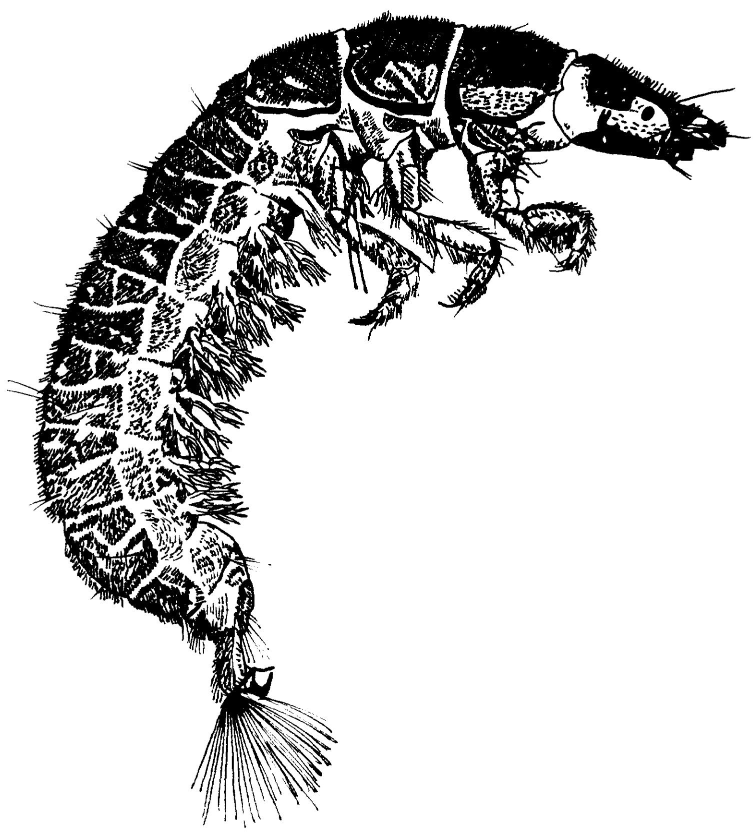
WATER-QUALITY DATA FOR THE BOISE RIVER, BOISE TO STAR, IDAHO, OCTOBER TO DECEMBER 1987

U.S. GEOLOGICAL SURVEY

Open-File Report 88-171



Prepared in cooperation with

CITY OF BOISE

WATER-QUALITY DATA FOR THE BOISE RIVER, BOISE TO STAR, IDAHO, OCTOBER TO DECEMBER 1987

By S.A. Frenzel and T.F. Hansen

U.S. GEOLOGICAL SURVEY

Open-File Report 88-171

Prepared in cooperation with

CITY OF BOISE

Boise, Idaho

1988

DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey, WRD
230 Collins Road
Boise, ID 83702
(208) 334-1750

Copies of this report can
be purchased from:

U.S. Geological Survey
Books and Open-File Reports
Federal Center, Bldg. 810
Box 25425
Denver, CO 80225
(303) 236-7476

CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

For the convenience of readers who may prefer to use metric (International System) units rather than the inch-pound units used in this report, conversion factors are listed below. Constituent concentrations are given in mg/L (milligrams per liter) or μg/L (micrograms per liter), which are equal to parts per million or parts per billion.

Multiply inch-pound unit	By	To obtain metric unit
foot (ft)	0.3048	meter
inch (in.)	25.40	millimeter
microsiemens per centimeter at 25 degrees Celsius (μS/cm)	1.000	micromhos per centimeter at 25 degrees Celsius
mile (mi)	1.609	kilometer

Temperature in °C (degrees Celsius) can be converted to °F (degrees Fahrenheit) as follows:

$$°F = (1.8)(°C) + 32$$

Water temperatures are reported to the nearest one-half degree.

WATER-QUALITY DATA FOR THE BOISE RIVER,

BOISE TO STAR, IDAHO, OCTOBER TO DECEMBER 1987

By

S.A. Frenzel and T.F. Hansen

ABSTRACT

Chemical and physical data were collected at six sites and biological data at five sites on the Boise River between Veterans Memorial Parkway in Boise to Star, Idaho, from October to December 1987. Data were collected to determine the impact of sewage effluent from two Boise wastewater treatment facilities on the water and biological quality of the Boise River. Similar data will be collected from January to March 1988 and will be published in a second noninterpretive report. Results of all data analyses will be discussed in a final interpretive report.

