Rock Creek

Twin Falls County

Water Quality

Status Report

Idaho
Division of Environment
Department of Health and Welfare

WATER QUALITY STATUS REPORT

ROCK CREEK

TWIN FALLS COUNTY, IDAHO

1970 - 1974

by

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Division of Environment
Idaho Department of Health and Welfare
Boise, Idaho

1975

Water Quality Series No. 18

STATE OF IDAHO

DEPARTMENT OF HEALTH AND WELFARE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS & SYMBOLS

ACOG	Ada Council of Governments
BOD	Biochemical Oxygen Demand
BLM	Bureau of Land Management
CFS	Cubic Feet Per Second
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
Ft	Foot, feet
FWPCA	Federal Water Pollution Control Administration
IDECS	Idaho Department of Environmental and Community Services (now IDHW)
IDH	Idaho Department of Health (now IDHW)
IDHW	Idaho Department of Health and Welfare
LC50	Median lethal concentration
M	Meter(s)
mg/l	Milligrams per liter
N	North
R	Range
RK	River Kilometer
RM	River Mile
S	Section Number
TOC	Total Organic Carbon
T	Township
USGS	United States Geological Survey
µg/l	Micrograms Per Liter
µmhos/cm	Micromhos Per Centimeter
o	Degree
I	Minute

WATER QUALITY STATUS REPORT - ROCK CREEK

Segment: Upper Rock Creek (Segment Number USB-720) to the mouth (Segment Number USB-730). Figure 1 shows the location of Rock Creek in Idaho.

Time Period: February 1970 to February 1974

Purpose of Study:

The study was designed to determine the characteristics and amounts of industrial and municipal wastes discharged to Rock Creek and subsequently into the Snake River and to evaluate the effects of these wastes on the biota and water quality of Rock Creek.

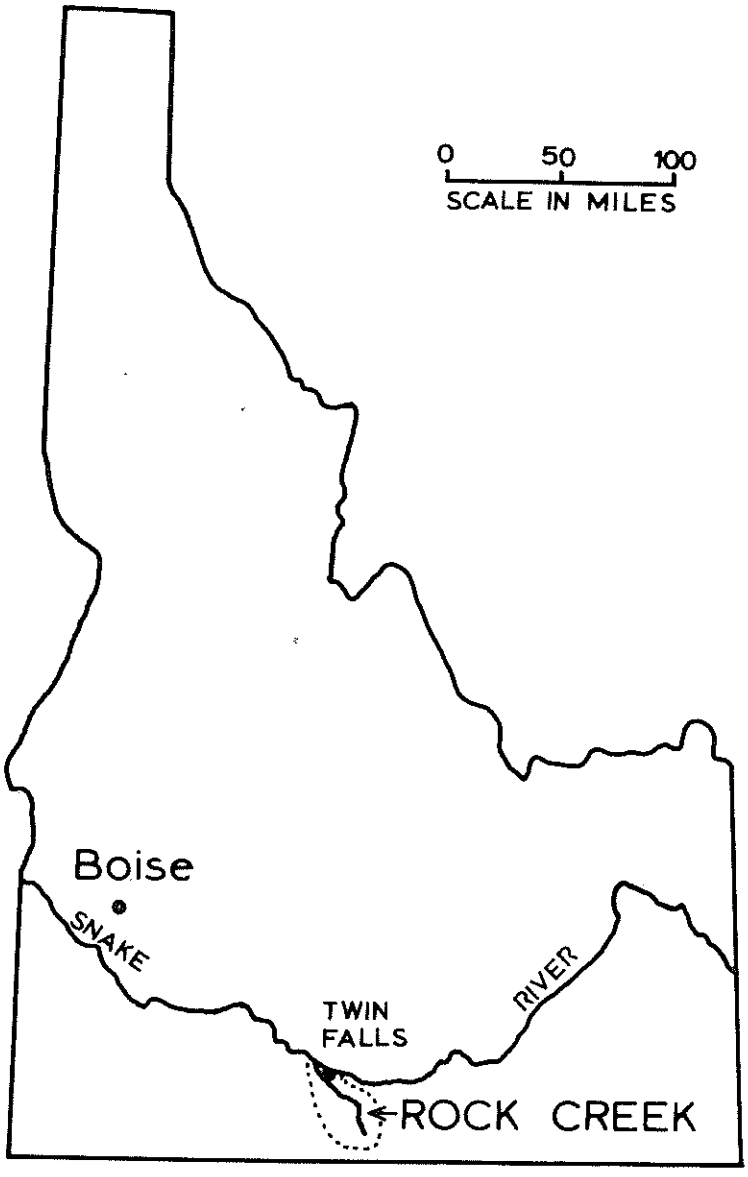
Segment Description:

