nr mouth nr Silverton, CO	NM	T40N R07W	-	-	10-04-71	1520	2.5	7.5	180	-	A	P-C	P	A
245	Cunningham G at mouth at Howardsville, CO	NM	T41N R07W	37 50 08	107 35 41	10-01-71	0930	4.0	8.1	290	OS	A	P-C	A	A
246	Maggie Gulch at mouth at Middleton, CO	NM	T42N R06W	-	-	10-01-71	0915	1.0	8.1	250	-	A	P-C	A	A
247	Minnie Gulch at mouth at Middleton, CO	NM	T42N R06W	37 51 44	107 34 07	10-01-71	0845	2.0	7.8	300	OS	-	-	-	-
248	Arrastra C at mouth nr Silverton, CO	NM	T41N R07W	-	-	10-01-71	1000	4.0	8.4	220	-	A	P-C	A	A
249	Mineral C at mouth at Silverton, CO	NM	T41N R07W	-	-	10-04-71	1550	10.0	6.9	410	RS ST	A	A	A	A
250	Cement C at mouth at Silverton, CO	NM	T41N R07W	37 48 54	107 39 39	10-04-71	1605	10.0	4.1	1075	OC RS CBT T	A	A	A	A
252	Bear C at mouth nr Silverton, CO	NM	T41N R08W	-	-	10-04-71	1500	-	-	-	NF	-	-	-	-
253	Mineral C ab S F nr Silverton, CO	NM	T41N R08W	37 49 16	107 43 09	10-04-71	1340	9.0	5.5	575	ROC RS ST	A	A	A	A
254	S F Mineral C at mouth nr Silverton, CO	NM	T41N R08W	37 49 00	107 43 40	10-04-71	1300	9.5	7.7	240	RS	A	A	A	A
255	S F Animas R at mouth at Eureka, CO	NM	T42N R06W	37 52 44	107 33 59	10-01-71	0755	2.5	7.8	350	OS	A	P-C	P	A
256	Animas R ab S F at Eureka, CO	NM	T42N R06W	37 52 46	107 33 55	10-01-71	0815	1.0	7.1	220	OS	A	P	A	A
257	Animas R at Silverton, CO (09358000)	NM	T41N R07W	37 48 40	107 39 32	10-04-71	1630	11.0	6.4	360	-	A	A	C	A
283	Cascade C ab diversion nr Cascade, CO	NM	T39N R09W	-	-	09-30-71	1605	7.0	7.9	200	ST	A	P-C	P	A

Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									Pitkin County (Continued)															
C	C	C	A	A	A	A	A	-	8	0	-	0	1	0	2	20	0.3	-	2	-	0	-	20	180
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Rio Blanco County															
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	C	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Routt County															
P	P	A	A	A	A	C	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	Edge- damselflies: P midges: C snails: P																
C	C	C	P(?)	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Saguache County															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	fungal or bacterial slime(?): P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	P	A	A	-	5	0	-	1	0	110	0	10	.3	-	0	-	0	-	20	20
P	P	P	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									San Juan County															
C	C	C	A	A	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	A	A	A	A	A	P	-	20	1	-	1	5	0	1	10	.4	-	0	-	0	-	70	83
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	0	0	-	1	0	40	2	50	2.9	-	0	-	0	-	70	92
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	11	-	22	170	4200	220	5200	.1	-	9	-	0	-	3500	560
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	0	5	-	15	90	4900	45	800	.3	9	9	-	0	-	1200	270
A	1(?)	A	A	A	A	A	A	-	2	0	-	1	3	530	3	30	.3	0	3	-	0	-	40	79
P	P	A	A	A	A	A	A	-	0	1	-	0	20	0	2	500	.3	-	2	-	0	-	680	160
A	A	A	A	A	A	A	A	-	0	4	-	1	60	0	5	770	.5	-	3	-	0	-	1100	73
A	A	A	A	A	A	A	A	-	5	2	-	0	10	20	10	330	.2	-	2	-	0	-	500	120
C	C	C	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	San Miguel County														
100	Leopard C at mouth at Placerville, CO	NM	T44N R11W	-	-	09-23-71	1045	7.0	8.2	475	-	A	P-C	P-C	A
101	Fall C at mouth at Fall Creek, CO	NM	T43N R11W	37 59 30	108 01 24	09-23-71	0930	2.5	8.1	400	-	A	P-C	P	A
102	Fall C ab Elk C nr Fall Creek, CO	NM	T43N R11W	-	-	09-23-71	0755	2.0	7.3	-	-	A	P-C	P	A
103	Elk C at mouth nr Fall Creek, CO	NM	T43N R11W	-	-	09-23-71	0855	4.0	8.2	290	-	A	P-C	P	A
272	Mill C at mouth at San Miguel, CO	NM	T43N R09W	-	-	09-21-71	0640	-	-	-	NF	-	-	-	-
273	Cornet C at mouth at Telluride, CO	NM	T43N R09W	-	-	09-21-71	0615	3.0	7.6	250	-	A	P-C	A	A
274	San Miguel R ab Bear C at Telluride, CO	NM	T42N R08W	37 56 05	107 48 08	09-20-71	1530	8.5	7.1	350	OS	A	A	P	A
275	Bear C at mouth at Telluride, CO	NM	T42N R09W	-	-	09-20-71	1830	5.5	6.9	175	-	A	A	P	A
276	Prospect C at mouth nr San Miguel, CO	NM	T43N R09W	-	-	09-21-71	0710	-	-	-	NF	-	-	-	-
277	Turkey C nr mouth nr Lime, CO	NM	T42N R09W	37 54 46	107 54 02	09-21-71	0910	3.5	8.5	450	ST	A	P-C	A	A
278	Howard F San Miguel R at mouth nr Ophir, CO	NM	T42N R09W	-	-	09-21-71	1020	5.5	7.7	550	-	A	P-C	A	A
278A	Howard F San Miguel R at Old Ophir, CO	NM	T42N R09W	37 51 29	107 50 42	09-21-71	1140	6.0	7.4	620	OC CS BT ST	A	P-C	A	A
279	Lake F San Miguel R at mouth nr Ophir, CO	NM	T42N R09W	-	-	09-21-71	1055	5.5	7.8	325	-	A	P-C	P	A
280	Lake F San Miguel R ab Trout Lk nr Ophir, CO	NM	T41N R09W	-	-	09-22-71	0730	2.0	6.9	220	-	A	P-C	A	A
281	S F San Miguel R at mouth nr Lime, CO	NM	T43N R09W	-	-	09-21-71	0830	5.5	7.7	550	-	A	P-C	P	A
282	San Miguel R ab S F nr Lime, CO	NM	T43N R09W	37 56 40	107 53 55	09-21-71	0730	5.0	7.5	340	GBS	A	P-C	P-C	A
588	Andy Draw bl unnamed tr nr Slick Rock, CO	NM	T43N R16W	-	-	10-07-71	0920	-	-	-	NF	-	-	-	-
589	Spring C tr nr source nr Slick Rock, CO	NM	T43N R16W	-	-	10-07-71	0905	-	-	-	NF	-	-	-	-
595	Big Gypsum C at mouth nr Slick Rock, CO	NM	T45N R18W	-	-	10-07-71	1015	-	-	-	NF	-	-	-	-
596	Dolores R ab Slick Rock, CO	NM	T43N R18W	38 00 40	108 50 14	10-07-71	0830	10.0	7.6	1750	-	A	P-C	P-C	A
597	Blue Canyon C at mouth nr Slick Rock, CO	NM	T43N R18W	-	-	10-07-71	0750	-	-	-	NF	-	-	-	-
598	Morrison Canyon C at mouth nr Slick Rock, CO	NM	T44N R18W	-	-	10-07-71	0800	-	-	-	NF	-	-	-	-
599	Bush Canyon C at mouth at Slick Rock, CO	NM	T44N R18W	-	-	10-07-71	0740	-	-	-	NF	-	-	-	-
600	Summit Canyon C at mouth nr Slick Rock, CO	NM	T44N R19W	-	-	10-07-71	0720	-	-	-	NF	-	-	-	-
601	Dolores R bl Slick Rock, CO	NM	T45N R18W	-	-	10-07-71	1000	12.0	7.7	1800	-	A	P-C	P	A
602	Nicholas Wash at mouth nr Slick Rock, CO	NM	T44N R18W	-	-	10-07-71	0815	-	-	-	NF	-	-	-	-
603	L Gypsum C at mouth nr Slick Rock, CO	NM	T45N R18W	-	-	10-07-71	1030	-	-	-	NF	-	-	-	-
	Summit County														
2	Snake R ab Deer C nr Montezuma, CO	S	T06S R76W	39 33 45	105 51 13	12-14-71	1600	0	4.7	240	-	-	-	-	-
477	N Rock C at mouth nr Dillon, CO	S	T04S R78W	-	-	11-24-71	0900	0	7.5	90	-	A	P-C	P	A
478	Deer C at mouth nr Montezuma, CO	S	T06S R76W	-	-	12-14-71	1410	0	8.1	120	-	A	P-C	P(?)	A
479	Snake R ab Peru C nr Montezuma, CO	S	T05S R76W	-	-	11-24-71	1100	0	7.4	180	-	-	-	-	-
480	Peru C at mouth nr Montezuma, CO	S	T05S R76W	-	-	11-24-71	1130	0	7.5	150	-	A	P-C	A	A
481	Snake R ab N F nr Montezuma, CO	S	T05S R76W	-	-	11-24-71	1045	0	7.5	170	-	A	P-C	P-C	A
482	N F Snake R at mouth nr Montezuma, CO	S	T05S R76W	-	-	11-24-71	1030	0	7.5	110	-	A	P-C	P	A
483	Swan R ab Gold Run Gulch nr Breckenridge, CO	S	T06S R77W	-	-	12-17-71	1120	0	8.4	150	-	-	-	-	-
484	Gold Run Gl at mouth nr Breckenridge, CO	S	T06S R77W	39 31 48	106 01 43	12-17-71	1045	0	7.3	325	-	A	P-C	C	A
485	Blue R ab Swan R nr Breckenridge, CO	S	T06S R77W	39 32 20	106 02 29	12-17-71	1020	2.0	8.4	220	-	A	P-C	C	A
486	N Barton Gulch at mouth nr Breckenridge, CO	S	T06S R78W	-	-	12-17-71	1140	0	8.4	85	-	A	P-C	P-C	A
487	M Barton Gulch at mouth nr Breckenridge, CO	S	T06S R78W	-	-	12-17-71	1220	0	8.3	80	-	A	P-C	P-C	A
488	S Barton Gulch at mouth nr Breckenridge, CO	S	T06S R78W	-	-	12-17-71	1205	0	8.3	60	-	A	P-C	P-C	A
489	Cucumber Gulch at mo nr Breckenridge, CO	S	T06S R77W	-	-	12-17-71	1345	0	7.4	90	-	A	P-C	P(?)	A
490	Sawmill Gulch at mouth at Breckenridge, CO	S	T06S R78W	-	-	12-15-71	1520	0	8.4	80	-	A	P-C	P(?)	A
491	Lehman Gulch at mouth at Breckenridge, CO	S	T07S R77W	-	-	12-17-71	1320	0	8.2	140	-	A	P-C	A	A
492	Spruce C nr Breckenridge, CO (09045500)	S	T07S R77W	-	-	12-17-71	-	0	-	-	-	-	-	-	-
493	McCullough Gulch nr Breckenridge, CO (0904500)	S	T07S R78W	-	-	12-15-71	1115	0	8.2	190	-	A	P-C	P(?)	A
494	Monte Cristo C nr Breckenridge, CO	S	T08S R78W	-	-	12-15-71	1040	0	8.3	180	-	A	P-C	A	A
495	Hoosier C nr Breckenridge, CO	S	T08W R78W	-	-	12-15-71	1020	-	-	-	NF	-	-	-	-
496	Blue R tr at mouth nr Breckenridge, CO	S	T07S R77W	-	-	12-15-71	1000	0	7.6	160	-	A	P-C	P(?)	A
497	Pennsylvania C at mouth nr Breckenridge, CO	S	T07S R77W	-	-	12-15-71	1150	-	-	-	NF	-	-	-	-
498	Indiana C ab Goose Pasture Lk nr Breckenridge, CO	S	T07S R77W	-	-	12-15-71	1345	0	8.4	220	-	A	P-C	P-C	A

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to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									San Miguel County															
C	C	C	A	A	A	A	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	0	-	-	-	-	-	-	-	-	8	-	0.3	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	1	A	A	A	A	A	-	0	4	-	4	10	0	1	1300	0.2	6	6	4	0	-	1400	140
A	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	P	A	A	-	1	0	-	0	3	20	17	30	.0	8	2	-	0	-	30	59
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	1	A	A	P	A	A	-	1	1	-	2	4	40	7	150	.5	0	7	-	0	-	210	380
A	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	A	A	A	A	-	8	2	-	0	4	20	4	280	.3	0	4	10	0	-	390	84
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	A	A	A	C	A	A	-	-	-	0	-	-	-	-	-	-	-	-	7	-	2.0	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	C	A	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Summit County															
-	-	-	-	-	-	-	-	-	0	5	-	10	31	380	12	1100	.3	-	20	-	1	-	500	89
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	2	0	-	0	1	20	2	36	.5	-	0	-	0	-	40	36
C	C	C	A	A	A	A	A	-	4	1	-	0	2	10	2	0	.3	-	0	-	0	-	50	27
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 5.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Township and Range	Latitude	Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Summit County (Continued)														
499	Illinois Gulch at mouth at Breckenridge, CO	S	T07S R77W	-	-	12-15-71	1435	-	-	-	NF	-	-	-	-
500	French Gulch nr mouth at Breckenridge, CO	S	T06S R77W	39 29 08	106 01 39	12-17-71	1240	0	7.9	400	OC OS	A	P(?)	A	A
501	Tenmile C ab W Tenmile C nr Kokomo, CO	S	T06S R78W	-	-	11-23-71	1545	0	7.4	200	-	A	P-C	P-C	A
502	Copper C at mouth nr Kokomo, CO	S	T07S R78W	-	-	11-23-71	1440	-	-	-	NF	-	-	-	-
503	Tucker Gulch at mouth nr Kokomo, CO	S	T07S R78W	-	-	11-23-71	1430	-	-	-	NF	-	-	-	-
505	Tenmile C at Kokomo, CO	S	T07S R79W	39 25 29	106 11 10	11-23-71	1335	.5	7.2	1400	OS	A	P-C	A	A
507	Searle Gulch at mouth nr Kokomo, CO	S	T07S R79W	39 25 39	106 11 17	11-23-71	1315	0	7.3	260	OC OS	A	P-C	A	A
508	Clinton Gulch at mouth at Kokomo, CO	S	T07S R79W	-	-	11-23-71	1400	-	-	-	NF	-	-	-	-
509	Mayflower Gulch at mouth nr Kokomo, CO	S	T07S R79W	-	-	11-23-71	1425	0	7.5	160	-	A	P-C	P	A
510	Humbug C at mouth nr Kokomo, CO	S	T07S R78W	-	-	11-23-71	1435	-	-	-	NF	-	-	-	-
511	Tenmile C tr at mouth nr Kokomo, CO	S	T07S R78W	-	-	11-23-71	1445	-	-	-	NF	-	-	-	-
512	W Tenmile C at mouth nr Kokomo, CO	S	T06S R78W	-	-	11-23-71	1530	2.0	7.5	180	-	A	P-C	C	A
657	Fredonia Gulch at mouth nr Breckenridge, CO	S	T07S R77W	-	-	12-15-71	1130	-	-	-	NF	-	-	-	-
658	Tenmile C tr No. 2 at mouth nr Kokomo, CO	S	T07S R78W	-	-	11-23-71	1505	-	-	-	NF	-	-	-	-
659	Tenmile C tr No. 3 at mouth nr Kokomo, CO	S	T07S R78W	-	-	11-23-71	1500	-	-	-	NF	-	-	-	-
660	Tenmile C tr No. 4 at mouth nr Kokomo, CO	S	T07S R78W	-	-	11-23-71	1450	-	-	-	NF	-	-	-	-
664	Snake R at Keystone, CO	S	T05S R77W	-	-	11-24-71	1010	0	7.4	150	-	A	P-C	P-C	A
679	Blue R bl Dillon, CO (09050700)	S	T05S R78W	-	-	11-24-71	0935	4.5	7.4	160	-	A	P-C	C	A

to determine the effect of metal mining in Colorado, 1971-72--Continued

Field observations									Laboratory determinations																		
Aquatic organisms																											
Fauna									Trace elements, micrograms per liter																		
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									Summit County (Continued)															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	10	9	-	1	1	180	2	1000	0.3	-	7	-	0	-	3900	130
P	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	1	5	-	1	10	60	3	1100	.4	4100	8	-	0	-	600	600
A	A	A	A	A	A	A	A	-	3	6	-	1	2	30	4	330	.2	0	2	-	0	-	1800	39
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	C	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 6.--*Chemical and biological quality of surface water at sites sampled to determine the effect of coal mining in Colorado, 1972*

[STATION NAME: ab, above; bl, below; Bk, Brook; Cn, Canyon; CO, Colorado; Co., County; C, Creek; di, distributary; D, Ditch; E, East; F, Fork; Ft., Fort; Gdn, Golden; Gl, Gulch; Hwy, Highway; Lk, Lake; L, Little; M, Middle; mo, mouth; Mtn, Mountain; nr, near; N, North; No., Number; Re, Reservoir; R, River; St., Saint; stp, sewage treatment plant; S, South; Spgs, Springs; tr, tributary; U.S., United States; W, West.