INTRODUCTION

The city of Boise operates two municipal WTF's (wastewater treatment facilities), that provide secondary sewage treatment and discharge the treated effluent into the Boise River. The Lander Street WTF discharges effluent immediately downstream from the Veterans Memorial Parkway bridge, and the West Boise WTF discharges into the south channel of the Boise River near Eagle Island State Park (fig. 1).

The NPDES (National Pollutant Discharge Elimination System) permits initially drafted to replace Boise's expired permits contained trace-element limits that were close to those currently (1987) being achieved by the Lander Street and West Boise WTF's. The city of Boise initiated discussions with the EPA (U.S. Environmental Protection Agency) and the IDHW-DOE (Idaho Department of Health and Welfare, Division of Environment) to modify the draft NPDES permits such that trace-element criteria are based on site-specific data rather than on laboratory-derived national criteria published in the EPA's Gold Book (U.S. Environmental Protection Agency, 1986). The basis of the city's request was that EPA national criteria may not accurately reflect the bioavailability or toxicity of a pollutant because of local physical, chemical, or biological characteristics of receiving water. The EPA and IDHW-DOE concurred with the city of Boise and issued new NPDES permits in March 1987. The new permits lack specific trace-element limits but call for increased biomonitoring and require a physical, chemical, and biological evaluation of the Boise River to determine the impacts of the two WTF's on the river. Additional toxics control at the two WTF's may be deemed necessary on the basis of information gathered during the biomonitoring and river evaluation.