River Mile: Snake River River Mile 606.8 (River Kilometer 971) (mouth of Rock Creek) to River Mile 606.8/12.4 (just above Amalgamated Sugar Company).

Classification: Class A_2 waters, "are for uses where the human body may come in direct contact with the raw water to the point of complete submergence. The raw water may be accidently ingested and certain sensitive organs such as eyes, ears, nose, etc., may be exposed to the water. These waters may be used for swimming, water skiing, skin diving, support and propagation of fish, aquatic and semi-aquatic life, and other forms of wildlife." (IDECS, 1973). Class A_2 waters are those which are not lakes and impoundments.

A. Drainage Area Description: The location of Rock Creek in the State and area is shown in Figures 1, 2 & 3. Rock Creek is principally located in Twin Falls County with headwaters near the 7,000 foot (2134 M) elevation in the Sawtooth National Forest in west central Cassia County. "Rock Creek, which drains the heart of the Cassia Division northward to the Snake River, is important winter range for deer and one of the keys to success of deer reproduction," (McConnell, et al, 1975). It flows through Twin Falls at an elevation of 3,750 feet (1143 M) and to the Snake River at an elevation of 2,992 feet (912 M). Cottonwood Creek, McMullen Creek and the west fork of Rock Creek are the main tributaries. Rock Creek drains an area of 310 square miles (803 KM2). USGS (1974) stated that the average discharge from the station near the small town of Rock Creek (about 12 miles south of Hansen) is 33.9 CFS (24,560 acre-ft/yr). Monthly mean flows for the years 1970-1974 taken from USGS (1971-1974) are shown in Table 9. These flows are from the USGS gage station, hence are smaller than the flows encountered in the section of Rock Creek near Twin Falls. The table may have some value when indicating the relative average flow for the different months. The highest stage of the creek at this station is in April and May and the low stages are found between August and December. Table 9a contains monthly flow records for the mouth of