PRINCIPAL MERIDIAN: NM, New Mexico; S, Sixth; U, Ute.

STREAM CONDITIONS: IR, irrigation return flow suspected; NF, no flow; RO, runoff due to rain; SF, flow primarily from underground springs(s) just upstream; SM, runoff due to snowmelt. BGC, blue-gray coating on rocks; BOC, black-orange coating; GBC, gray-brown coating; OC, orange coating; OTC, orange-tan coating; RC, red coating; ROC, red-orange coating; TC, tan coating. BS, black stain on rocks; GBS, gray-brown stain; OS, orange stain; RS, red stain. BT, water has brown tinge; GT, gray tinge; GBT, gray-brown tinge; OT, orange tinge; WT, white tinge; YT, yellow tinge. VST, water is very slightly turbid; ST, slightly turbid; T, turbid; VT, very turbid.

AQUATIC ORGANISMS (no distinction among riffle, edge, and bottom samples): A, absent; 1, one organism observed; P, present, P-C, present to common; C, common; C+, abundant; (?), classification questionable.]

Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location				Date	Time	Field observations							
												Aquatic organisms			
												Flora			
		Principal meridian	Township and Range	Latitude	Longitude			Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Rooted aquatics	Diatoms	Green algae	Blue-green algae
				PLATTE RIVER BASIN											
				Adams County											
706	Third C nr Barr Lake, CO	S	T02S R65W	-	-	06-19-72	1500	-	-	-	NF	-	-	-	-
707	Second C nr Barr Lake, CO	S	T02S R66W	-	-	06-19-72	1445	-	-	-	IR	-	-	-	-
708	First C nr Irondale, CO	S	T03S R66W	-	-	06-19-72	1410	22.5	7.6	1120	SF	A	P	P	A
711	Sand C ab Toll Gate C at Aurora, CO	S	T03S R66W	-	-	06-02-72	1630	20.0	8.2	900	ST	A	A	P	A
712	Toll Gate C nr mouth at Aurora, CO	S	T03S R66W	-	-	06-02-72	1705	22.0	8.2	2200	-	A	A	C	A
				Arapahoe County											
713	Bear C at mouth at Sheridan, CO (06711500)	S	T05S R68W	39 39 08	105 01 57	04-19-72	0710	6.5	-	555	-	-	-	-	-
714	Dutch C at mouth at Littleton, CO	S	T05S R68W	-	-	06-01-72	1555	22.5	8.4	580	IR	-	-	-	-
				Boulder County											
702	Boulder C ab Coal C nr Erie, CO	S	T01N R69W	-	-	06-20-72	0910	16.5	7.6	310	VST	A	C	C	A
703	Coal C at mouth nr Erie, CO	S	T01N R69W	40 04 10	105 03 32	05-04-72	1350	26.0	-	-	T	-	-	-	-
				Douglas County											
718	Indian C at mouth at Louviers, CO	S	T07S R68W	-	-	06-01-72	1500	29.0	9.1	300	VST	A	P	P-C	A
719	W Plum C at mouth at Sedalia, CO	S	T07S R68W	-	-	05-03-72	1130	17.0	7.4	240	T	-	-	-	-
721	Jackson C at mouth nr Sedalia, CO	S	T08S R68W	-	-	06-01-72	1410	22.5	7.5	140	-	A	P-C	P-C	A
				Elbert County											
724	E Bijou C ab Deer Trail, CO	S	T06S R59W	-	-	06-02-72	1520	-	-	-	NF	-	-	-	-
726	W Bijou C bl Fondis, CO	S	T09S R62W	-	-	06-02-72	1235	29.0	8.1	910	-	A	-	P-C	A
727	Commanche C nr Fondis, CO	S	T08S R62W	-	-	06-02-72	1125	-	-	-	NF	-	-	-	-
				Jackson County											
741	Canadian R ab Crystal Spring C at Cowdrey, CO	S	T10N R79W	-	-	06-21-72	1100	16.0	7.5	425	YT	A	P-C	P	A
742	Canadian R tr at mouth nr Walden, CO	S	T09N R78W	-	-	06-21-72	1205	-	-	-	NF	-	-	-	-
743	Canadian R ab unnamed tr nr Walden, CO	S	T09N R78W	-	-	06-21-72	1210	15.0	7.1	250	-	P	C	P	C
744	N F N Platte R bl Lone Pine C nr Walden, CO	S	T09N R81W	-	-	06-16-72	1410	14.5	7.1	90	SM VST	P	P	P	A
745	Beaver C at mouth nr Walden, CO	S	T08N R81W	-	-	06-16-72	1340	18.5	7.1	180	VST	A	P-C	A	A
746	Chedsey C nr mouth nr Coalmont, CO	S	T07N R81W	-	-	06-16-72	1210	12.5	6.9	70	-	A	P-C	P	A
747	L Grizzly C ab Chedsey C nr Coalmont, CO	S	T07N R81W	-	-	06-16-72	1230	17.0	7.2	210	SM ST	A	A	A	A
749	Grizzly C ab Buffalo C nr Hebron, CO	S	T07N R80W	-	-	06-16-72	1135	14.5	7.8	185	SM VST	P	P-C	A	A
751	Arapaho C at mouth nr Hebron, CO	S	T06N R81W	-	-	06-16-72	0925	11.5	6.8	220	-	A	P	A	A
751A	Grizzly C ab Arapaho C nr Hebron, CO	S	T06N R81W	-	-	06-16-72	0855	10.5	6.9	115	SM T	A	P	A	A
				Jefferson County											
709	Ralston C bl Leyden C at Arvada, CO	S	T03S R69W	39 49 04	105 07 06	06-19-72	1230	16.0	6.8	950	-	A	C	P-C	A
710	Clear C at Kipling St Bridge at Wheat Ridge, CO	S	T03S R69W	-	-	04-24-72	0720	8.0	8.0	820	T	A	P	P	P

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Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
PLATTE RIVER BASIN																								
Adams County																								
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	P	P-C	P-C	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	A	P	P	P-C	P	A	adult beetles: P amphipods: P crayfish: P-C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	P-C	P-C	A	P	A	damselflies: 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arapahoe County																								
P	A	P	A	A	A	A	A	fish observed fungal or bacterial slime: P	0	0	-	-	3	70	0	83	-	-	-	-	-	-	10	110
P	A	P	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder County																								
A	C	A	A	C	P	P	P-C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	C	A	P	A	damselflies: P flatworms: P	2	0	-	-	3	30	0	58	-	-	-	-	-	-	10	260
Douglas County																								
P	P-C	A	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	misc. dip-teran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1(?)	P-C	P	A	P	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elbert County																								
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	A	A	A	A	A	A	crane fly: 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson County																								
A	P	P	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	P	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P-C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	A	P-C	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P-C	A	P	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	A	A	A	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	P	P-C	P(?)	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	P	P-C	A	A	P-C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	A	P	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson County																								
A	A	A	A	A	A	P	P	misc. dip-teran: P	0	0	-	0	5	50	3	13	0.0	-	4	10	0	-	0	250
A	A	A	A	A	A	A	A	tubificids: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
			PLATTE RIVER BASIN (Continued)												
				Larimer County											
731	Spottlewood C nr Norfolk, CO	S	T10N R68W	-	-	06-20-72	1730	-	-	-	NF	-	-	-	-
731A	Coal C nr Norfolk, CO	S	T10N R68W	-	-	06-20-72	1750	-	-	-	NF	-	-	-	-
				Park County											
732	Kenosha C at mouth at Webster, CO	S	T07S R75W	-	-	06-28-72	1300	15.5	6.8	85	VST	A	P-C	P	P
734	Snyder C at mouth nr Jefferson, CO	S	T08S R75W	-	-	06-28-72	1410	24.5	8.0	420	YT	A	P	C	P
735	Jefferson C ab Snyder C nr Jefferson, CO	S	T08S R75W	-	-	04-25-72	0945	5.5	7.5	100	-	-	-	-	-
				Weld County											
700	Box Elder C nr Kuner, CO	S	T04N R64W	-	-	06-20-72	1230	22.5	8.4	3200	VST	A	C	P	A
701A	St. Vrain C tr nr Dacono, CO	S	T01N R68W	-	-	06-20-72	1035	-	-	-	NF	-	-	-	-
705	Big Dry C bl Eastlake, CO	S	T01N R67W	-	-	06-19-72	1640	21.0	8.4	2300	YT	A	C	C	A
705A	L Dry C bl St. Vrains, CO	S	T01N R67W	40 03 36	104 55 24	06-19-72	1600	21.5	8.8	4400	VST YT	A	C	P-C	A
729	Lone Tree C bl Carr, CO	S	T11N R67W	-	-	06-20-72	1545	24.0	7.6	500	-	A	C	P	A
730	Spring C tr nr Carr, CO	S	T10N R67W	-	-	06-20-72	1625	-	-	-	NF	-	-	-	-

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Field observations									Laboratory determinations																
Aquatic organisms																									
Fauna									Trace elements, micrograms per liter																
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									PLATTE RIVER BASIN (Continued)																
									Larimer County																
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									Park County																
P	P	P	A	A	A	A	A	water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Weld County																
A	A	P	A	A	C+	A	A	dragonflies: P damselflies: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	A	A	A	A	P	P	A	amphipods: P-C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	P	A	P	A	amphipods: P crayfish: 1	2	0	-	0	1	60	3	280	0.0	-	5	-	0	-	30	2100
P	A	P-C	A	A	C+	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	Field observations: pH	Field observations: Specific conductance, micromhos per centimeter at 25°C	Field observations: Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Aquatic organisms, Flora: Diatoms	Aquatic organisms, Flora: Green algae	Aquatic organisms, Flora: Blue-green algae
	ARKANSAS RIVER BASIN														
	Elbert County														
842	Mustang C nr Kutch, CO	S	T12S R59W	-	-	06-21-72	1630	-	-	-	NF	-	-	-	-
843	Willow Gulch ab unnamed re nr Cedar Point, CO	S	T09S R58W	-	-	06-21-72	1545	-	-	-	NF	-	-	-	-
843A	Big Sandy C ab Willow Gulch nr Cedar Point, CO	S	T09S R58W	-	-	06-21-72	1555	-	-	-	NF	-	-	-	-
844	Big Sandy C at Simla, CO	S	T10S R60W	-	-	06-21-72	1500	-	-	-	NF	-	-	-	-
874	Horse C nr Kutch, CO	S	T13S R59W	-	-	06-21-72	1645	18.0	7.5	210	SF	P	A	P	A
	El Paso County														
899	Black Squirrel C tr nr Ellicott, CO	S	T14S R63W	-	-	06-21-72	1730	-	-	-	NF	-	-	-	-
900	Jimmy Camp C nr Colorado Springs, CO	S	T14S R65W	-	-	06-21-72	1400	-	-	-	NF	-	-	-	-
901	E F Sand C nr Colorado Springs, CO	S	T14S R65W	-	-	06-21-72	1355	-	-	-	NF	-	-	-	-
902	Cottonwood C nr mouth nr Pikeview, CO	S	T13S R66W	-	-	06-21-72	1200	-	-	-	NF	-	-	-	-
903	Kettle C ab unnamed re nr Pikeview, CO	S	T12S R66W	38 58 54	104 47 01	06-21-72	1230	29.0	7.9	360	T	A	A	A	A
904	Monument C ab W Monument C nr Pikeview, CO	S	T12S R67W	-	-	06-21-72	1330	24.0	7.8	240	T	P	A	C	A
	Fremont County														
905	Mineral C ab Newlin C nr Portland, CO	S	T20S R69W	-	-	06-21-72	1000	-	-	-	NF	-	-	-	-
906	Newlin C nr Portland, CO	S	T20S R69W	-	-	06-21-72	1005	-	-	-	NF	-	-	-	-
907	Newlin C tr nr Portland, CO	S	T20S R69W	-	-	06-21-72	1010	-	-	-	NF	-	-	-	-
908	Newlin C tr No. 2 nr Portland, CO	S	T20S R69W	-	-	06-21-72	1005	-	-	-	NF	-	-	-	-
909	Newlin C at upper station nr Portland, CO	S	T20S R69W	-	-	06-21-72	1000	-	-	-	NF	-	-	-	-
910	Second Alkali C nr mouth nr Rockvale, CO	S	T19S R69W	-	-	06-21-72	1015	-	-	-	NF	-	-	-	-
911	Coal C ab First Alkali C nr Rockvale, CO	S	T19S R69W	-	-	06-21-72	1020	-	-	-	NF	-	-	-	-
912	S Oak C at mouth at Rockvale, CO	S	T19S R69W	-	-	06-21-72	1025	-	-	-	NF	-	-	-	-
913	Oak C ab S Oak C at Rockvale, CO	S	T19S R70W	-	-	06-21-72	1030	20.5	8.1	800	-	P	P	P	A
914	Chandler C nr mouth nr Florence, CO	S	T19S R70W	-	-	06-21-72	1035	-	-	-	NF	-	-	-	-
	Huerfano County														
180	S Abeyta C nr mouth nr La Veta, CO	S	T29S R69W	-	-	06-15-72	1900	14.5	8.4	340	T	A	A	P-C	A
291	Middle C bl Oak C nr La Veta, CO	S	T29S R68W	-	-	06-15-72	1830	17.5	8.4	690	T	P	P	C	A
879	Pictou Arroyo tr nr Pictou, CO	S	T27S R67W	-	-	06-20-72	0930	-	-	-	NF	-	-	-	-
880	Pictou Arroyo tr at Walsenburg, CO	S	T28S R66W	-	-	06-20-72	0845	18.0	8.6	3800	BT	P	A	C	A
881	Pictou Arroyo nr Walsenburg, CO	S	T27S R66W	-	-	06-20-72	0915	22.5	8.4	6000	T	P	A	A	A
882	Maitland Arroyo tr nr Pictou, CO	S	T27S R67W	-	-	06-20-72	0935	-	-	-	NF	-	-	-	-
883	Maitland Arroyo nr Pictou, CO	S	T27S R67W	-	-	06-20-72	0925	-	-	-	NF	-	-	-	-
884	Gordon Arroyo tr nr Delcarbon, CO	S	T27S R67W	-	-	06-20-72	0920	-	-	-	NF	-	-	-	-
885	Gordon Arroyo tr No. 2 nr Delcarbon, CO	S	T27S R67W	-	-	06-20-72	0910	-	-	-	NF	-	-	-	-
886	Gordon Arroyo tr No. 3 nr Delcarbon, CO	S	T27S R67W	-	-	06-20-72	0940	-	-	-	NF	-	-	-	-
887	Gordon Arroyo tr No. 4 nr Delcarbon, CO	S	T27S R67W	-	-	06-20-72	0945	-	-	-	NF	-	-	-	-
888	Gordon Arroyo nr Delcarbon, CO	S	T27S R67W	-	-	06-20-72	0950	-	-	-	NF	-	-	-	-
889	Hezron Gulch nr Pryor, CO	S	T29S R65W	-	-	06-20-72	1230	-	-	-	NF	-	-	-	-
889A	Santa Clara C bl Pryor, CO	S	T29S R65W	-	-	06-20-72	1235	-	-	-	NF	-	-	-	-
890	Mayne Arroyo nr Pryor, CO	S	T29S R66W	-	-	06-20-72	1240	-	-	-	NF	-	-	-	-
890A	Walaen Arroyo tr nr Walsenburg, CO	S	T28S R66W	-	-	06-20-72	1200	-	-	-	NF	-	-	-	-
891	Walsen Arroyo nr Walsenburg, CO	S	T28S R66W	-	-	06-20-72	1210	-	-	-	NF	-	-	-	-
892	Bear C nr mouth at Walsenburg, CO	S	T28S R66W	-	-	06-20-72	1205	-	-	-	NF	-	-	-	-
893	Cucharas R at Walsenburg, CO	S	T28S R66W	-	-	06-20-72	1045	24.0	8.5	1750	-	C	P	C	A
894	Sand Arroyo at mouth nr Walsenburg, CO	S	T28S R67W	-	-	06-20-72	1050	-	-	-	NF	-	-	-	-
895	N Abeyta C nr mouth nr La Veta, CO	S	T28S R67W	-	-	06-20-72	1130	-	-	-	NF	-	-	-	-
896	Cucharas R ab N Abeyta C nr La Veta, CO	S	T29S R67W	-	-	06-20-72	1100	22.5	8.0	540	SF ST	P	C	C	A
897	Ojo de Alamo Arroyo nr mouth nr Delcarbon, CO	S	T27S R67W	-	-	06-20-72	0945	-	-	-	NF	-	-	-	-
898	Dog Springs Arroyo nr Delcarbon, CO	S	T27S R68W	-	-	06-20-72	1000	-	-	-	NF	-	-	-	-