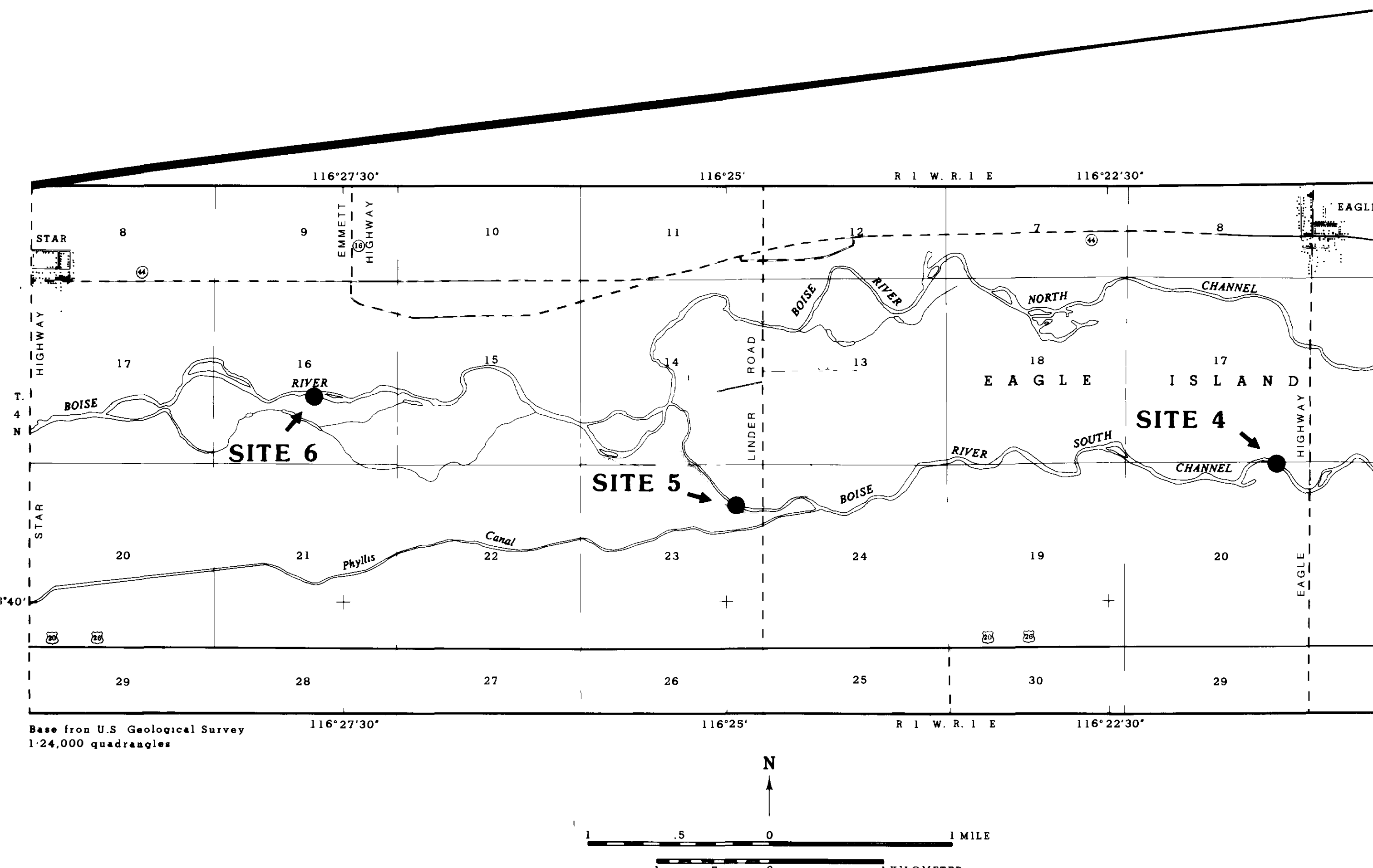