FIG. 1. ROCK CREEK STUDY AREA



Key to Figure 2

ROCK CREEK SAMPLE STATIONS AND GENERAL SOILS MAP

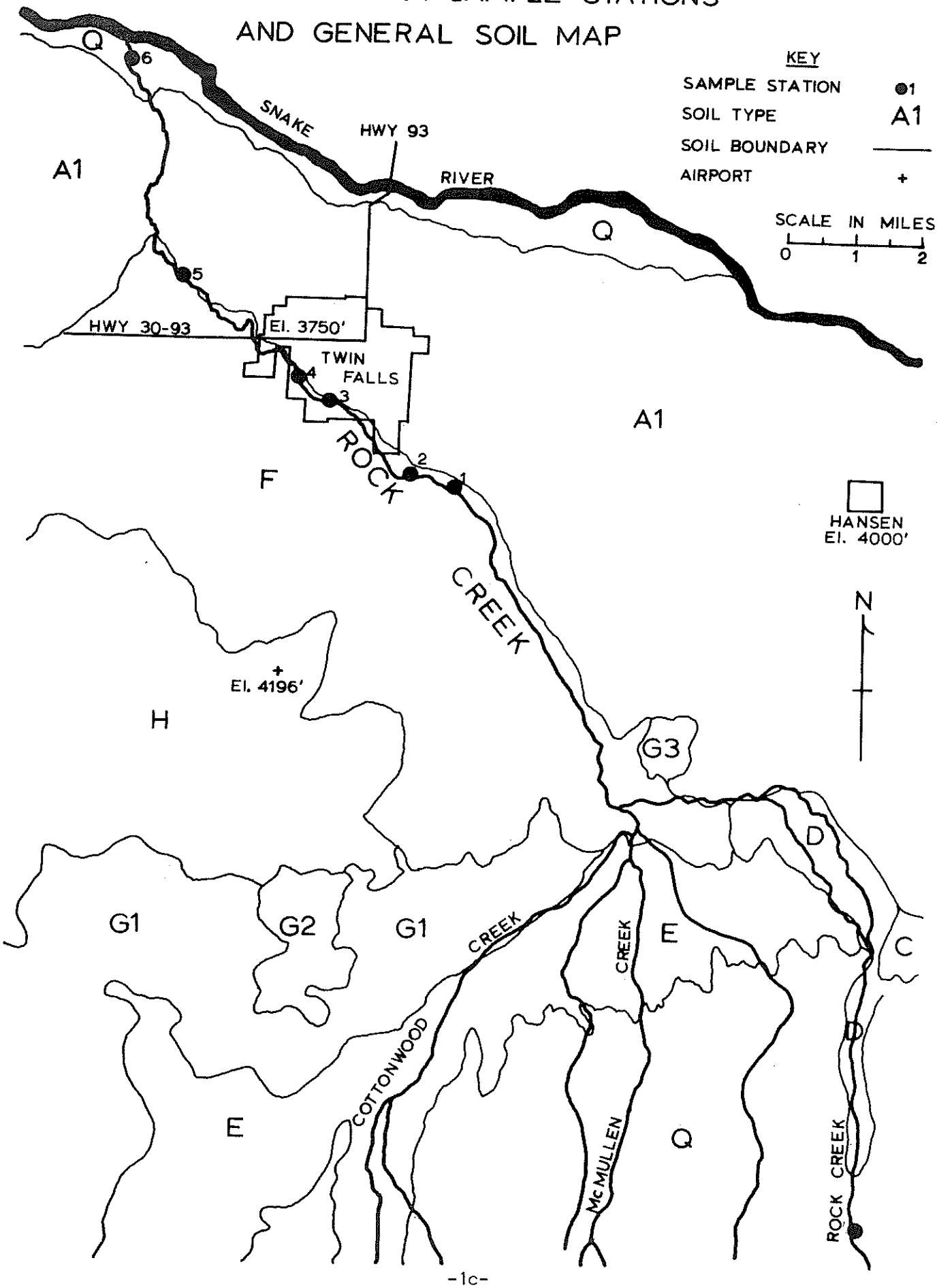
S T A T I O N

1. Rock Creek below Independent Meat Company.
2. Rock Creek at Eastland Drive Bridge.
3. Rock Creek below Twin Falls State Fish Hatchery.
4. Rock Creek below Idaho Frozen Foods, Inc.
5. Rock Creek near Poleline Road Bridge.
6. Rock Creek, near mouth.

S O I L T Y P E S

Refer to Drainage Area Description Section of this report.