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Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									ARKANSAS RIVER BASIN															
									Elbert County															
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									El Paso County															
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									Fremont County															
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									Huerfano County															
C	P	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	A	A	A	amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	A	A	C	A	A	A	adult beetles: C water mites: C tubificids: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	C+	A	A	A	adult beetles: C tubificids(?): P flatworms(?): P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	P	A	A	P	C	C	C	adult beetles: C misc. hemipteran: C fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	P	C	A	P	P	C	1	misc. hemipterans: C fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	ARKANSAS RIVER BASIN (Continued)														
	Las Animas County														
845	Trinchera C at Trinchera Plaza, CO	S	T35S R60W	-	-	06-20-72	1530	-	-	-	NF	-	-	-	-
846	San Francisco C tr nr Nola, CO	S	T34S R61W	-	-	06-20-72	1430	-	-	-	NF	-	-	-	-
846A	San Francisco C tr No. 2 nr Nola, CO	S	T34S R60W	37 03 19	104 10 30	06-20-72	1500	24.0	8.2	3500	ST	C	A	C	A
847	San Francisco C ab unnamed re at Barela, CO	S	T34S R61W	-	-	06-20-72	1400	-	-	-	NF	-	-	-	-
848	Frijole C nr Barela, CO	S	T33S R62W	-	-	06-20-72	1405	-	-	-	NF	-	-	-	-
849	Tingley Canyon C nr Ludlow, CO	S	T32S R64W	-	-	06-20-72	1335	-	-	-	NF	-	-	-	-
850	Chicosa Canyon C nr Ludlow, CO	S	T31S R64W	-	-	06-20-72	1330	-	-	-	NF	-	-	-	-
851	Berwind Canyon C nr Ludlow, CO	S	T31S R64W	-	-	06-20-72	1340	-	-	-	NF	-	-	-	-
852	Powell Arroyo nr mouth nr Trinidad, CO	S	T32S R64W	-	-	06-20-72	1325	-	-	-	NF	-	-	-	-
852A	Purgatoire R tr at mouth at Trinidad, CO	S	T33S R64W	-	-	06-16-72	0715	-	-	-	NF	-	-	-	-
853	Colorado Canyon C at mouth at Jansen, CO	S	T33S R64W	-	-	06-16-72	0800	-	-	-	NF	-	-	-	-
854	Raton C at mouth at Jansen, CO	S	T33S R64W	-	-	06-16-72	0730	16.0	8.4	950	-	A	P	P	A
854A	Purgatoire R bl Carpios Canyon nr Trinidad, CO	S	T33S R64W	-	-	06-16-72	0805	17.0	8.3	315	VT	A	P(?)	P	A
855	Purgatoire R tr at mouth at Sopris, CO	S	T33S R64W	-	-	06-16-72	0745	-	-	-	NF	-	-	-	-
856	Purgatoire R tr No. 2 at mo at Sopris, CO	S	T33S R64W	-	-	06-16-72	0815	-	-	-	NF	-	-	-	-
857	Long Canyon C at mouth nr Sopris, CO	S	T33S R64W	-	-	06-16-72	0830	19.5	8.0	960	ST	A	P	C	P
858	Reilly Canyon C nr mouth at Cokedale, CO	S	T33S R65W	-	-	06-16-72	0900	-	-	-	NF	-	-	-	-
859	Madrid Canyon C at mouth nr Tijeras, CO	S	T33S R65W	-	-	06-16-72	0910	-	-	-	NF	-	-	-	-
860	Burro Canyon C at mouth at Tijeras, CO	S	T33S R65W	-	-	06-16-72	0915	23.0	8.6	1050	SF(?) ST	A	A	P	A
861	Widow Woman Canyon C at mo nr Valdez, CO	S	T33S R65W	-	-	06-16-72	0945	-	-	-	NF	-	-	-	-
862	Smith Canyon C at mouth nr Valdez, CO	S	T33S R66W	-	-	06-16-72	0950	-	-	-	NF	-	-	-	-
863	Zarcillo Canyon C at mo at San Juan, CO	S	T33S R66W	-	-	06-16-72	1025	19.5	8.5	725	-	P	A	C	A
864	Lorencito Canyon C at mo nr San Juan, CO	S	T34S R66W	-	-	06-16-72	1000	-	-	-	NF	-	-	-	-
865	Cow Canyon C at mouth nr Weston, CO	S	T33S R66W	-	-	06-16-72	1035	-	-	-	NF	-	-	-	-
866	Molino Canyon C at mouth nr Weston, CO	S	T33S R66W	-	-	06-16-72	1030	-	-	-	NF	-	-	-	-
867	S F Purgatoire R at mouth at Weston, CO	S	T33S R67W	-	-	06-16-72	1040	21.0	8.4	280	T	P	A	P	A
868	Wet Canyon C at mouth at Weston, CO	S	T33S R67W	-	-	06-16-72	1100	22.5	8.4	675	ST	A	A	A	A
869	Purgatoire R ab Wet Cn C nr Weston, CO	S	T33S R67W	-	-	06-16-72	1130	17.0	8.4	240	T	P	P	C	A
870	Ciruela Canyon C at mouth nr Vigil, CO	S	T33S R67W	-	-	06-16-72	1200	-	-	-	NF	-	-	-	-
871	Apache Canyon C at mouth nr Vigil, CO	S	T33S R67W	-	-	06-16-72	1330	-	-	-	NF	-	-	-	-
872	N F Purgatoire R at mouth at Vigil, CO	S	T33S R68W	-	-	06-16-72	1340	17.5	8.3	240	T	A	C	C	A
873	Purgatoire R ab N F at Vigil, CO	S	T33S R68W	37 09 40	104 57 20	06-16-72	1430	18.5	8.4	220	T	C	P	P	A
875	Apishapa R tr at Ludlow, CO	S	T31S R64W	-	-	06-20-72	1335	-	-	-	NF	-	-	-	-
876	Apishapa R tr nr Aguilar, CO	S	T30S R65W	-	-	06-20-72	1340	-	-	-	NF	-	-	-	-
877	Gonzales Canyon C nr mouth at Aguilar, CO	S	T30S R65W	-	-	06-20-72	1245	-	-	-	NF	-	-	-	-
878	Apishapa R ab Gonzales Canyon C at Aguilar, CO	S	T30S R65W	-	-	06-20-72	1300	-	-	-	NF	-	-	-	-

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to determine the effect of coal mining in Colorado, 1972--Continued

Field observations: Aquatic organisms: Fauna								Field observations: Aquatic organisms	Laboratory determinations: Trace elements, micrograms per liter															Laboratory determinations
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									ARKANSAS RIVER BASIN (Continued)															
									Las Animas County															
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A	A	A	A	C	A	P	A	amphipods: P crayfish: P tubificids(?): P fish observed	2	0	-	0	5	10	2	80	-	-	6	100	0	-	30	2300
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	P	C	A	C	A	C	A	dragonfly: 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	A	P	A	A	G	C	A	adult beetles: C misc. hemipteran: C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	A	C	A	A	C	C	A	adult beetles: C misc. hemipteran: C tubificids: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	A	C	A	A	C	A	A	adult beetles: C misc. hemipteran: C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	A	C	A	A	C	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	C	A	A	amphipods: C tubificids: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	A	C	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	C	A	A	A	dragonflies(?): P	0	0	-	0	3	30	1	13	-	-	5	-	0	-	0	18
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Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location				Date	Time	Field observations				Aquatic organisms			
												Flora			
		Principal meridian	Township and Range	Latitude	Longitude			Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Rooted aquatics	Diatoms	Green algae	Blue-green algae
				RIO GRANDE BASIN											
				(No known coal deposits in this part of Colorado)											
				COLORADO RIVER BASIN											
				Archuleta County											
942	Yellowjacket C at mouth at Piedra, CO	NM	T34N R04W	-	-	06-15-72	1400	18.5	8.2	675	-	-	-	-	-
943	Coal C nr mouth nr Pagosa Springs, CO	NM	T36N R01W	-	-	06-15-72	1530	18.0	8.1	220	-	-	-	-	-
				Delta County											
965	Alkali C ab Lone Star D nr Huff, CO	S	T14S R96W	-	-	07-01-72	1120	14.0	7.3	120	-	A	A	A	P
988	Surface C bl Milk C nr Cedaredge, CO	S	T13S R94W	-	-	07-06-72	0945	13.0	7.5	85	-	A	P	P	P
989	Doughspoon C at mouth nr Orchard City, CO	S	T14S R95W	-	-	07-06-72	1645	-	-	-	NF	-	-	-	-
991	Sand C at mouth nr Cedaredge, CO	S	T13S R95W	38 55 28	108 00 21	07-06-72	1325	21.5	9.1	1150	VST	A	A	P	A
						07-18-72	1530	20.0	8.8	1350	ST	A	A	C	A
992	Kiser C tr at mouth nr Cedaredge, CO	S	T13S R95W	-	-	07-06-72	1210	-	-	-	NF	-	-	-	-
993	Youngs C at mouth nr Cedaredge, CO	S	T13S R95W	-	-	07-06-72	1225	14.5	8.3	950	ST	A	A	C	P
994	Kiser C ab Youngs C nr Cedaredge, CO	S	T13S R95W	-	-	07-06-72	1220	-	-	-	NF	-	-	-	-
995	Ward C ab Kiser C nr Cedaredge, CO	S	T13S R95W	-	-	07-06-72	1130	17.5	7.9	800	-	A	A	P	A
996	Cedar Mesa D nr Cedaredge, CO	S	T13S R94W	-	-	07-06-72	1045	-	-	-	NF	-	-	-	-
998	Currant C ab W F nr Cedaredge, CO	S	T13S R94W	-	-	07-06-72	1530	-	-	-	NF	-	-	-	-
999	Dever C nr Hotchkiss, CO	S	T13S R93W	-	-	07-07-72	0845	13.0	7.5	800	T	A	A	P	A
1000	Jay C at mouth nr Hotchkiss, CO	S	T14S R92W	-	-	07-07-72	1030	19.0	8.4	1500	-	A	A	P	A
1001	Bell C at mouth nr Hotchkiss, CO	S	T14S R92W	-	-	07-07-72	1110	18.0	8.3	900	-	A	A	P	A
1002	Reynolds C nr mouth nr Paonia, CO	S	T14S R91W	-	-	07-07-72	1350	20.0	8.5	750	IR	A	A	C	A
1003	Roatcap C at mouth nr Paonia, CO	S	T14S R92W	-	-	07-07-72	1420	18.0	7.9	1400	-	A	A	P	P
1004	Minnesota C tr nr Paonia, CO	S	T13S R91W	-	-	07-07-72	1455	-	-	-	NF	-	-	-	-
1005	Minnesota C tr No. 2 nr Paonia, CO	S	T13S R91W	-	-	07-07-72	1500	-	-	-	NF	-	-	-	-
1008	Stevens Gulch at mouth at Paonia, CO	S	T13S R91W	-	-	07-07-72	1600	-	-	-	NF	-	-	-	-
1009	Coal Gulch nr Paonia, CO	S	T13S R91W	-	-	07-07-72	1615	-	-	-	NF	-	-	-	-
1010	Terror C at mouth nr Bowie, CO	S	T13S R91W	-	-	07-07-72	1630	23.5	8.3	560	VST	A	A	P	A
1011	N F Gunnison R tr at Bowie, CO	S	T13S R91W	-	-	07-07-72	1650	-	-	-	NF	-	-	-	-
1012	N F Gunnison R tr No. 2 at Bowie, CO	S	T13S R91W	-	-	07-07-72	1655	-	-	-	NF	-	-	-	-
1013	Hubbard C at mouth nr Bowie, CO	S	T13S R91W	-	-	07-07-72	1700	19.5	8.4	700	-	A	A	P	P
1023	L Coal C at mouth nr Crawford, CO	S	T15S R91W	-	-	07-07-72	1155	23.5	8.7	240	ST	A	A	P	A
1024	Smith F nr Crawford, CO (09128500)	S	T15S R91W	-	-	07-07-72	1220	19.5	8.1	250	-	A	P	P	A
				Garfield County											
953	E Salt C ab Howard Canyon C nr Mack, CO	S	T08S R102W	-	-	07-02-72	0950	-	-	-	NF	-	-	-	-
958	Big Salt Wash ab Ruby D nr Fruita, CO	S	T08S R102W	-	-	07-02-72	1100	-	-	-	NF	-	-	-	-
1042	Estes Gulch at mouth nr Rifle, CO	S	T05S R93W	-	-	07-03-72	0910	-	-	-	NF	-	-	-	-
1043	Government C ab Estes Gulch nr Rifle, CO	S	T05S R93W	-	-	07-03-72	0915	-	-	-	NF	-	-	-	-
1044	W Rifle C bl Rifle Gap Re nr Rifle, CO	S	T05S R92W	-	-	07-02-72	1010	11.5	8.1	850	-	A	P(?)	P	A
1044A	W Rifle C ab Middle Rifle C nr Rifle, CO	S	T05S R93W	39 38 46	107 46 47	07-03-72	1130	17.0	8.0	2800	OS ST	A	A	P	A
1045	E Divide C ab E Divide C D nr Silt, CO	S	T07S R91W	-	-	07-03-72	1500	21.0	8.7	300	-	A	A	P	P
1046	W Divide C bl Alkali C nr Silt, CO	S	T07S R92W	-	-	07-03-72	1640	21.0	9.0	650	-	A	P	P	A
1047	Colorado R tr nr New Castle, CO	S	T06S R91W	-	-	07-03-72	1810	-	-	-	NF	-	-	-	-
1048	Alkali C at mouth at New Castle, CO	S	T06S R91W	-	-	07-03-72	1740	-	-	-	NF	-	-	-	-
1049	E Elk C at mouth nr New Castle, CO	S	T05S R91W	-	-	07-03-72	1910	13.5	8.5	450	-	A	P	P	P
1050	Main Elk C at mouth nr New Castle, CO	S	T05S R91W	-	-	07-03-72	1840	14.0	8.6	400	-	A	P	P	C
1051	South Canyon C at mo nr Glenwood Spgs, CO	S	T06S R90W	39 33 37	107 24 29	07-04-72	0925	19.0	8.7	2100	T	A	A	C	A
						07-17-72	1410	29.0	9.0	2300	ST	A	A	P	A

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to determine the effect of coal mining in Colorado, 1972--Continued

Field observations									Laboratory determinations															
Aquatic organisms									Trace elements, micrograms per liter															Sulfate (SO_4), milligrams per liter
Fauna																								
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	
RIO GRANDE BASIN																								
(No known coal deposits in this part of Colorado)																								
COLORADO RIVER BASIN																								
Archuleta County																								
P	A	A	A	C	A	P	A	dragonflies: C damselflies: C amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	P	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Delta County																								
P	P	P	A	A	A	A	P	dragonflies: P adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	A	C	A	damselflies: P adult beetles: C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	A	A	A	P	A	A	adult beetles: P misc. dipteran: P	2	0	-	1	2	40	1	0	0.0	-	3	-	0	-	0	59
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	P	A	A	A	misc. dipteran: P amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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P	A	P	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	A	C	P	damselflies: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	P	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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P	P	A	A	A	P	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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P	P	A	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	A	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Garfield County																								
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P	P	A	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	6	0	-	0	2	10	1	200	.0	-	16	-	0	-	20	1100
P	C	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	P	P	A	water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	P	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	C	A	A	damselflies: P	1	0	-	0	2	30	1	0	.0	-	3	-	0	-	0	110