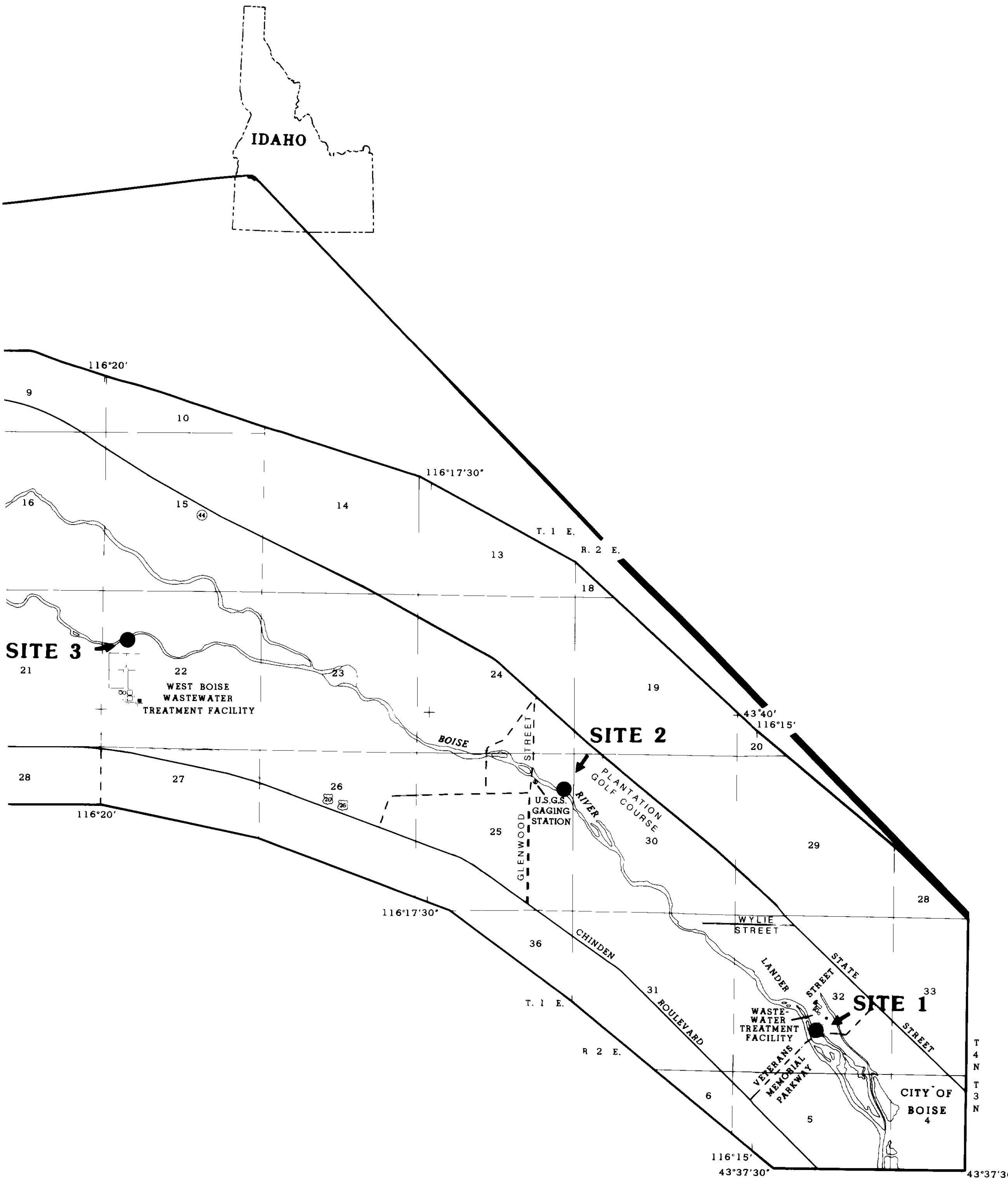