FIG. 2. ROCK CREEK SAMPLE STATIONS AND GENERAL SOIL MAP



Key to Figure 3

ROCK CREEK SAMPLE STATIONS AND MAJOR INDUSTRIAL EFFLUENTS

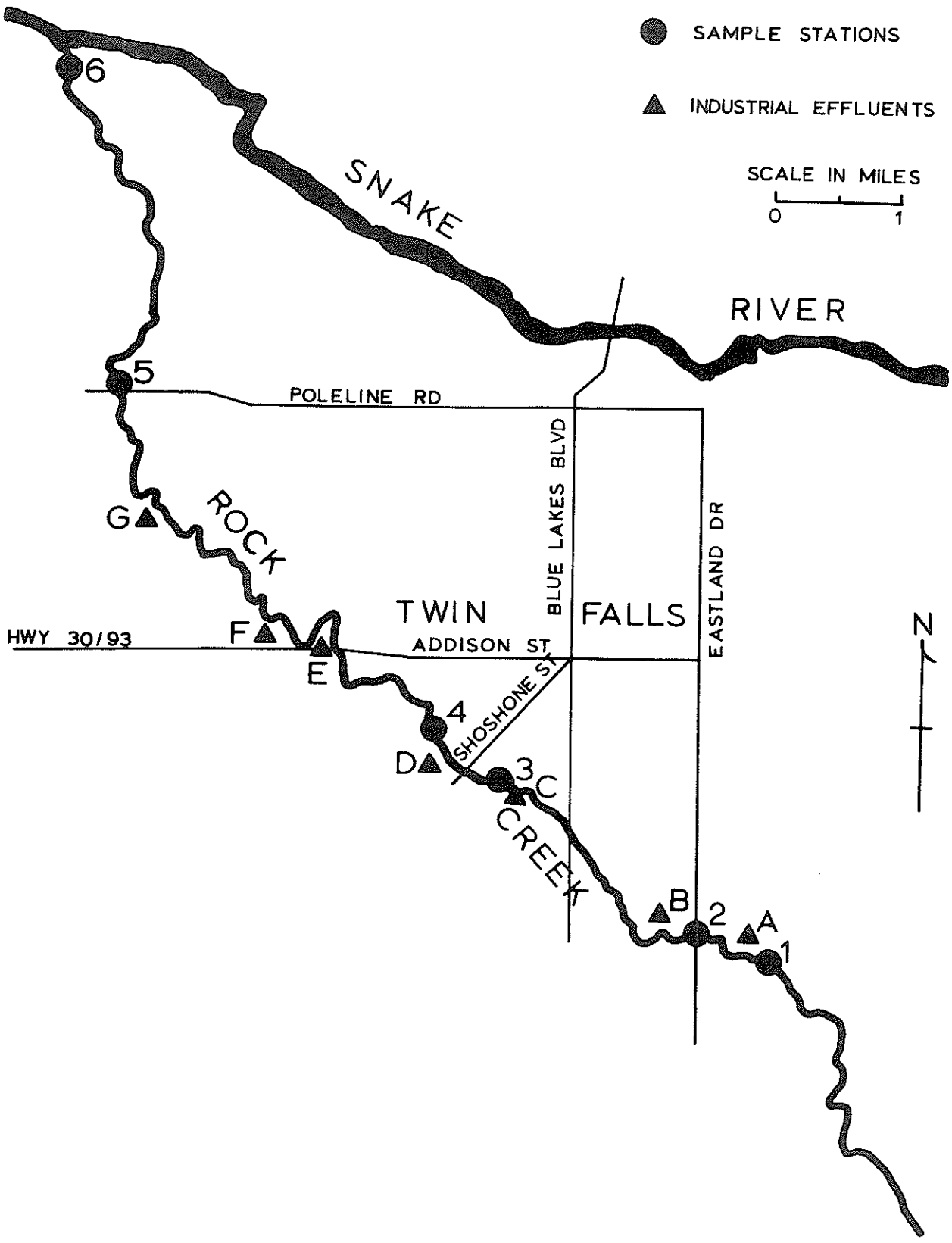
S T A T I O N

1. Rock Creek below Independent Meat Company.
2. Rock Creek at Eastland Drive Bridge.
3. Rock Creek below Twin Falls State Fish Hatchery.
4. Rock Creek below Idaho Frozen Foods, Inc.
5. Rock Creek near Poleline Road Bridge.
6. Rock Creek, near mouth.

I N D U S T R Y

A. The Amalgamated Sugar Company.
B. Independent Meat Company.
C. Twin Falls State Fish Hatchery
D. Idaho Frozen Foods, Inc.
E. Colonial Concrete, Inc.
F. Ready-to-Pour.
G. Canyon Trout Farm, Inc.