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Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Garfield County (Continued)														
1052	Fourmile C tr nr Glenwood Springs, CO	S	T07S R89W	-	-	07-04-72	1130	-	-	-	NF	-	-	-	-
1053	Fourmile C ab Freeman C nr Glenwood Springs, CO	S	T07S R89W	-	-	07-04-72	1200	15.5	8.6	510	-	A	A	C	C
1054	Edgerton C nr Carbondale, CO	S	T07S R89W	-	-	07-04-72	1240	-	-	-	NF	-	-	-	-
	Gunnison County														
54	Ruby Anthracite C bl Bracken C nr Oliver, CO	S	T14S R87W	-	-	07-08-72	1345	15.0	7.2	80	-	A	P	P	A
56E	Slate R at mouth nr Crested Butte, CO	S	T14S R85W	-	-	07-09-72	0820	12.0	7.3	200	-	A	P	P	A
57A	Anthracite C bl Munsey C nr Oliver, CO	S	T13S R88W	-	-	07-07-72	1915	15.0	7.4	100	-	A	P	P	P
71	Mill C at mouth nr Baldwin, CO	S	T15S R86W	-	-	07-08-72	1545	18.0	8.4	180	ST	A	P	P	A
73	Carbon C at mouth nr Baldwin, CO	S	T15S R86W	38 44 10	107 01 48	07-08-72	1520	19.0	7.0	200	ST	A	P	P	P
						07-19-72	0750	11.5	7.4	220	ST	A	P(?)	P	C
1006	Dry F Minnesota C nr Paonia, CO	S	T13S R90W	-	-	07-07-72	1515	19.0	-	520	VST	A	A	P	A
1014	Bear C at mouth nr Somerset, CO	S	T13S R90W	-	-	07-07-72	1725	19.0	8.6	850	VST	A	A	P	A
1015	N F Gunnison R tr at Somerset, CO	S	T13S R90W	-	-	07-07-72	1740	-	-	-	NF	-	-	-	-
1015A	N F Gunnison R bl Coal Gl nr Oliver, CO	S	T13S R90W	-	-	07-07-72	1810	17.0	8.8	140	VST	A	A	P	A
1016	Coal Gulch at mouth at Oliver, CO	S	T13S R90W	-	-	07-07-72	1750	-	-	-	NF	-	-	-	-
1018	Coal C at mouth nr Oliver, CO	S	T13S R89W	-	-	07-07-72	1835	17.5	8.5	120	-	A	P	P	P
1019	Cliff C at mouth nr Oliver, CO	S	T14S R89W	-	-	07-08-72	1035	12.0	8.2	100	-	A	P	P	A
1020	Robinson C at mouth nr Oliver, CO	S	T14S R89W	-	-	07-08-72	1120	16.0	8.6	240	-	A	P	P	A
1021	Coal C ab Robinson C nr Oliver, CO	S	T14S R89W	-	-	07-08-72	1140	14.5	8.8	160	IR	A	P	P	A
1022	Snowshoe C at mouth nr Oliver, CO	S	T13S R89W	-	-	07-07-72	1850	18.0	7.5	120	-	A	P	P	P
1025	Coal C ab Cimarron Canal nr Cimarron, CO	NM	T47N R07W	-	-	06-12-72	1500	9.0	7.3	90	ST	-	-	-	-
1026	W F Cimarron R nr mouth nr Cimarron, CO	NM	T45N R06W	-	-	06-12-72	1620	10.0	7.9	60	ST	-	-	-	-
1030	Elk C at mouth nr Crested Butte, CO	S	T14S R87W	-	-	07-08-72	1725	9.5	8.1	200	-	-	-	-	-
1031	Coal C nr source nr Crested Butte, CO	S	T14S R87W	-	-	07-08-72	1700	16.0	7.9	300	-	A	P	P	A
1032	Slate R ab Coal C at Crested Butte, CO	S	T13S-R86W	38 52 39	106 58 37	07-09-72	0745	11.5	7.2	220	-	A	P(?)	P(?)	A
						07-18-72	1905	16.0	8.3	120	-	A	P	A	A
	La Plata County														
923	Mc Dermott Arroyo nr Redmesa, CO	NM	T32N R12W	-	-	06-14-72	1830	-	-	-	NF	-	-	-	-
924	Johnny Pond Arroyo at mo nr Redmesa, CO	NM	T32N R13W	-	-	06-14-72	1715	-	-	-	NF	-	-	-	-
925	Long Hollow C at mouth nr Redmesa, CO	NM	T32N R13W	-	-	06-14-72	1545	18.0	8.3	1175	ST	P	P-C	C	A
926	Cherry C at mouth nr Redmesa, CO	NM	T33N R12W	-	-	06-14-72	1715	16.5	8.6	850	T	A	A	P	A
927	Alkali Gulch nr mouth nr Kline, CO	NM	T34N R12W	-	-	06-14-72	1645	-	-	-	NF	-	-	-	-
928	Hay Gulch ab Mormon Re, CO	NM	T34N R12W	-	-	06-14-72	1600	16.5	8.1	960	T	-	-	-	-
928A	Hay Gulch tr nr Hesperus, CO	NM	T35N R11W	-	-	06-14-72	1535	-	-	-	NF	-	-	-	-
928B	Roberts Canyon C at mouth nr Hesperus, CO	NM	T35N R11W	-	-	06-14-72	-	-	-	-	NF	-	-	-	-
928C	Hay Gulch tr No. 2 nr Hesperus, CO	NM	T35N R11W	-	-	06-14-72	1530	-	-	-	NF	-	-	-	-
929	La Plata R ab Hay Gulch nr Kline, CO	NM	T34N R12W	-	-	06-14-72	-	15.5	8.2	230	-	P	P	A	P-C
930	La Plata R ab Hay Gulch D at Hesperus, CO	NM	T35N R11W	-	-	06-14-72	-	13.0	8.0	135	-	A	P	P	A
931	Cottonwood Gulch at mo nr Loma Linda, CO	NM	T33N R09W	-	-	06-15-72	1000	14.5	8.6	440	IR	P	P	C	A
932	Florida R tr nr Loma Linda, CO	NM	T34N R08W	-	-	06-15-72	1130	19.0	8.2	580	-	-	-	-	-
933	Sawmill Cañyon C at mouth nr La Posta, CO	NM	T34N R10W	-	-	06-15-72	0900	-	-	-	NF	-	-	-	-
934	Basin C at mouth nr La Posta, CO	NM	T34N R10W	37 11 12	107 52 46	06-15-72	0830	13.0	8.3	2000	ST	A	A	C	A
935	Wilson Gulch nr Loma Linda, CO	NM	T34N R09W	-	-	06-15-72	0930	-	-	-	NF	-	-	-	-
936	Animas R tr at Durango, CO	NM	T35N R09W	-	-	06-15-72	0715	-	-	-	NF	-	-	-	-
937	Wildcat Canyon C at mouth nr Durango, CO	NM	T35N R10W	-	-	06-14-72	1900	-	-	-	NF	-	-	-	-
938	Lightner C tr nr Durango, CO	NM	T35N R10W	-	-	06-15-72	0630	-	-	-	NF	-	-	-	-
939	Coal Gulch at mouth nr Durango, CO	NM	T35N R10W	-	-	06-15-72	0700	-	-	-	NF	-	-	-	-
940	Dry C ab Gem Village, CO	NM	T34N R07W	-	-	06-15-72	1300	24.0	7.9	260	ST	P	P	P	A
941	Beaver C nr Bayfield, CO	NM	T34N R06W	-	-	06-15-72	1330	18.5	8.0	240	VST	P	P	P-C	A

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to determine the effect of coal mining in Colorado, 1972—Continued

Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									Garfield County (Continued)															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Gunnison County															
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	A	A	A	A	misc. dipteran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	P	A	A	P	A	A	-	5	0	-	1	1	270	2	70	0.0	-	2	-	0	-	0	8.1
A	A	A	A	A	C	A	A	misc. dipteran: C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	A	A	A	A	A	A	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	damselflies: P misc. dipteran: P water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	C	C	A	P-C	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P(?)	P	A	A	A	A	A	-	6	0	-	1	1	40	1	0	.0	-	3	-	0	-	20	18
									La Plata County															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	C	A	C	A	amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	A	A	C	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	A	A	C	A	A	A	adult beetles: C amphipods: P																
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	C	A	P	A	adult beetles: P misc. hemipteran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	C	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	A	A	C	A	C	P	flatworms: P mussels (?): P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	A	A	C	C	A	A	water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	1	A	A	C	C	A	A	amphipods: P	0	0	-	0	5	20	2	0	-	-	4	-	0	-	0	1100
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	C	C	C	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	C	A	C	C	C	A	misc. hemipteran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	Field observations: pH	Field observations: Specific conductance, micromhos per centimeter at 25°C	Field observations: Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Aquatic organisms, Flora: Diatoms	Aquatic organisms, Flora: Green algae	Aquatic organisms, Flora: Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Mesa County														
951	Prairie Canyon C at mouth nr Mack, CO	S	T09S R104W	-	-	07-02-72	0900	-	-	-	NF	-	-	-	-
952	W Salt C ab Prairie Canyon C nr Mack, CO	S	T09S R104W	-	-	07-02-72	0910	-	-	-	NF	-	-	-	-
957	Coal Gulch nr mouth nr Fruita, CO	S	T08S R102W	-	-	07-02-72	1110	-	-	-	NF	-	-	-	-
959	L Salt Wash nr Fruita, CO	S	T09S R101W	-	-	07-02-72	1310	-	-	-	NF	-	-	-	-
960	Hunter Wash tr nr Grand Junction, CO	S	T10S R100W	-	-	07-02-72	1410	-	-	-	NF	-	-	-	-
961	Persigo Wash tr nr Grand Junction, CO	S	T10S R100W	-	-	07-02-72	1450	-	-	-	NF	-	-	-	-
964	N F Kannah C ab Laurent D nr Whitewater, CO	S	T12S R97W	-	-	07-01-72	1515	19.0	8.0	190	-	A	A	A	P
1033	Sink C nr Clifton, CO	U	T01S R02E	-	-	07-01-72	1730	-	-	-	NF	-	-	-	-
1034	Colorado R tr nr Palisade, CO	S	T11S R98W	-	-	07-02-72	1610	-	-	-	NF	-	-	-	-
1035	Colorado R tr at Palisade, CO	S	T11S R98W	-	-	07-02-72	1630	-	-	-	NF	-	-	-	-
1036	Colorado R tr No. 2 at Palisade, CO	S	T11S R98W	-	-	07-02-72	1635	-	-	-	NF	-	-	-	-
1037	Colorado R tr No. 2 nr Palisade, CO	S	T11S R98W	-	-	07-02-72	1650	20.0	7.8	380	-	A	A	P	A
1038	Rapid C at mouth nr Cameo, CO	S	T11S R98W	-	-	07-02-72	1750	-	-	-	NF	-	-	-	-
1039	Coal Canyon C at mouth at Cameo, CO	S	T10S R98W	-	-	07-02-72	1820	-	-	-	NF	-	-	-	-
1040	Jerry C at mouth nr Cameo, CO	S	T10S R98W	-	-	07-02-72	1830	-	-	-	NF	-	-	-	-
1041	Horseshoe Cn C at mouth nr De Beque, CO	S	T09S R97W	-	-	07-03-72	0805	-	-	-	NF	-	-	-	-
	Moffat County														
783	Spring C tr nr Maybell, CO	S	T07N R95W	-	-	05-18-72	1530	-	-	-	NF	-	-	-	-
784	Spring C ab unnamed tr nr Maybell, CO	S	T07N R95W	-	-	05-18-72	1430	19.0	8.4	5500	-	A	P-C	P	A
785	Lay C tr nr Maybell, CO	S	T07N R94W	-	-	05-18-72	1705	-	-	-	NF	-	-	-	-
786	Lay C tr No. 2 nr Maybell, CO	S	T07N R94W	-	-	05-18-72	1720	16.0	8.1	2000	-	-	-	-	-
787	Big Gulch at mouth nr Lay, CO	S	T07N R93W	-	-	05-18-72	1850	19.0	8.3	2600	-	A	P(?)	P	A
788	Lay C ab Big Gulch at Lay, CO	S	T07N R93W	-	-	05-18-72	1830	14.0	8.3	1500	SF(?)	A	A	P-C	A
789	Temple Gl at mo nr Juniper Hot Spgs, CO	S	T06N R94W	-	-	05-18-72	1330	-	-	-	NF	-	-	-	-
790	Maudlin Gl at mo nr Juniper Hot Spgs, CO	S	T06N R94W	-	-	05-18-72	1320	-	-	-	NF	-	-	-	-
791	Boxelder Gl at mo nr Juniper Hot Spgs, CO	S	T05N R93W	-	-	05-18-72	1310	-	-	-	NF	-	-	-	-
792	Morgan Gl ab Boxelder Gl nr Juniper Hot Springs, CO	S	T05N R93W	-	-	05-18-72	1300	19.0	8.2	>8000	YT	A	P-C	A	A
794	Jubb C nr mouth nr Axial, CO	S	T05N R93W	-	-	05-17-72	1510	-	-	-	NF	-	-	-	-
795	Wilson C ab Jubb C nr Axial, CO	S	T04N R93W	-	-	05-17-72	1515	16.5	8.4	2000	VST	A	C	P	A
796	Stinking Gulch at mouth nr Axial, CO	S	T05N R92W	-	-	05-17-72	1545	18.0	8.5	3500	IR VT	-	-	-	-
796A	Stinking Gulch at Iles Grove, CO	S	T05N R92W	40 20 05	107 41 19	05-18-72	1030	15.5	8.6	3300	ST	A	C	A	A
797	Good Spring C at Axial, CO	S	T04N R93W	40 17 22	107 47 22	05-17-72	1345	18.0	8.5	1600	ST	A	C+	A	A
798	Milk C ab Good Spring C nr Axial, CO	S	T04N R92W	-	-	05-17-72	1445	14.0	8.3	335	SM VT	A	C	A	A
798A	Castor Gulch at mouth at Hamilton, CO	S	T05N R91W	-	-	06-05-72	1420	-	-	-	NF	-	-	-	-
799	Deer C nr mouth nr Hamilton, CO	S	T04N R91W	-	-	05-18-72	1145	13.0	8.3	460	SM T	A	P-C	P	A
800	Morapos C nr Hamilton, CO	S	T04N R91W	-	-	05-18-72	1125	10.0	8.4	370	SM T	A	C	A	A
802	Waddle C nr Hamilton, CO	S	T04N R90W	-	-	06-06-72	1040	15.0	8.0	750	IR OS T	-	-	-	-
806	Pine C at mouth nr Pagoda, CO	S	T03N R90W	-	-	06-05-72	1755	11.5	7.0	280	SM ST	A	P	P	A
808	S F Williams F ab Pine C nr Pagoda, CO	S	T03N R90W	-	-	06-05-72	1820	10.0	8.0	150	SM OS T	-	-	-	-
810	Yampa R tr nr Craig, CO	S	T06N R91W	-	-	05-17-72	1720	-	-	-	NF	-	-	-	-
811	Fortification C ab Ralph White Re, CO	S	T08N R90W	-	-	05-18-72	0740	11.0	8.1	180	SM VT	-	-	-	-
812	Coal Gulch nr Craig, CO	S	T08N R90W	40 37 45	107 25 40	05-18-72	0815	11.0	7.6	3100	YT	P	P-C	P-C	A
813	L Bear C ab Dry F nr Craig, CO	S	T08N R90W	-	-	05-17-72	1840	12.5	7.9	100	SM T	A	P(?)	A	A
814	Dry F L Bear C at mouth nr Craig, CO	S	T08N R90W	-	-	05-17-72	1820	13.5	8.1	120	SM T	A	C	A	A
815	Deacon Gulch tr nr Craig, CO	S	T06N R90W	40 28 50	107 30 22	06-06-72	1230	10.0	6.3	1600	BC	A	A	P-C	A
815A	Deacon Gulch nr Crsig, CO	S	T06N R90W	40 28 25	107 30 32	06-06-72	1330	23.5	8.1	3500	OS ST	-	-	-	-