Figure 1.--Location



of study area.

Purpose and Scope

The purpose of this study was to determine the impact of effluent discharges from the city of Boise's Lander Street and West Boise WTF's on the Boise River. Data will be collected at the beginning (October to December 1987) and end (January to March 1988) of the low-flow period and separate reports will be produced. An interpretive report will incorporate all data and emphasize the impact of trace elements on the water and biological quality of the Boise River. The scope of this report is limited to data collected at the beginning of the low-flow period from October to December 1987 and analyzed before March 1, 1988; additional data analyses from this sampling period may be included in later reports.

Methods of Data Collection

Dispersion characteristics of the effluent mixing zones were determined from cross-sectional field measurements using fluorometric dye tracing as described by Kilpatrick and Cobb (1984) and Hubbard and others (1981). Three cross sections were located downstream from each WTF. Cross sections were located on the basis of approximate lengths of mixing zones calculated for each WTF discharge using the equation given by Kilpatrick and Cobb (1984, p. 47). Rhodamine WT dye was injected into each WTF's effluent discharge using the slug-injection method (Kilpatrick and Cobb, 1984, p. 9-12), and dye clouds were sampled at the three cross sections below each WTF.

Water-quality sites were located in riffles where water depths and velocities among the sites were comparable. Sites downstream from each WTF were located where effluent was mixed completely with the river.

Water-quality samples were collected by cross-sectional depth-integrated sampling methods (Skougstad and others, 1979). At each site, water was composited in a churn splitter and aliquots were withdrawn, processed onsite, and sent for analysis to the U.S. Geological Survey National Water-Quality Laboratory in Arvada, Colo. After the water samples were collected, bottom-material samples in depositional areas near each cross section were collected using a stainless steel Ponar dredge or a quart Teflon[1] bottle. To ensure an adequate amount of bottom material for analysis, multiple grab samples were obtained at some sites and were composited. Bottom material was sieved through a 2.0-mm stainless steel mesh, then sent to the U.S.

---

[1] Use of trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Geological Survey National Water-Quality Laboratory and sieved through a 0.062-mm mesh. Material finer than 0.062 mm was analyzed for trace elements.

Benthic invertebrates were collected using 12 artificial substrates each at sites 1, 2, 3, 5, and 6. Substrates consisted of 5/8-in. mesh wire cloth, 12 in. by 12 in. by 6 in., filled with 3- to 6-in. diameter cleaned river rocks. Substrates were placed randomly within riffles and were retrieved about 45 days later. During substrate retrieval, a 0.210-mm mesh drift net was placed immediately downstream from the substrates to capture dislodged organisms. Rocks from the substrates were scrubbed to remove invertebrates, and material cleaned from the rocks was poured through the drift net. Material retained in the drift net was placed in plastic containers and the containers were filled with 70 percent alcohol.