FIG. 3. ROCK CREEK SAMPLE STATIONS IN RELATION TO MAJOR INDUSTRIAL EFFLUENTS



Rock Creek in CFS and acre feet for the time period of the study. The data presented in Table 9a is courtesy of J.A. Bondurant of the Snake River Conservation Research Center, Kimberly, Idaho. These flows are used later in this report to estimate loadings entering the Snake River from Rock Creek.

For comparison, EPA (1973), reported flows for November 12-16, 1971, as follows: RM 606.8/14.7, 13 CFS; RM 606.8/4.3 (near Canyon Trout Farm), 165 CFS; and RM 606.8/0.2 (near Mouth), 170 (CFS).

Rock Creek passes through national forest and BLM lands and when it enters Magic Valley it is used extensively for irrigation. About half of the flow of Rock Creek is diverted for irrigation (Crosthwaite, 1969). The creek enters a deep narrow canyon about 10 miles southwest of Twin Falls through which it flows to the Snake River. The creek is used for recreation and as an industrial water supply here.

According to Chugg et al, (1967), about 2/3 of the land in Twin Falls County is irrigable. The land surrounding Rock Creek is irrigable from about 10 miles south of Hansen to its confluence with the Snake River, thus, approximately 20 miles of the Creek runs through presently irrigated areas.

A general soils map after Chugg et al, (1967) is shown in Figure 2. The soils in the Rock Creek area can be generally described as follows:

1. Areas dominated by soils with thin dark colored, medium textured surface soils and very strongly calcareous silty subsoils.

   F. Deep to moderately deep, well drained soils on nearly level to very gently sloping loose covered lava plain.
   G1. Moderately deep to shallow, well drained soils on nearly level to sloping loose covered lava plains.
   G2. Moderately deep to shallow, well drained soils on sloping to nearly level loose covered volcanoes.
   G3. Moderately deep to shallow, well drained soils on gently sloping loose covered volcanoes.
   H. Deep to moderately deep, well drained soils on nearly level to sloping loose covered lava plains.

2. Areas dominated by soils with dark colored medium textured surface soils and loamy subsoils.

   D. Deep, somewhat poorly or moderately well drained and moderately saline-alkaili soils on nearly level to very gently sloping alluvial fans and bottoms.

3. Areas dominated by soils and thin dark colored, medium textured surface soils and very strongly calcareous loamy subsoils.

C. Deep, well drained soils on nearly level to very gently sloping alluvial fans.
E. Deep to shallow, well drained soils on nearly level to very gently sloping alluvial fans.

4. Areas dominated by hills, mountains, plains, and canyons.

Q. Unidentified soil mapping unit: very shallow to moderately deep, very stony or very rocky, well drained soils on nearly level to gently sloping lava plains and steep to very steep ignimbrite hills, mountains, and canyons.

According to Crosthwaite (1969) the headwater areas of Rock Creek consist of rocks of pre-tertiary age, limestone, quartzite, shale, sandstone, granite, and metamorphosed sediments. These rocks yield larger supplies of groundwater to the northeast.

B. Sampling Location: (see Figure 2 for location of stations)

1. Routine stations: One routine network sampling station, referred to as "Station 5" in this report, is located on Rock Creek. This station is sampled monthly for chemical and bacteriological analysis. This station is designated as Storet No. 151053 and is located at river mile 606.8/4, latitude 42° 35' North, longitude 114° 31' W, T10S, R16, S12, just below Canyon Trout Farm, Inc. (1 mile west, 3/4 mile north, then 1/4 mile west of Magic Valley Memorial Hospital). Prior to August 17, 1971, the station was located at the Pole Line Road bridge on the section line between T9S, R16E, S36 and T10S, R16E, S1.