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Field observations: Aquatic organisms: Fauna: Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Laboratory determinations: Trace elements, micrograms per liter: Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
									COLORADO RIVER BASIN (Continued)															
									Mesa County															
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P	P	P	A	A	P	A	A	dragonflies: P tubificids: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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									Moffat County															
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A	A	P	A	P	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	A	P(?)	P	P-C	P	A	damsel- flies: P-C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	C	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	P	A	A	A	A	A	adult beetles: P-C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	P-C	C	A	A	A	P	A	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	C	A	A	A	-	1	0	-	0	1	20	0	13	0.0	-	1	-	0	-	10	590
P	A	P-C	A	P-C	A	P	A	adult beetles: P amphipods: C	0	0	-	0	1	20	3	80	.0	-	4	-	0	-	10	540
P-C	P	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	A	P	A	P	P-C	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P-C	A	A	A	A	A	misc. dip- teran: 1 amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P-C	P	A	P	C+	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	P	P	A	P	P-C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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P	A	A	A	A	A	A	A	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P-C	1	A	A	A	A	adult beetles: P misc. hemip- teran: P fungal or bacterial slime: C	5	0	-	0	3	20	1	25	.2	-	8	-	0	-	30	1200
A	A	A	A	A	P	A	A	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	P-C	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	-	2	0	-	0	0	20	3	13	.0	-	3	-	1	-	10	200
A	A	A	A	A	A	A	A	adult beetle: 1	3	0	-	0	0	10	1	490	.0	-	5	-	0	-	20	2000

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Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Moffat County (Continued)														
816	Elkhead C at mouth at Elkhead, CO	S	T07N R90W	-	-	06-06-72	1440	19.5	7.6	225	SM T	A	C	P	A
837	Willow C nr Dixon, WY (09258000)	S	T11N R90W	40 54 56	107 31 16	06-08-72	0910	8.0	6.2	70	SM T	A	C	P	P
838	Slater F nr Slater, CO (09255000)	S	T12N R89W	-	-	06-08-72	1100	10.5	6.6	90	SM ST	-	-	-	-
	Montezuma County														
109	E Mancos R nr Mancos, CO	NM	T36N R13W	-	-	06-14-72	-	14.5	8.1	160	-	A	P	C	A
917	Ute Canyon C at mouth nr Mancos, CO	NM	T33N R16W	-	-	06-14-72	1130	24.5	8.3	2000	RO ST	-	-	-	-
918	Grass Canyon C at mouth nr Mancos, CO	NM	T33N R16W	-	-	06-14-72	1100	-	-	-	NF	-	-	-	-
919	Navajo Canyon C at mouth nr Mancos, CO	NM	T33N R15W	-	-	06-14-72	1145	-	-	-	NF	-	-	-	-
920	Johnson Canyon C at mouth nr Mancos, CO	NM	T33N R15W	-	-	06-14-72	1200	-	-	-	NF	-	-	-	-
921	Morfield Canyon C at mouth nr Mancos, CO	NM	T33N R15W	-	-	06-14-72	1230	-	-	-	NF	-	-	-	-
922	Weber Canyon C at mouth nr Mancos, CO	NM	T34N R13W	-	-	06-14-72	-	22.5	8.2	3600	ST	P	P	P-C	A
	Montrose County														
944	Coal Canyon C nr mouth nr Nucla, CO	NM	T47N R16W	-	-	06-13-72	1630	-	-	-	NF	-	-	-	-
945A	Tuttle Draw nr Nucla, CO	NM	T47N R16W	38 16 52	108 35 42	06-13-72	1600	19.5	7.8	2000	-	P	P	P-C	A
945B	Tuttle Draw at upper station nr Nucla, CO	NM	T47N R16W	-	-	06-13-72	1515	20.0	8.3	1150	-	A	A	P	A
946	San Miguel R tr nr Vancorum, CO	NM	T46N R16W	-	-	06-13-72	1445	-	-	-	NF	-	-	-	-
947	Dry C at mouth at Vancorum, CO	NM	T46N R16W	-	-	06-13-72	1420	23.5	8.2	4000	-	A	A	C	A
948	Bramiers Draw at mouth at Naturita, CO	NM	T46N R15W	-	-	06-13-72	1400	-	-	-	NF	-	-	-	-
949	Naturita C at mouth at Naturita, CO	NM	T46N R15W	-	-	06-13-72	-	22.0	8.3	1500	T	P	A	P	A
986	Beaton C nr Colona, CO	NM	T47N R08W	38 21 38	107 41 28	06-13-72	1020	10.5	8.3	600	ST	-	-	-	-
	Ouray County														
265	Cow C ab Nate C nr Ridgway, CO	NM	T45N R07W	-	-	06-12-72	1730	10.0	7.9	130	ST	-	-	-	-
987	Burro C nr Eldredge, CO	NM	T46N R08W	-	-	06-13-72	0815	10.0	8.1	235	ST	-	-	-	-
	Pitkin County														
1055	N Thompson C nr mouth nr Carbondale, CO	S	T08S R89W	-	-	07-04-72	1325	19.5	8.7	280	-	A	P	P	P
1056	S Thompson C at mouth nr Carbondale, CO	S	T09S R88W	-	-	07-04-72	1430	18.5	8.7	600	-	A	P	C	P
1057	M Thompson C at mouth nr Carbondale, CO	S	T09S R89W	-	-	07-04-72	1400	15.0	8.5	120	-	A	P	P	P
1058	Coal C at mouth at Redstone, CO	S	T10S R88W	-	-	07-04-72	1620	19.5	9.3	340	-	A	P	P	A
1059	Dutch C tr nr Redstone, CO	S	T10S R89W	-	-	07-04-72	1745	12.0	8.0	340	OS ST	A	P	P(?)	A
1059A	Coal C nr Redstone, CO	S	T10S R89W	39 11 57	107 17 59	07-04-72	1830	14.0	8.3	340	VST	A	A	A	A
						07-17-72	1600	19.5	8.7	520	-	A	P	P	A
1060	Crystal R ab Coal C at Redstone, CO	S	T10S R88W	-	-	07-04-72	1700	14.5	8.1	220	-	A	P	P	A
	Rio Blanco County														
753	Cottonwood C at mouth nr Rangely, CO	S	T01N R103W	-	-	05-15-72	1355	-	-	-	NF	-	-	-	-
754	Shavetail Wash at mouth nr Rangely, CO	S	T01N R103W	-	-	05-15-72	1340	-	-	-	NF	-	-	-	-
755	Coal Gulch at mouth nr Rangely, CO	S	T01N R103W	-	-	05-15-72	1535	-	-	-	NF	-	-	-	-
756	Stinking Water C at mouth nr Rangely, CO	S	T01N R102W	-	-	05-15-72	1445	29.0	8.9	>8000	YT	A	P-C	A	A
757	Coal Mine Draw at mouth at Rangely, CO	S	T01N R102W	-	-	05-15-72	1315	-	-	-	NF	-	-	-	-
758	White R tr at mouth at Rangely, CO	S	T01N R102W	-	-	05-15-72	1600	-	-	-	NF	-	-	-	-
759	Douglas C nr mouth nr Rangely, CO	S	T01N R101W	-	-	05-15-72	1620	24.0	9.0	1080	VT	A	P	P-C	A
760	Coal Draw at mouth nr Rangely, CO	S	T01S R101W	-	-	05-15-72	1700	-	-	-	NF	-	-	-	-
761	Big Horse Draw at mouth nr Rangely, CO	S	T01S R101W	-	-	05-15-72	1705	-	-	-	NF	-	-	-	-
762	E Douglas C at mouth nr Rangely, CO	S	T02S R101W	-	-	05-15-72	1740	20.5	8.8	825	VT	-	-	-	-
763	W Douglas C at mouth nr Rangely, CO	S	T02S R101W	-	-	05-15-72	1750	-	-	-	NF	-	-	-	-

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to determine the effect of coal mining in Colorado, 1972--Continued

Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															Sulfate (SO_4), milligrams per liter
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	
COLORADO RIVER BASIN (Continued)																								
Moffat County (Continued)																								
P	P	P	A	P	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	P	A	A	A	-	0	0	-	0	1	110	1	0	0.0	-	4	-	0	-	0	6.1
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Montezuma County																								
P	C	C	A	C	A	A	A	adult beetles: P misc. hemipteran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	C	A	C+	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Montrose County																								
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A	A	C	A	C+	A	P	A	damselflies: P amphipods: P	3	0	-	1	5	40	2	370	-	-	13	-	0	-	30	1200
C	A	P	A	P	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	P	A	C+	A	A	A	adult beetles: P misc. hemipteran: P amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	C	A	C	P	C	A	amphipods: C fish observed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	A	A	A	A	-	1	0	-	0	7	20	3	0	-	-	6	-	0	-	30	93
Ouray County																								
C	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	C	A	C	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitkin County																								
C	P	C	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	C	C	P	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	A	P	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	A	A	A	P	A	A	-	0	1	-	0	1	10	1	0	.0	-	3	-	0	-	0	49
P	P	C	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rio Blanco County																								
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C	A	A	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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A	A	P	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
			COLORADO RIVER BASIN (Continued)												
			Rio Blanco County (Continued)												
764	Scullion Gulch at mouth nr Massadona, CO	S	T02N R101W	-	-	05-15-72	1830	-	-	-	NF	-	-	-	-
765	Red Wash at mouth nr Massadona, CO	S	T02N R101W	-	-	05-15-72	1840	-	-	-	NF	-	-	-	-
766	Spring C nr Massadona, CO	S	T02N R101W	40 09 23	108 40 55	05-15-72	1930	13.5	8.2	>8000	SF	A	P-C	P-C	A
767	Fletcher Gulch at mouth nr Massadona, CO	S	T02N R100W	-	-	05-16-72	0805	-	-	-	NF	-	-	-	-
767A	Hall Draw at mouth nr Massadona, CO	S	T03N R100W	-	-	05-16-72	0815	-	-	-	NF	-	-	-	-
768	L Spring C at mouth nr Massadona, CO	S	T03N R99W	-	-	05-16-72	0820	11.5	8.7	1880	ST	P	P-C	P-C	A
770	Yellow C nr White River, CO (09306255)	S	T02N R98W	40 09 59	108 24 00	05-16-72	0950	17.0	8.7	3800	ST	A	P(?)	P-C	A
771	Crooked Wash at mouth nr Massadona, CO	S	T03N R98W	40 10 48	108 21 53	05-16-72	1120	27.5	8.7	3800	OS ST	-	-	-	-
772	Fourteenmile C nr Rio Blanco, CO	S	T03S R94W	-	-	05-16-72	1425	17.5	8.6	600	SM VT	-	-	-	-
773	Piceance C at Rio Blanco, CO (09305500)	S	T04S R94W	-	-	05-16-72	1345	18.5	8.4	700	SM ST	A	P(?)	A	A
774	Strawberry C nr Meeker, CO	S	T01N R94W	-	-	05-16-72	1505	22.5	8.4	5450	ST	A	P(?)	A	A
775	Sheep C at mouth nr Meeker, CO	S	T01N R94W	-	-	05-16-72	1550	-	-	-	NF	-	-	-	-
776	Lion Canyon C nr Meeker, CO	S	T01N R94W	-	-	05-16-72	1545	-	-	-	NF	-	-	-	-
777	Flag C ab Meeker, CO	S	T01S R94W	-	-	05-16-72	1630	10.0	8.1	2000	VST	A	C	A	A
778	Sulphur C at mouth at Meeker, CO	S	T01N R94W	-	-	05-16-72	1645	-	-	-	NF	-	-	-	-
779	Curtis C at mouth nr Meeker, CO	S	T01N R94W	-	-	05-16-72	1700	18.0	8.1	7500	VST	A	C	P	A
779A	Curtis C nr Meeker, CO	S	T02N R93W	-	-	05-17-72	1310	18.0	8.4	1200	-	A	P-C	A	A
779B	Curtis C at upper station nr Meeker, CO	S	T02N R93W	-	-	05-17-72	1305	15.5	8.4	1200	-	-	-	-	-
780	L Beaver C at mouth nr Meeker, CO	S	T01N R93W	-	-	05-16-72	1800	15.0	8.3	1425	SM VT	-	-	-	-
781	Coal C ab L Beaver C nr Meeker, CO	S	T01N R93W	-	-	05-16-72	1525	15.0	8.3	1100	YT	-	-	-	-
782	Big Beaver C ab Lake Avery, CO	S	T01S R91W	-	-	05-17-72	0755	4.5	8.2	200	SM T	A	P(?)	A	A
797A	Good Spring C ab Axial, CO	S	T02N R93W	-	-	05-17-72	1330	-	-	-	-	A	P(?)	P(?)	A
809	E F Williams F ab Poose C nr Pagoda, CO	S	T03N R88W	-	-	06-06-72	0845	5.5	7.1	130	SM T	-	-	-	-
832	Trout C nr source nr Oak Creek, CO	S	T02N R87W	-	-	06-21-72	1620	4.0	7.2	100	SM VST	A	C	A	A
			Routt County												
803	Beaver C at mouth nr Pagoda, CO	S	T04N R89W	-	-	06-05-72	1550	13.5	7.5	185	SM ST	A	P	A	A
804	Cedar C at mouth nr Pagoda, CO	S	T03N R89W	40 15 46	107 26 07	06-05-72	1620	15.0	8.3	720	SM T	-	-	-	-
805	Coal C at mouth nr Pagoda, CO	S	T03N R89W	40 15 30	107 26 23	06-05-72	1850	14.5	7.9	1600	SM VST	A	A	P-C	A
817	Dry F Elkhead C at mouth nr Elkhead, CO	S	T08N R88W	-	-	06-06-72	1640	22.0	8.2	250	SM VST	P	C	P	A
818	N F Elkhead C at mouth nr Elkhead, CO	S	T08N R88W	-	-	06-06-72	1820	17.0	7.0	80	SM ST	A	C	P	A
820	S F Elkhead C nr mouth nr Elkhead, CO	S	T09N R87W	-	-	06-07-72	1500	17.0	7.8	115	SM ST	A	C	P	A
821	Elkhead C ab S F nr Elkhead, CO	S	T09N R87W	-	-	06-07-72	1530	20.0	7.7	120	SM(?) VST	A	C	P	A
822	Yampa R tr nr Elkhead, CO	S	T06N R89W	-	-	06-06-72	1535	26.0	8.6	3000	YT	-	-	-	-
823	Holderness Gulch nr Hayden, CO	S	T06N R89W	-	-	06-07-72	0800	16.0	8.3	2200	-	A	P-C	P-C	A
824	Stokes Gulch at mouth nr Hayden, CO	S	T06N R88W	-	-	06-07-72	0940	-	-	-	NF	-	-	-	-
825	Dry Creek nr Hayden, CO	S	T05N R88W	-	-	06-07-72	0910	18.5	7.9	1200	-	-	-	-	-

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Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
Field observations									Laboratory determinations															
Aquatic organisms									Trace elements, micrograms per liter															
Fauna																								
									COLORADO RIVER BASIN (Continued)															
									Rio Blanco County (Continued)															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	P-C	A	A	A	adult beetles: P; water mite: 1	1	0	-	3	1	130	3	1200	0.0	-	12	-	0	-	20	4700
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	P	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	P-C	P	A	A	-	4	0	-	0	2	10	2	0	.0	-	2	-	0	-	10	660
A	A	A	A	A	A	A	A	-	3	0	-	0	5	20	1	25	.0	-	6	-	0	-	20	1300
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P-C	A	P-C	A	P	P	damselflies: P; adult beetles: P-C; misc. dipteran: 1; amphipods: P-C; oligochaetes: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	A	A	A	A	A	A	adult beetles: P; water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P	A	A	A	P	A	adult beetles: P; misc. hemipteran: P; amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	C	A	A	A	A	A	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	P-C	A	P	A	amphipods: C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	A	1	A	C	A	A	A	adult beetles: P; misc. hemipteran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P-C	A	P	A	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P-C	A	A	P-C	P	P	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	P	A	A	A	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	P	P	A	A	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									Routt County															
P	C	C	A	P	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	1	1	A	A	P	A	A	-	2	0	-	0	1	20	3	0	.0	-	3	-	0	-	0	130
A	A	P-C	A	A	A	A	A	adult beetle: 1	0	0	-	0	1	30	1	38	.0	-	4	-	0	-	20	690
A	P	P-C	A	P-C	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	P-C	C	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P-C	A	P	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P-C	A	P-C	C+	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	A	A	P	A	C+	A	adult beetles: P; amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P-C	A	P	P	A	P-C	A	A	adult beetles: P; amphipods: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.--*Chemical and biological quality of surface water at sites sampled*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	Field observations: pH	Field observations: Specific conductance, micromhos per centimeter at 25°C	Field observations: Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Aquatic organisms, Flora: Diatoms	Aquatic organisms, Flora: Green algae	Aquatic organisms, Flora: Blue-green algae
	COLORADO RIVER BASIN (Continued)														
	Routt County (Continued)														
826	Morgan C ab Mat Gulch nr Hayden, CO	S	T07N R87W	-	-	06-07-72	1745	22.5	8.2	1750	-	A	C	P	A
827	Sage C ab Lower Re nr Mt. Harris, CO	S	T05N R88W	-	-	06-07-72	1010	16.0	8.6	600	ST	A	C	A	A
828	Grassy C nr mouth nr Mt. Harris, CO	S	T06N R87W	40 27 02	107 08 58	06-07-72	1055	20.5	7.7	1100	T	A	P(?)	A	A
829	Fish C at mouth nr Milner, CO	S	T05N R86W	-	-	06-09-72	0840	15.5	7.4	560	SM ST	A	C	P	A
830	Middle C nr mouth nr Milner, CO	S	T05N R86W	-	-	06-09-72	0925	15.0	7.2	550	SM T	P	C	P	A
831	Trout C ab Middle C nr Milner, CO	S	T05N R85W	40 24 16	106 58 08	06-09-72	0950	10.0	7.9	145	SM T	A	C	P	A
834	Deep C bl Smith C nr Deep Creek, CO	S	T08N R86W	-	-	06-15-72	1715	24.5	8.3	300	-	A	A	P	A
835	Oak C bl Haybro, CO	S	T05N R85W	-	-	06-09-72	1230	15.0	6.7	580	SM T	P	C	A	A
835A	Oak C bl Oak Creek Drain nr Oak Creek, CO	S	T04N R85W	-	-	06-09-72	1415	14.5	7.7	520	SM T	-	-	-	-
835B	Oak Creek Drain nr Oak Creek, CO	S	T04N R85W	40 17 29	106 57 54	06-09-72	1340	12.0	6.6	3000	OS	C	A	P	A
835C	Oak C bl Oak Creek, CO	S	T04N R85W	-	-	06-09-72	1530	16.0	8.0	390	SM T	-	-	-	-
836	Hunt C at mouth at Phippsburg, CO	S	T03N R85W	-	-	06-21-72	1535	18.5	8.1	580	SM ST	A	C	A	A
839	S F Slater F nr mouth nr Slater, CO	S	T10N R88W	-	-	06-08-72	1300	9.5	6.9	50	SM ST	A	C	P	P
840	Slater F ab S F nr Slater, CO	S	T10N R88W	-	-	06-08-72	1210	13.5	7.9	100	SM VST	A	C	P	A
841	S F L Snake R at mouth nr Columbine, CO	S	T12N R86W	-	-	06-08-72	1440	17.5	7.7	140	SM ST	A	C	P	A