Invertebrate samples were sorted in the laboratory by using a series of sieves to remove debris. Only the invertebrates retained on a 0.250-mm or larger sieve were identified. Due to the large numbers of invertebrates colonizing the substrates, subsamples were taken from each substrate for identification. Benthic invertebrates were identified to the lowest taxonomic level possible by using keys from Usinger (1956), Edmondson (1959), Jensen (1966), Edmunds and others (1976), Baumann and others (1977), Wiggins (1977), and Merritt and Cummins (1984). Diversity of insects colonizing artificial substrates was calculated using the Shannon-Wiener equation (Southwood, 1975, p. 348).

Locations of Sampling Sites

Physical and chemical data were collected at six sites on the Boise River (fig. 1):

1) At Veterans Memorial Parkway immediately upstream from the Lander Street WTF;

2) Above Glenwood Road, downstream from the effluent mixing zone of the Lander Street WTF;

3) South channel, immediately upstream from the West Boise WTF;

4) South channel near Eagle Highway, within the effluent mixing zone of the West Boise WTF;

5) South channel near Linder Road, downstream from the effluent mixing zone of the West Boise WTF; and

6) Downstream from the confluence of north and south channels near Star.

RESULTS

Benthic invertebrate data are presented in table 1. Data shown are mean numbers per artificial substrate based on analysis of 10 substrates per site. Chemical data are presented in table 2.

Table 1.--Taxa and densities of benthic invertebrates per artificial substrate

[Densities are rounded to 2 significant figures, or the nearest whole number; --, classified at a lower level or not present]

TAXA PHYLUM Class Subclass Order Suborder Family Genus species	Site 1	Site 2	Site 3	Site 5	Site 6
Date of substrate placement (1987)	10/15	10/15	10/15	10/15	10/16
Date of substrate retrieval (1987)	12/ 1	12/ 1	12/ 2	12/ 2	11/30
ANNELIDA	--	--	--	--	--
Hirundinea	--	--	--	1	--
Oligochaeta	present	present	present	present	present
ARTHROPODA	--	--	--	--	--
Arachnida	--	--	--	--	--
Acarina	230	170	320	170	200
Crustacea	--	--	--	--	--
Amphipoda	--	--	--	--	--
Gammaridae	--	1	2	5	6
Cladocera	6	3	6	--	3
Copepoda	--	--	--	--	--
Cyclopoida	--	3	3	3	16
Harpacticoida	3	10	--	3	--
Decapoda	--	--	--	--	--
Astacidae	--	--	--	--	--
Pacifastacus sp.	--	--	--	1	--
Isopoda	--	--	--	--	--
Asellidae	--	6	--	4	14
Ostracoda	--	--	--	--	22
Insecta	--	--	--	--	--
Diptera	14	17	8	12	26
Chironomidae	1,300	3,400	1,700	2,400	3,500
Empididae	4	10	40	11	10
Psychodidae	--	--	--	--	3
Simuliidae	5,300	5,700	5,200	1,400	2,400
Tipulidae	--	1	--	1	1

Table 1.--Taxa and densities of benthic invertebrates per artificial substrate (Continued)

TAXA PHYLUM Class Subclass Order Suborder Family Genus species	Site 1	Site 2	Site 3	Site 5	Site 6
Ephemeroptera	--	19	--	26	10
Baetidae	--	--	--	--	--
Baetis spp.	910	3,100	2,500	1,500	3,700
Ephemerellidae	--	--	--	--	--
Ephemerella sp.	32	25	3	23	74
Heptageniidae	3	3	1	3	10
Heptagenia sp.	--	2	1	3	2
Rithrogena sp.	--	4	--	1	--
Stenonema sp.	--	--	--	4	9
Tricorythidae	--	--	--	--	--
Tricorythodes sp.	10	3	13	84	150
Lepidoptera	--	--	--	--	--
Pyralidae	--	--	--	--	--
Petrophila sp.	--	14	22	23	26
Odonata	--	--	--	--	--
Coenagrionidae	--	--	1	--	--
Plecoptera	14	26	64	22	3
Perlidae	--	--	--	--	--
Claassenia sp.	1	1	--	--	--
Perlodidae	35	94	130	25	--
Trichoptera	22	3	7	7	87
Brachycentridae	--	--	--	--	--
Brachycentrus sp.	--	1	--	--	3
Glossosomatidae	--	--	--	3	--
Glossosoma sp.	--	--	1	1	--
Hydropsychidae	230	500	710	160	460
Cheumatopsyche sp.	11	49	170	92	54
Hydropsyche sp.	330	680	950	120	220
Hydroptilidae	--	--	--	--	--
Hydroptila sp.	18	--	10	4	110
Leucotricia sp.	--	--	1	--	--
Leptoceridae	--	--	--	--	--
Oecetis sp.	--	--	--	1	--
Tardigrada	3	--	--	1	13