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Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															Sulfate (SO_4), milligrams per liter
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	
									COLORADO RIVER BASIN (Continued)															
									Routt County (Continued)															
P	A	P	A	P	C+	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	A	P	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	P-C	A	P	A	A	A	-	0	0	-	0	0	20	1	810	0.0	-	6	-	0	-	10	300
P-C	A	P	A	P	P	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	P	A	P-C	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	P	A	P	P	A	A	-	1	0	-	0	1	130	2	0	.0	-	3	-	0	-	30	15
A	P	C	A	A	C	A	A	misc. hemipteran: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	A	C	A	P	A	P	A	adult beetles: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	A	A	A	A	A	A	A	fungal or bacterial slime: C	1	0	-	1	0	7000	3	180	.0	-	12	-	0	-	40	1600
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P	A	P	A	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	A	A	A	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	P	P-C	A	P	P-C	A	A	water mites: P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	P	C	P(?)	P	P	P	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 7.--*Chemical and biological quality of surface water at control sites in Colorado, 1971-72*

[STATION NAME: ab, above; C, Creek; E, East; F, Fork; L, Little; M, Middle; nr, near; N, North; Re, Reservoir; R, River; S, South.

PRINCIPAL MERIDIAN: NM, New Mexico; S, Sixth.

STREAM CONDITIONS: T, water is turbid; YT, water has yellow tinge.

AQUATIC ORGANISMS (no distinction among riffle, edge, and bottom samples): A, absent; P, present; P-C, present to common; C, common; (?), classification questionable.]

Table 7.—*Chemical and biological quality of surface water*

Station number	Station name	Location: Principal meridian	Location: Township and Range	Location: Latitude	Location: Longitude	Date	Time	Field observations: Temperature, °C	pH	Specific conductance, micromhos per centimeter at 25°C	Stream conditions	Aquatic organisms, Flora: Rooted aquatics	Diatoms	Green algae	Blue-green algae
	PLATTE RIVER BASIN														
	Clear Creek County														
462	Chicago C ab S Chicago C nr Idaho Springs, CO	S	T04S R73W	39 40 56	105 36 46	06-28-72	1805	11.0	7.0	60	-	A	P	A	A
	Larimer County														
739	L Beaver C nr Rustic, CO (06748530)	S	T08N R73W	40 37 23	105 33 52	05-19-72	0900	3.5	7.9	55	-	A	P-C	P	A
	ARKANSAS RIVER BASIN														
	Custer County														
916	Grape C nr source nr Westcliffe, CO	S	T24S R72W	37 56 01	105 27 08	06-21-72	0830	8.0	7.4	70	-	P	P	P	C
	Lake County														
323	Halfmoon C nr Malta, CO (07083000)	S	T10S R81W	39 10 20	106 23 19	02-15-72	1200	0	7.9	60	-	-	-	-	-
	Las Animas County														
915	Whiskey C nr Stonewall, CO	S	T33S R69W	37 12 01	105 03 01	06-15-72	2000	8.0	8.2	220	-	A	-	P	A
	RIO GRANDE RIVER BASIN														
	Conejos County														
1063	Los Piños R ab Trujillo Meadows Re, CO	NM	T33N R05E	37 03 11	106 27 36	06-30-72	1020	13.0	6.5	60	-	A	P	P	P
	Saguache County														
1062	M F Saguache C ab N F nr Saguache, CO	NM	T43N R03E	38 01 00	106 41 31	06-23-72	0900	4.5	6.4	70	-	A	P	P	A
	COLORADO RIVER BASIN														
	Dolores County														
1027	Disappointment C nr Dunton, CO	NM	T41N R13W	37 49 50	108 20 27	06-13-72	1900	14.0	8.3	165	T	A	-	P-C	A
	Garfield County														
773A	Piceance C nr source nr Rio Blanco, CO	S	T03S R94W	39 45 29	107 53 47	06-22-72	1230	18.0	8.0	900	YT	A	C	P	A
	La Plata County														
115	Vallecito C nr Bayfield, CO (09352900)	NM	T37N R06W	37 28 39	107 32 35	09-29-71	0820	5.5	7.4	100	-	A	P-C	P-C	A
	Mesa County														
1061	Plateau C ab Vega Re, CO	S	T10S R93W	39 12 43	107 45 54	07-05-72	1335	17.0	7.8	420	-	A	P	P	C
	Rio Blanco County														
752	E Marvine C at mouth nr Buford, CO	S	T01N R89W	40 00 37	107 25 35	05-17-72	0910	5.5	8.2	120	-	A	C	P	A
	Routt County														
560	Whiskey C ab Whiskey Park nr Columbine, CO	S	T12N R85W	40 58 55	106 54 35	06-15-72	1410	15.5	6.4	60	-	P	C	P	P

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Field observations									Laboratory determinations															
Aquatic organisms																								
Fauna									Trace elements, micrograms per liter															
Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches	Miscellaneous	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mecury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Vanadium (V)	Zinc (Zn)	Sulfate (SO_4), milligrams per liter
													PLATTE RIVER BASIN											
													Clear Creek County											
P	P	P	A	A	P	A	A	-	2	0	0	0	1	70	2	0	0.0	0	4	1	0	0.3	10	5.6
													Larimer County											
C	C	C	A	A	P	A	A	-	-	0	0	0	2	130	2	0	-	0	7	6	0	.6	0	-
													ARKANSAS RIVER BASIN											
													Custer County											
P	C	P	A	A	P	A	A	tubificids(?): P	0	0	0	0	3	70	2	0	-	0	5	2	0	1.8	40	6.8
													Lake County											
-	-	-	-	-	-	-	-	-	6	1	0	1	2	30	1	0	.2	0	2	1	0	.3	20	6.3
													Las Animas County											
C	P	C	A	P	A	A	A	fish observed	2	0	0	0	2	10	2	0	-	0	5	1	0	1.8	20	20
													RIO GRANDE RIVER BASIN											
													Conejos County											
P	P	P	A	A	P	A	A	flatworms: P	0	1	0	0	1	50	1	10	0	0	10	0	0	1.4	20	3.6
													Saguache County											
P	P	C	A	A	A	A	A	-	1	0	0	0	0	60	3	13	0	1	4	1	0	.9	0	3.6
													COLORADO RIVER BASIN											
													Dolores County											
P	C	C	A	C	A	A	A	-	2	0	0	0	4	100	3	0	-	1	5	6	0	.8	10	20
													Garfield County											
P	P-C	P	A	P	P	A	P	adult beetles: P	0	0	0	0	1	20	2	70	.7	3	6	6	1	.2	10	250
													La Plata County											
C	C	C	A	A	A	A	A	-	3	0	0	0	3	10	7	0	0	0	3	8	0	.1	30	9.5
													Mesa County											
C	A	C	P	A	A	A	A	-	2	0	0	0	2	40	1	30	0	0	6	2	0	1.0	20	10
													Rio Blanco County											
C	C	P	A	P	P	A	A	water mites: P	0	0	0	0	0	40	3	13	.8	0	5	1	1	1.8	10	3.6
													Routt County											
P	P	P	A	A	P	A	A	-	3	0	0	0	1	80	2	25	0	0	2	5	0	.9	40	6.0

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Table 8.--*Maximum values for various water-quality parameters in Colorado surface waters, 1971-72*

Water-quality parameter	Maximum value,[1] micrograms per liter[2]		
	Metal-mining survey	Coal-mining survey	Control-site survey
Arsenic	20	6	6
Cadmium	520	1	1
Chromium	0	--------	0
Cobalt	280	3	1
Copper	10,000	7	4
Iron	45,000	7,000	130
Lead	220	3	7
Manganese	82,000	1,200	70
Mercury	4.5	.2	.8
Molybdenum	26,000	--------	3
Nickel	900	16	10
Selenium	24	100	8
Silver	2	1	1
Vanadium	510	--------	1.8
Zinc	99,000	40	40
Sulfate (mg/l)	1,700	4,700	250
Specific conductance (μmhos/cm at 25°C)	3,600	>8,000	900
pH (units)	3.0	6.2	6.4

[1]Minimum values are shown for pH (maximum acidity).
[2]All values expressed as μg/l, unless otherwise specified.

Table 9.--*Sites where water samples showed concentrations in excess of recommended drinking water standards*

[U.S. Public Health Service, 1962, 1970; Colorado Dept. Health, 1971a]

Water-quality parameter	Percentage of sample sites where concentration exceeded drinking water standards (total number of sites sampled in parentheses)					
	Metal-mining survey		Coal-mining survey		Control-site survey	
Arsenic-----------	[1]1.4	(144)	[1]0	(30)	[1]0	(12)
Cadmium-----------	12.5	(144)	0	(30)	0	(13)
Chromium[2]---------	0	(13)	----	(0)	0	(13)
Cobalt[3]-----------	------------		----------		----------	
Copper------------	2.8	(144)	0	(30)	0	(13)
Iron--------------	19.4	(144)	3.3	(30)	0	(13)
Lead--------------	2.1	(144)	0	(30)	0	(13)
Manganese---------	58.3	(144)	40.0	(30)	7.7	(13)
Mercury-----------	0	(139)	0	(22)	0	(9)
Molybdenum[3]-------	------------		----------		----------	
Nickel[3]-----------	------------		----------		----------	
Selenium[2]---------	19.5	(41)	50.0	(2)	0	(13)
Silver------------	0	(144)	0	(28)	0	(13)
Vanadium[3]---------	------------		----------		----------	
Zinc--------------	9.0	(144)	0	(30)	0	(13)
Sulfate-----------	22.9	(144)	53.3	(30)	0	(12)

[1]Based on the limit of 10 μg/l; no sample exceeded the less restrictive limit of 50 μg/l.

[2]These elements were determined only in samples where they were expected to be found; thus, the results may be somewhat biased.

[3]There are no drinking water standards for these elements.

The percentages of sample sites where concentrations exceed the criteria suggested for fish and other aquatic life (table 3, this report) are shown in table 10. The differences between these percentages and those in table 9 reflect the differences in the respective limits. The data in table 10 do point out, rather dramatically, the potential problem of toxicity to aquatic organisms due to high zinc and copper concentrations. These elements are not of much concern, it will be remembered, with respect to drinking water standards. With this exception, the elements follow about the same order as before in regard to the frequency with which their criteria are exceeded.

Additional insight can be gained from examination of figure 8. This shows, for the metal-mining survey only, the frequency (number of sample sites) with which a specified number of water-quality parameters is exceeded. As would be expected, the frequency decreases with increasing number of parameters. This occurs rapidly at first, and then seems to increase slightly before going to zero. The rather high frequency with which the limit for only one parameter is surpassed is due primarily to manganese in the case of drinking water standards, and to zinc in the case of criteria for aquatic life. These elements have relatively low limits and high background concentrations in Colorado streams. The reason for the slight increase before going to zero, on the other hand, appears to be the result of several elements which often occur together in high concentrations. These include cadmium, copper, iron, manganese, zinc, and sometimes lead and nickel.

With regard to pH, it is interesting to compare the results of the present study with those of Biesecker and George (1966) for the Appalachian region. In the present study, only 1.5 percent of the stations (7 of 478 for the metal-mining survey only) had pH values less than 4.5. This is considerably less than the 14 percent found by Biesecker and George (1966). (See p. 31.) As both sampling programs were designed similarly (streams were selected where effects due to mine drainage were known or suspected), this would indicate that acid production is more of a problem in the coal-mining areas of Appalachia than in the metal-mining areas of Colorado. The relative importance of high concentrations of trace elements in metal-mining and coal-mining areas cannot be adequately assessed at this time because of the paucity of such data from coal-mining areas.

The only station which appears to be affected by the oxidation of pyritic materials associated with coal is the Oak Creek Drain near Oak Creek (station 835B, p. 90-91; fig. 9). Here, water issuing from an abandoned adit contains relatively high concentrations of iron and sulfate. It deposits a bright-orange coating on the substate between the adit and Oak Creek, a distance of several hundred feet. Upon entering the stream, the drainage raises the specific conductance about 100 μmhos/cm at 25°C and lowers the pH about 1 unit. However, except for iron, concentrations of trace elements in the Oak Creek Drain are not very great, and concentrations of iron in the stream above and below

Table 10.--*Sites where water samples showed concentrations in excess of suggested stream criteria for fish and other aquatic life*

[Table 3, this report]

Water-quality parameter	Percentage of sample sites where concentration exceeded stream criteria for fish and other aquatic life (total number of sites sampled in parentheses)					
	Metal-mining survey		Coal-mining survey		Control-site survey	
Arsenic----------	0	(144)	0	(30)	0	(12)
Cadmium----------	12.5	(144)	0	(30)	0	(13)
Chromium[1]--------	0	(13)	----	(0)	0	(13)
Cobalt-----------	0	(144)	0	(28)	0	(13)
Copper-----------	[2]21.5	(144)	[2]0	(30)	[2]0	(13)
Iron-------------	19.4	(144)	3.3	(30)	0	(13)
Lead-------------	[2]12.5	(144)	[2]0	(30)	[2]0	(13)
Manganese--------	22.9	(144)	3.3	(30)	0	(13)
Mercury----------	2.2	(139)	0	(22)	0	(9)
Molybdenum-------	------------		----------		----------	
Nickel-----------	6.9	(144)	0	(28)	0	(13)
Selenium[1]--------	0	(41)	0	(2)	0	(13)
Silver-----------	[3]1.4	(144)	[3]0	(28)	[3]0	(13)
Vanadium---------	------------		----------		----------	
Zinc-------------	[2]47.2	(144)	[2]0	(30)	[2]0	(13)
pH (units)-------	4.2	(478)	0	(191)	0	(13)

[1]These elements were determined only in samples where they were expected to be found; thus, the results may be somewhat biased.

[2]Based on the maximum value given in table 3, p. 27.

[3]Based on a value of 1 μg/l, instead of 0.1 μg/l as given in table 3, since 1 μg/l is presently the minimum value reported by the U.S. Geological Survey's Central Laboratory in Salt Lake City, Utah.

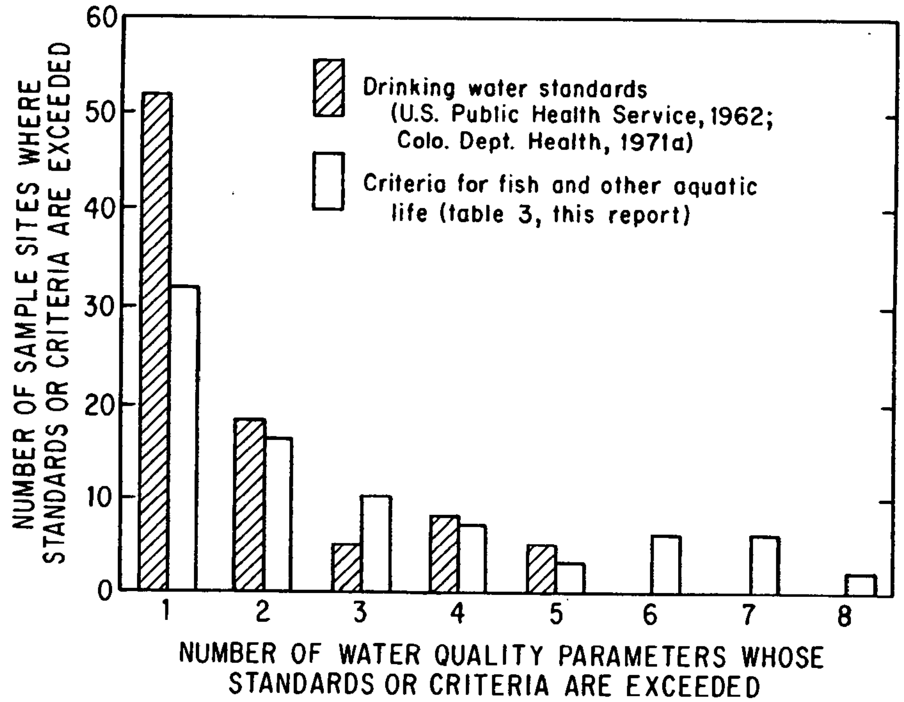

Figure 8.--Frequency with which water-quality standards or criteria are exceeded at metal-mining survey sites.

Figure 9.--Coal-mine drainage issuing from the Oak Creek Drain near Oak Creek (station 835B).

the drain are not considerably different. (Chemical data for the stations on Oak Creek above and below the drain will be published in a subsequent report.)

A possible explanation for the lack of a problem due to coal-mine drainage is the low sulfur content of Colorado's coal, and of western coal in general. For example, Averitt (1969) noted that 65 percent of the total bituminous, subbituminous, and lignite reserves in the United States contain 1 percent or less total sulfur; whereas, for those reserves east of the Mississippi River, 43 percent contain more than 3.0 percent total sulfur. In Colorado, 89.5 percent of the coal analyses listed by Walker and Hartner (1966) contain 1.0 percent or less total sulfur, while only 1.3 percent of the analyses contain greater than 3.0 percent total sulfur. The low total sulfur content is a reflection of the low pyritic sulfur content, and thus the absence of the key ingredient required for the formation of mine drainage.

In contrast to the above, this investigation has located a minimum of 25 areas in Colorado that are adversely affected by metal-mine drainage (see cover for examples). The streams in question are listed in table 11 and are shown on plate 3. All except five of the affected areas (North Fork Rabbit Creek, Salt Creek, Sulphur Gulch, Urad-Henderson, and Uravan on pl. 3) lie within the Colorado mineral belt or are associated with major volcanic deposits outside the belt. One of the affected areas (Uravan) lies within the Uravan mineral belt. Combined, the affected areas account for a total of almost 450 stream miles (the numbers in table 11 add up to 442 miles = 711 kilometers). They represent effects due to practically all possible causes, including flow from drainage tunnels, milling operations, active and abandoned mines, active and abandoned tailings ponds, and natural mineral seeps.

The decision as to whether or not a stream is regarded as affected was based primarily on comparison of the laboratory analyses and field pH values with the limits presented in table 2 (U.S. Public Health Service, 1962, 1970; Colorado Dept. Health, 1971a) and the criteria presented in table 3. Because of the synergistic action of copper and zinc, streams were considered affected if both values fell within the ranges listed in table 3, or if either value was greater than the appropriate maximum value. Also, streams were considered affected if the lead concentration was greater than the maximum value shown in table 3 or if the silver concentration was greater than 1 μg/l. The latter value was used for silver, instead of 0.1 μg/l as listed in table 3, since the minimum value reported by the U.S. Geological Survey's Central Laboratory in Salt Lake City, Utah, is presently 1 μg/l. Chemical data to be published in a subsequent report and the other field observations included in this report were used for guidance in determining affected areas. Manganese, sulfate, and selenium concentrations were not considered in this classification scheme because of the high background concentrations which may occur in areas not affected by mine drainage.

Table 11.--*Colorado streams affected by metal-mine drainage*

[Listed alphabetically within major river basins]

River basin Stream Tributary(ies)	Point or approximate reach affected	Estimated miles of stream affected[1]
Platte River basin		
Clear Creek----------------	Above South Clear Creek to below Golden---------------	40
Chicago Creek		
Ute Creek--------------	Mouth-----------------------	1
North Clear Creek--------	Above Chase Gulch to mouth---	8
Chase Gulch------------	Mouth-----------------------	3
Gregory Gulch----------	Above Nevada Gulch to mouth--	1
Russell Gulch----------	Mouth-----------------------	4
Soda Creek---------------	-----do---------------------	1
South Clear Creek		
Leavenworth Creek------	-----do---------------------	1
Virginia Canyon Creek----	-----do---------------------	1
West Fork----------------	Above Butler Gulch to below Woods Creek---------------	4
Lion Creek-------------	Minnesota mines to mouth-----	2
Woods Creek------------	Urad mine to mouth-----------	1
Gold Run------------------	Mouth-----------------------	2
Lefthand Creek		
James Creek--------------	Little James Creek to Lefthand Creek-------------	3
Little James Creek-----	Above Argo-Burlington-Emmett mine complex to mouth------	1
Sixmile Canyon Creek-----	Mouth-----------------------	5
North Fork Rabbit Creek----	Above Haystack Gulch---------	10
North Fork South Platte River----------------	Above Beaver Creek-----------	6
Geneva Creek-------------	Above Duck Creek-------------	7
Handcart Gulch-----------	----------------------------	3
Sacramento Creek-----------	Mouth-----------------------	7
Arkansas River basin		
Arkansas River---------------	Confluence of East Fork and Tennessee Creek to Lake Creek----------------------	15
California Gulch-----------	Source to mouth--------------	8
East Fork------------------	Above Climax to below French Gulch and Leadville Drain to mouth------------------	10
Evans Gulch--------------	Near mouth------------------	5
Leadville Drain----------	Source to mouth--------------	1
Iowa Gulch----------------	Source to mouth--------------	11

Table 11.--*Colorado streams affected by metal-mine drainage*--Continued

River basin Stream Tributary(ies)	Point or approximate reach affected	Estimated miles of stream affected[1]
Arkansas River basin--Continued		
Lake Creek	Confluence of North and South Forks to below Crystal Lake Creek	3
South Fork Lake Creek	Mouth	5
Pine Gulch	Above West Pierce Gulch	5
Tennessee Creek	St. Kevin Gulch to mouth	3
St. Kevin Gulch	Mouth	2
Gleason Gulch	-----do	1
Rio Grande basin		
Alamosa Creek	Iron Creek to Terrace Reservoir	20
Alum Creek	Mouth	1
Bitter Creek	-----do	1
Iron Creek	Near mouth	3
Wightman Fork	Source to mouth	6
San Luis Creek	Kerber Creek to Rock Creek	1
Kerber Creek	Above Squirrel Creek to mouth	20
Copper Gulch	Mouth	2
Greenback Gulch	-----do	1
Rawley Gulch	-----do	2
Squirrel Creek	Above Rawley mine to mouth	1
Rio Grande	Willow Creek to below Wason Ranch	4
Willow Creek	Confluence of East and West Willow Creeks to mouth	3
East Willow Creek	Mouth	2
West Willow Creek	-----do	2
Colorado River basin		
Animas River	Above Eureka to below Mineral Creek	15
Cement Creek	Mouth	7
Mineral Creek	Above South Fork to mouth	10
Middle Fork	----------	2
South Fork	Mouth	6
Minnie Gulch	-----do	3
South Fork	-----do	2
West Fork	----------	1
Blue River	Below French Gulch	2
French Gulch	Lincoln to mouth	4
Cross Creek	Mouth	1

Table 11.--*Colorado streams affected by metal-mine drainage*--Continued

River basin Stream Tributary(ies)	Point or approximate reach affected	Estimated miles of stream affected[1]
Colorado River basin--Continued		
Dolores River	Below Rico	9
Lake Fork Gunnison River		
Cooper Creek	Mouth	3
Silver Creek	-----do	2
Salt Creek	-----do	2
San Miguel River	Above Bear Creek to South Fork and Uravan to mouth	13
South Fork		
Howard Fork	At Old Ophir	3
Turkey Creek	Near mouth	4
Slate River	Oh-Be-Joyful Creek to mouth	15
Coal Creek	Above Keystone mine to mouth	6
Oh-Be-Joyful Creek	Mouth	1
Snake River	Above Deer Creek to Dillon Reservoir	15
Peru Creek	Above Cinnamon Gulch to mouth	6
Cinnamon Gulch	Mouth	1
Sulphur Gulch	-----do	4
Tenmile Creek	Climax to Dillon Reservoir	15
Searle Gulch	Mouth	1
Uncompahgre River	Above Red Mountain Creek to below Portland	15
Canyon Creek	Confluence of Imogene and Sneffels Creeks to mouth	5
Imogene Creek	Mouth	2
Sneffels Creek	-----do	2
Red Mountain Creek	Red Mountain to mouth	7
Williams Fork	Above Keyser Creek	9

[1]Distances are shown to the nearest mile; distances less than 1 mile are shown as 1 mile.

Furthermore, it should be pointed out that the number 450 is not intended to be absolute. The length of stream affected will vary depending on the time of the year and flow conditions. Moreover, both the number of areas and the number of stream miles affected are considered to be minimum estimates. This is partly a result of the procedure used to select the stations at which water samples were taken. As noted earlier, this decision was based on pH, specific conductance, visual observations, and aquatic flora and macroinvertebrates. Of these, it was originally thought that the latter two would be almost infallible indicators of mine drainage. However, in actuality, fish are often much more sensitive to trace elements than are these aquatic forms. Thus, some affected stations were undoubtedly passed up for sample collection. Note, for example, stations 357 (p. 44-45) and 454 (p. 38-39): these are considered affected, but they have fairly healthy populations of algae and macroinvertebrates.

FURTHER STUDY

Based on the results of this investigation, considerable knowledge would be gained by studying some of the affected areas in greater detail. Such studies might include spatial and temporal variations (the latter over at least a 1-year period), sources and sinks of trace elements, chemical transformations within the hydrologic system (particularly sediment-water interactions), interactions between surface- and groundwater systems, effects on aquatic biota, and effects on water use (human consumption, livestock watering, irrigation). This information would allow for better management of these areas in the future. Knowledge gained from one area could be applied to others where problems are similar.

The establishment of a monitoring system would allow long-term trends to be followed in selected areas, particularly those where changing conditions are anticipated in future years.

Table 12 shows the 25 affected areas previously noted, ranked according to the severity of the problem in each area: the more severely affected areas are listed toward the top of the table, while those which are less severely affected are listed toward the bottom. The criteria used to determine this hierarchy include (1) number of stream miles affected, (2) number and types of drainage sources, (3) number of parameters exceeding drinking water standards and criteria for aquatic life, and (4) the degree by which these standards and criteria are exceeded.

Also indicated in table 12 are those areas where intensive study would provide a maximum amount of new and useful information. Primary stations (those in primary study areas) would be sampled bimonthly, secondary stations would be sampled twice (at low and high flows), and tertiary stations would be sampled only once (at low flow). All areas would eventually be converted so that one or more monitoring stations

Table 12.--*Areas in Colorado affected by metal-mine drainage where intensive study and monitoring would allow for a more complete understanding of the water-quality problem*

[Areas listed in order of decreasing severity of problem[1])

Affected area	Degree of intensive study[2]	Monitoring stations (page numbers in parentheses indicate where reconnaissance data are presented)	
		Control[3]	Affected
Clear Creek	M	456 (38-39)	428, 670, 671, 673 (40-41)
Kerber Creek	1	65E (54-55)	66 (54-55)
Leadville	2	630 (48-49)	625, 626, 631A, 645 (48-51)
Silverton	----	------------	---------------------------
Boulder	2	390 (38-39)	386, 389, 678 (38-39)
Ouray	3	([4])	264 (62-63)
Alamosa Creek	3	266 (52-53)	161 (52-53)
Crested Butte	2	56 (58-59)	53B, 55 (58-59)
Snake River	2	([4])	2, 480 (66-67)
Telluride	----	------------	---------------------------
Climax	3, M	509 (68-69)	501 (68-69)
Cross Creek	----	------------	---------------------------
Creede	2	([4])	141, 284 (52-53)
North Fork South Platte River	----	------------	---------------------------
Urad-Henderson	M	([4])	441, 444 (38-39)
French Gulch	M	([4])	500 (68-69)
North Fork Rabbit Creek	----	------------	---------------------------
Sulphur Gulch	----	------------	---------------------------
Cooper Creek-Silver Creek	----	------------	---------------------------
Lake Creek	3, M	316 (48-49)	315 (48-49)
Rico	----	------------	---------------------------
Sacramento Creek	----	------------	---------------------------
Pine Gulch	----	------------	---------------------------
Salt Creek	----	------------	---------------------------
Uravan	M	([4])	([5])

[1]Bracketed areas are considered to be equally affected; areas are arranged alphabetically within the brackets. (See text for criteria used to determine the overall order of listing.)

[2]The numbers 1, 2, and 3 refer to primary, secondary, and tertiary areas, respectively. The letter M indicates a monitoring area. (See text for explanation.)

[3]Controls were chosen, insofar as possible, to reflect what water quality might be like in the absence of metal-mining activities.

[4]No suitable control stations were visited during the field survey.

[5]No suitable affected stations were visited during the field survey.

would be sampled in each area three times during the year. Potential monitoring stations for each area are shown in the last column of table 12.

In addition to the intensive study areas listed in table 12, the monitoring of Fourmile Creek (station 336, p. 50-51) and the Williams Fork (station 663, p. 56-57, part of the Urad-Henderson study area) would allow detection of potential changes due to an anticipated increase in mining activity in the future. The Oak Creek Drain (station 835B) might be monitored, on at least a short-term basis, in an attempt to substantiate the present belief that this drainage is relatively innocuous.

ACKNOWLEDGMENTS

The author would like to thank James Biesecker, John Briggs, Daniel Haubenreiser, Richard Glanzman, John Klein, and Robert Moran for assistance rendered in the completion of this investigation, particularly in regard to the collection of the field data.

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APPENDIX

Thermodynamic Considerations Regarding the Anaerobic Oxidation of FeS_2

Reaction 8 (p. 20) is given as

$$FeS_{2(s)} + 8H_2O \rightleftarrows Fe^{++} + 2SO_4^{=} + 2H^+ + 7H_2. \quad (A1)$$

The standard Gibbs free-energy change (ΔG_r^o) for this reaction at 25°C and 1 atmosphere total pressure can be calculated as follows, where all values for ΔG_f^o (standard Gibbs free energy of formation) are from Garrels and Christ (1965):

$$\Delta G_r^o = \Sigma\Delta G_f^o(\text{products}) - \Sigma\Delta G_f^o(\text{reactants}), \quad (A2)$$

$$= \left[\Delta G_{f(Fe^{++})}^o + 2\Delta G_{f(SO_4^{=})}^o + 2\Delta G_{f(H^+)}^o + 7\Delta G_{f(H_2)}^o\right]$$

$$- \left[\Delta G_{f(FeS_2)}^o + 8\Delta G_{f(H_2O)}^o\right],$$

$$= [(-20.30) + 2(-177.34) + 2(0) + 7(0)]$$

$$-[(-36.00) + 8(-56.69)],$$

$$= -374.98 + 489.52,$$

$$\Delta G_r^o = +114.54 \text{ kilocalories.}$$

The equilibrium constant (K) for reaction A1 can be computed from equation A3,

$$\Delta G_r^o = -RT \ln K. \quad (A3)$$

At 25°C (298.16° Kelvin) and 1 atmosphere this becomes

$$\Delta G_r^o = -1.364 \log K. \quad (A4)$$

Substituting,

$$114.54 = -1.364 \log K,$$

$$\log K = -83.97 \approx -84,$$

$$K = 10^{-84}.$$

The equilibrium constant for reaction A1 is defined as

$$K = \frac{(a_{Fe^{++}})(a_{SO_4^{=}})^2(a_{H^+})^2(a_{H_2})^7}{(a_{FeS_2})(a_{H_2O})^8}, \quad (A5)$$

where a represents the activities of the various constituents. Assuming $a_{FeS_2} \approx a_{H_2O} \approx 1$ and approximating activities by concentrations, then

$$K \approx [Fe^{++}] [SO_4^{=}]^2 [H^+]^2 \left(P_{H_2}\right)^7, \quad (A6)$$

where P_{H_2} represents the partial pressure of hydrogen gas in atmospheres. Substituting the value for K calculated above, and the various values of $[Fe^{++}]$, $[SO_4^{=}]$, and $[H^+]$ reported by Barnes and others (1964), we obtain values for P_{H_2} which range from $10^{-10.3}$ to $10^{-9.5}$ atmospheres. Thus, in order for reaction A1 to proceed in the direction written, the partial pressure of hydrogen would have to be less than $10^{-10.3}$ to $10^{-9.5}$ atmospheres. This might be accomplished in a closed system via a hydrogen sink such as hydrogenation of coal or bacterial utilization, as suggested by Barnes and Clarke (1964).