Table 1.--Taxa and densities of benthic invertebrates per artificial substrate (Continued)

TAXA PHYLUM Class Subclass Order Suborder Family Genus species	Site 1	Site 2	Site 3	Site 5	Site 6
MOLLUSCA	--	--	--	--	--
Gastropoda	--	--	13	1	1
Pulmonata	--	--	--	--	--
Basommatophora	--	--	--	--	--
Ancylidae	--	--	--	9	--
Physidae	--	--	--	1	--
Planorbidae	--	--	--	1	1
NEMATODA	--	10	--	4	10
PLATYHELMINTHES	--	--	--	--	--
Turbellaria	--	--	7	--	--
Mean number of invertebrates	8,400	14,000	12,000	6,100	11,000
Number of noninsect taxa	5	8	7	14	10
Number of insect families	11	13	13	14	13
Diversity index for insect families	1.55	1.92	1.98	2.01	2.06

Table 2.--Chemical analyses from the Boise River

[ft^3/s, cubic feet per second; *, calculated value; mm Hg, millimeters of mercury; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter; °C, degrees Celsius; NTU, nephelometric turbidity unit; μg/L, micrograms per liter; <, less than the given value, which is the detection limit; hex, hexavalent; --, no data available; μg/g, micrograms per gram]

	Sampling sites, Date (1987), Time (24-hour)					
Chemical constituents	1 10/30 0930	2 10/30 1230	3 10/29 1225	4 10/28 1215	5 10/29 0920	6 10/28 0850
Onsite Determinations						
Instantaneous discharge (ft^3/s)	147	173	77.2	106	101	164
Dissolved oxygen (mg/L)	9.7	11.6	10.0	8.8	9.4	8.3
Percent saturation*	95	120	102	90	94	80
Barometric pressure (mm Hg)	692	693	693	698	693	700
pH (standard units)	8.0	8.2	7.8	7.6	8.0	8.0
Alkalinity (mg/L as $CaCO_3$)	57	79	63	72	114	101
Bicarbonate (mg/L as HCO_3)	70	97	77	88	139	123
Specific conductance (μS/cm)	124	178	159	288	314	299
Water temperature (°C)	10.5	13.0	12.0	12.5	11.0	10.0
Laboratory Analyses						
pH (standard units)	8.0	7.8	7.9	7.5	8.0	7.9
Alkalinity (mg/L as $CaCO_3$)	55	61	62	71	111	102
Hardness, total (mg/L as $CaCO_3$)*	46	52	55	69	95	90
Residue, dissolved, at 180 °C (mg/L)	76	107	103	180	192	185
Dissolved solids, sum (mg/L)*	79	110	100	170	190	230
Specific conductance (μS/cm)	130	181	167	299	330	308
Turbidity (NTU)	3.5	1.5	1.7	3.0	2.0	.8
Calcium, dissolved (mg/L as Ca)	15	17	18	22	29	28
Magnesium, dissolved (mg/L as Mg)	2.0	2.4	2.5	3.5	5.4	4.9
Potassium, dissolved (mg/L as K)	1.1	2.1	1.7	3.0	2.7	2.7
Silica, dissolved (mg/L as SiO_2)	12	15	14	17	21	19
Sodium, dissolved (mg/L as Na)	7.1	14	12	31	32	29
Sodium adsorption ratio*	.5	.8	.7	2	1	1
Sodium, percent*	25	36	32	48	42	40
Nitrogen, ammonia, total (mg/L as N)	.04	.52	.22	.26	.22	.18
Chloride, dissolved (mg/L as Cl)	1.2	5.2	3.9	23	12	12
Fluoride, dissolved (mg/L as F)	.50	.70	.60	.60	.60	.50
Sulfate, dissolved (mg/L as SO_4)	5.9	11	9.1	24	22	21
Aluminum, total (μg/L as Al)	170	170	170	290	140	80
Cadmium, total (μg/L as Cd)	<1	<1	<1	<1	<1	1
Chromium, total (μg/L as Cr)	2	4	3	3	2	3
Chromium hex, total (μg/L as Cr)	<1	<1	<1	<1	<1	<1
Copper, total (μg/L as Cu)	1	4	3	3	2	3
Cyanide, total (μg/L as CN)	--	<10	<10	<10	<10	<10
Iron, total (μg/L as Fe)	230	250	260	410	230	160
Lead, total (μg/L as Pb)	<5	<5	<5	<5	<5	<5
Nickel, total (μg/L as Ni)	3	1	1	1	<1	<1
Silver, total (μg/L as Ag)	<1	<1	<1	<1	<1	<1
Zinc, total (μg/L as Zn)	<10	<10	<10	20	<10	<10
Aluminum, bottom (μg/g as Al)	1,800	890	1,700	950	920	1,700
Arsenic, bottom (μg/g as As)	3	2	3	2	1	2
Cadmium, bottom (μg/g as Cd)	<1	<1	<1	<1	<1	<1
Chromium, bottom (μg/g as Cr)	<10	<10	<10	<10	<10	<10
Copper, bottom (μg/g as Cu)	2	1	2	1	1	2
Cyanide, bottom (μg/g as CN)	<.5	<.5	<.5	<.5	<.5	<.5
Iron, bottom (μg/g as Fe)	3,100	1,800	2,900	1,500	1,800	2,900
Lead, bottom (μg/g as Pb)	<10	<10	<10	<10	<10	<10
Nickel, bottom (μg/g as Ni)	<10	<10	<10	<10	<10	<10
Zinc, bottom (μg/g as Zn)	20	10	20	10	10	20

REFERENCES CITED

Baumann, R.W., Gaufin, A.R., and Surdick, R.F., 1977, The stoneflies (plecoptera) of the Rocky Mountains: American Entomological Society, no. 31, 208 p.

Edmondson, W.T., ed., 1959, Freshwater biology: New York, John Wiley and Sons, Inc., 2nd ed., 1248 p.

Edmunds, G.F. Jr., Jensen, S.L., and Berner, Lewis, 1976, The mayflies of North and Central America: Minneapolis, University of Minnesota Press, 330 p.

Hubbard, E.F., Kilpatrick, F.A., Martens, L.A., and Wilson, J.F. Jr., 1981, Measurement of time of travel and dispersion in streams by dye tracing: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A9, 44 p.

Jensen, S.L., 1966, The mayflies of Idaho (ephemeroptera): Salt Lake City, M.S. Thesis, University of Utah, 367 p.

Kilpatrick, F.A., and Cobb, E.D., 1984, Measurement of discharge using tracers: U.S. Geological Survey Open-File Report 84-136, 73 p.

Merritt, R.W., and Cummins, K.W., eds., 1984, An introduction to the aquatic insects of North America: Dubuque, Iowa, Kendall/Hunt Publishing Co., 2nd ed., 722 p.

Southwood, T.R.E., 1975, Ecological methods with particular reference to the study of insect populations: London, Chapman and Hall Ltd., 3rd printing, 391 p.

Skougstad, M.W., Fishman, M.J., Friedman, L.C., Erdmann, D.E., and Duncan, S.S., 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 626 p.

U.S. Environmental Protection Agency, 1986, Quality criteria for water, 1986: Washington, D.C., U.S. Government Printing Office.

Usinger, R.L., ed., 1956, Aquatic insects of California: Berkeley, University of California Press, 508 p.

Wiggins, G.B., 1977, Larvae of the North American caddisfly genera (trichoptera): Toronto, University of Toronto Press, 401 p.