The mole fraction percent hydrogen for dry, sea-level atmosphere is reported as 5.0×10^{-5} by Hodgman (1962, p. 3497). Expressed as P_{H_2}, this becomes $10^{-6.3}$ atmospheres when the total pressure is 1 atmosphere. Assuming the pyritic material is open to the atmosphere, then either: (1) the ambient P_{H_2} of $10^{-6.3}$ would be enough to prevent reaction A1 from occurring; or (2) the hydrogen sink, in the process of keeping P_{H_2} values less than $10^{-10.3}$ to $10^{-9.5}$, would also be using up atmospheric hydrogen.

In a completely closed system with no hydrogen sink, the P_{H_2} would rapidly become large enough to again prevent reaction A1 from occurring.

COLORADO WATER RESOURCES CIRCULARS

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2. Ground water in the vicinity of Brush, Colorado. 1950.
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5. Ground water in the Ogallala and several consolidated formations in Colorado. 1960.
6. Legal and management problems related to the development of an artesian ground-water reservoir. 1962.
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9. Ground water in Colorado - Its importance during an emergency. 1963.
10. Effects of water management on a reach of the Arkansas Valley, La Junta to Las Animas, Colorado. 1963.
11. Pumping tests in Colorado. 1965.
12. Geohydrologic data from the Piceance Creek basin between the White and Colorado Rivers, northwestern Colorado. 1968.
13. Availability of water for artificial recharge, Plains Ground Water Management District, Colorado. 1970.
14. Electric analog model evaluation of a water-salvage plan, San Luis Valley, Colorado. 1970.
15. Ground-water occurrence in northern and central parts of western Colorado. 1972.
16. Extent of development and hydrologic conditions of the alluvial aquifer, Fountain and Jimmy Camp Valleys, Colorado, 1972. 1973.
17. Simulation of hydrologic and chemical-quality variations in an irrigated stream-aquifer system - A preliminary report. 1973.
18. Water in the San Luis Valley, south-central Colorado. 1973.
19. Digital model of the hydrologic system, northern High Plains of Colorado - A preliminary report. 1973.
20. Transit losses and travel times for reservoir releases, upper Arkansas River basin, Colorado. 1973 [1974].
21. Effect of mine drainage on the quality of streams in Colorado, 1971-72. 1974.
22. Appraisal of water resources of northwestern El Paso County, Colorado. [In press.]
23. Water-level declines and ground-water quality, upper Black Squirrel Creek basin, Colorado. 1973.

EXPLANATIONS OF PHOTOGRAPHS ON FRONT COVER

[Clockwise from upper left]

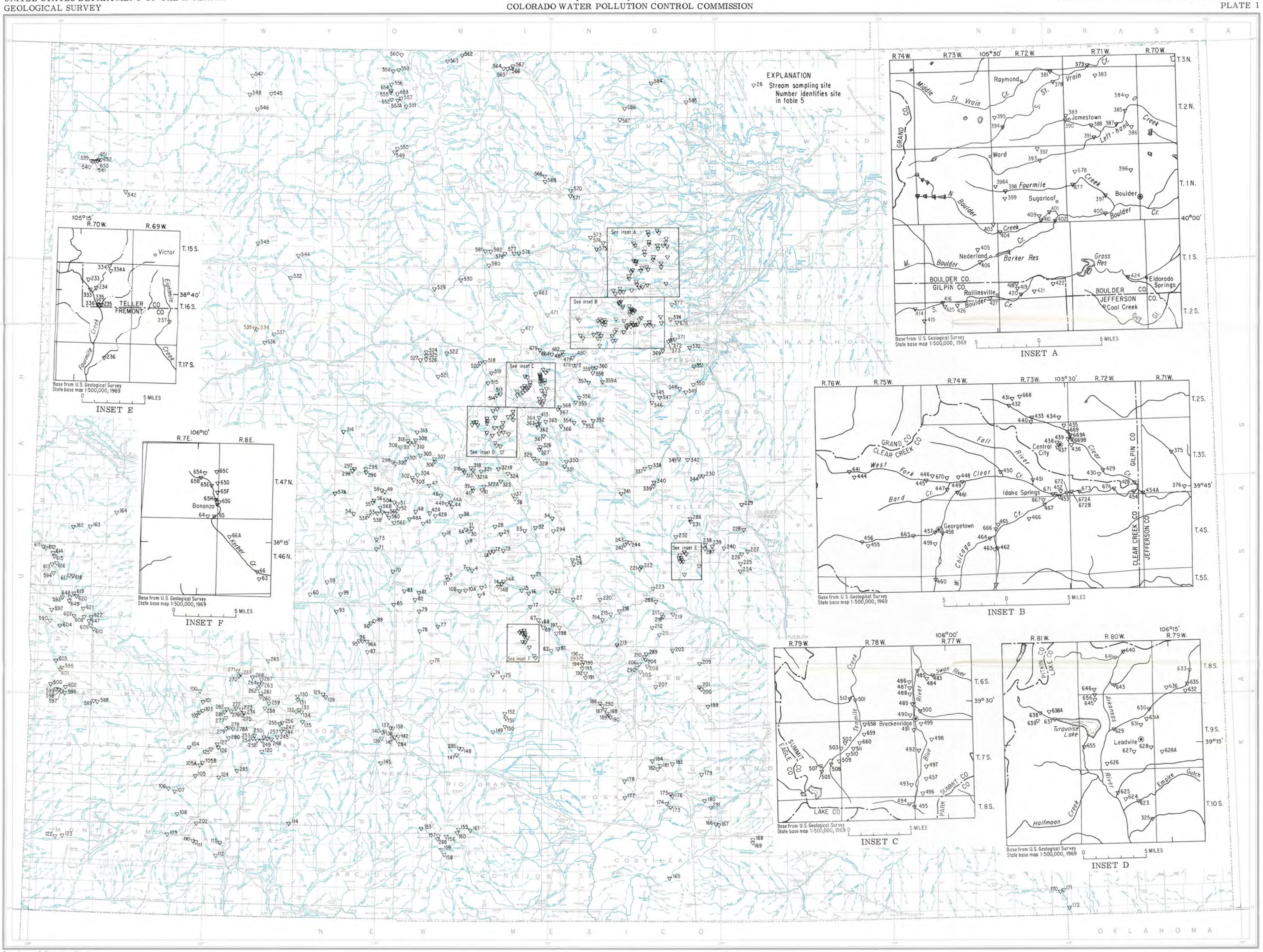
RAWLEY GULCH NEAR BONANZA SHOWING THE ABSENCE OF VEGETATION ALONG THE STREAM BANK (upstream from station 65F, p. 54-55; photograph by Robert E. Moran).

SQUIRREL CREEK FLOWING THROUGH ABANDONED TAILINGS NEAR BONANZA (upstream from station 65D, p. 54-55; photograph by Robert E. Moran).

WIGHTMAN FORK ALAMOSA CREEK NEAR JASPER SHOWING TURBIDITY RESULTING FROM SUSPENDED FERRIC HYDROXIDE (station 155, p. 52-53; photograph by Robert E. Moran).

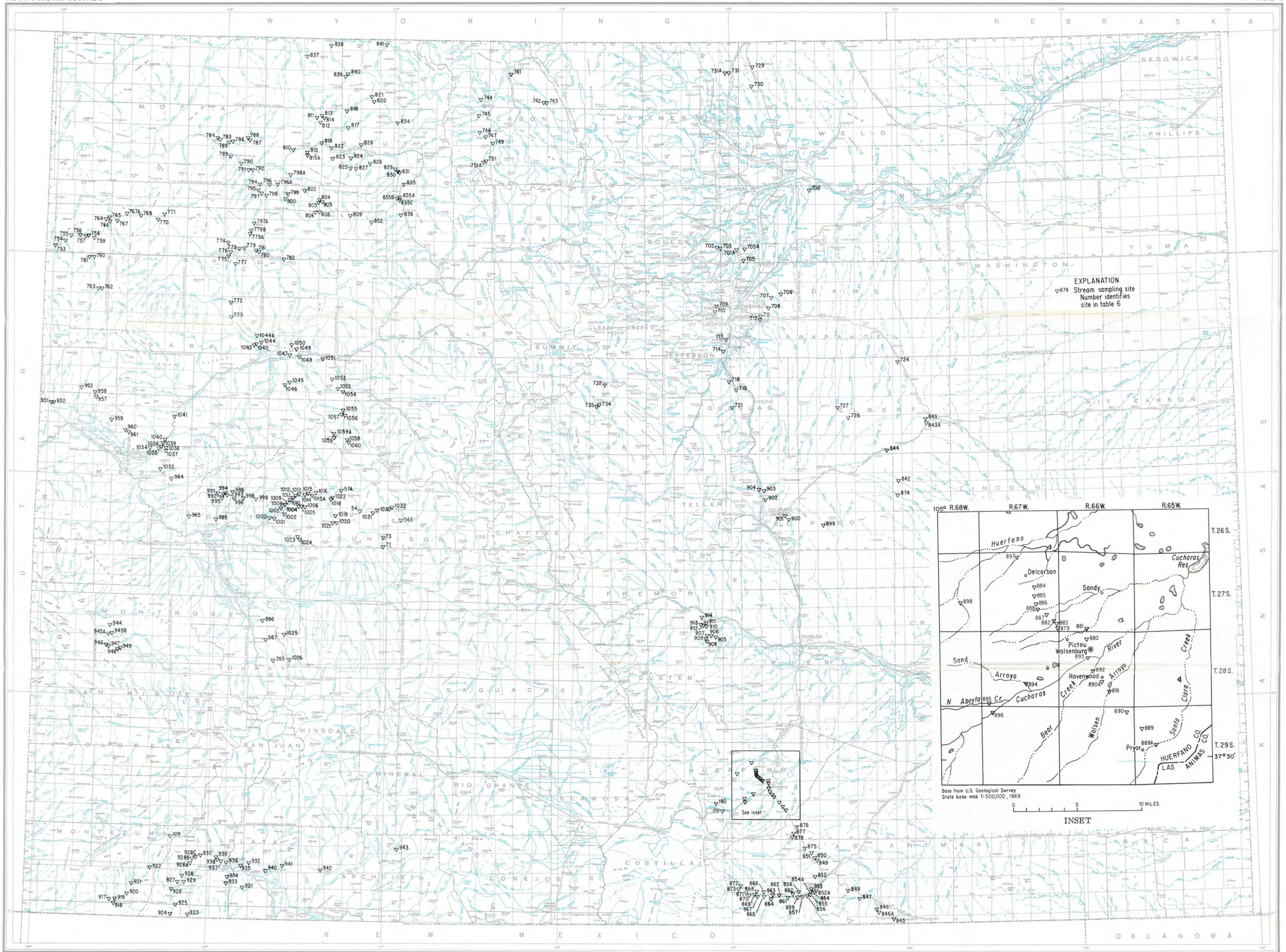
METAL-MINE DRAINAGE ISSUING FROM THE YAK TUNNEL NEAR LEADVILLE (station 628, p. 48-49; photograph by Robert E. Moran).

Prepared in cooperation with the
COLORADO WATER POLLUTION CONTROL COMMISSION



Base from U.S. Geological Survey
1:500,000 State base map, 1969

MAP SHOWING LOCATION OF SITES SAMPLED TO DETERMINE THE EFFECT OF METAL MINING ON SURFACE-WATER QUALITY IN COLORADO, 1971-72



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MAP SHOWING LOCATION OF SITES SAMPLED TO DETERMINE THE EFFECT OF COAL MINING ON SURFACE-WATER QUALITY IN COLORADO, 1972

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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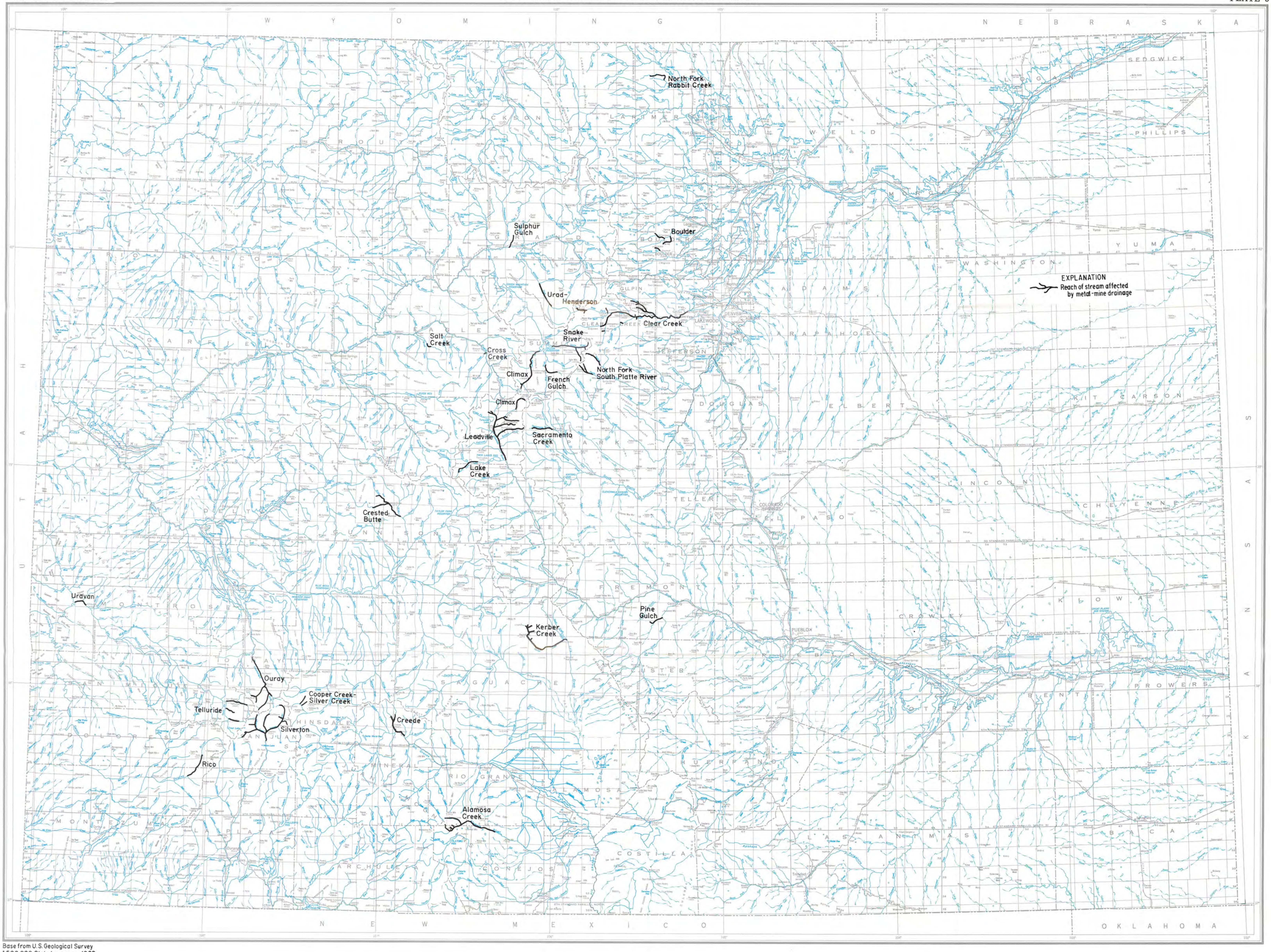
COLORADO WATER RESOURCES CIRCULAR 21
PLATE 3



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MAP SHOWING STREAMS IN COLORADO WHICH ARE AFFECTED BY METAL-MINE DRAINAGE, 1971-72