2. Special Stations: Stations 1 to 4 and 6 are located in or near the city of Twin Falls near an elevation of 3,700 feet. These were the most frequently sampled stations. Approximately 10 miles south of Hansen is located a station that was sampled on two dates (12/18/70 and 6/11/72) only for bacteriological analysis. The station is located in T12S, R18E, S25 NW¼.

Station 1: This station is located just upstream from Amalgamated Sugar Company at river mile 606.8/12.4, T10S, R17E, S26. Prior to December 28, 1970, the station was located about one mile further upstream at T10S, R18E, S36.

Station 2: Located at the road bridge on Eastland Drive South, above Independent Meat Company and below Amalgamated Sugar Company at River Mile 606.8/11.8, T10S, R17E, S27.

Station 3: This station is located just below Twin Falls State Fish Hatchery at River Mile 606.8/9.4 T10S, R17E, S21 north part. Drive south on highway 93 (Blue Lakes Blvd.) to Addison Avenue, turn southwest at the 5-point intersection on Shoshone Street, proceed to Minidoka Avenue (about 15 blocks), turn left on Minidoka Avenue, go 7 blocks to Canyon Street and turn right, follow sign to hatchery.

Station 4: Just below Idaho Frozen Foods, Inc., outfall to Rock Creek at River Mile 606.8/8.7 T10S, R17E, S17 SE¼.

Station 6: This station is located just above the confluence with the Snake River at River Mile 606.8/0.2, T9S, R26E, S23. The station was only sampled on February 17, 1970.

Waste Sources:

A. Point Sources: "A point source is any discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged," (IDECS, 1973). The location of the major point sources along lower Rock Creek are shown in Figure 3.

Several industries and trout farms in the Twin Falls area discharge wastewater directly into Rock Creek. The special study conducted on Rock Creek by the Environmental Protection Agency(1973a) produced effluent guidelines for these wastewater discharges. Following the study, EPA began issuing National Pollutant Discharge Elimination System (NPDES) Permits stating effluent limitations, monitoring requirements and a schedule of compliance.

1. Industrial: (See Table 2 for results of analysis of effluents)

Amalgamated Sugar Company

Type of Operation: Sugar beet processing mill.
Treatment: Flume water, time wastes and ash-laden wastewaters are treated in a "closed" water recycle system. By September 1, 1975, their discharge to Rock Creek must meet permit limitations. These limitations are:

Parameters	14 Day Average	24-Hour Composite
BOD_5	454 Kg/d (1000 lb/d)	680 Kg/d (1500 lb/d)
SS	454 Kg/d (1000 lb/d)	680 Kg/d (1500 lb/d)
pH	Must be between 6.0 and 8.5	
Foam and floating Solids	No visible permitted.	
Settleable Solids	Less than 0.1 ml/l	

Colonial Concrete, Inc.

Type of Operation: Gravel washing and crushing, concrete batching.
Treatment: None in existence. Permit requires complete recycling of wash and waste water, eliminating discharge to Rock Creek by December 31, 1975.

Idaho Frozen Foods, Inc.

Type of Operation: Processes potatoes to produce frozen packaged potatoes.
Treatment: Much flume water is recycled. A primary clarifier is used for flume and process water. Process water also goes through a grease trap and rotating screens. Pipeline is completed to the Twin Falls municipal sewer and is awaiting completion of the sewage treatment plant. Excess clarifier water is presently dischar ed to Rock Creek. Discharge to Rock Creek will be eliminated by February, 1976.

Independent Meat Company

Type of Operation: Slaughter of cattle and hogs, process meat to finished products and renders edible fat.
Treatment: All wastewater except condenser water is discharged to an anaerobic lagoon. The condenser water is discharged directly into Rock Creek as is the lagoon effluent. Discharge will go to the Twin Falls sewer when the City completes a necessary lift station.

Ready-To-Pour Concrete Company

Type of Operation: Wet screening and washing of sand and gravel products.
Treatment: Wash water is discharged into a settling basin with 2-day or more retention time for removal of settleable solids. The permit requires no discharge or water of better quality than intake water. Settling ponds appear to be providing adequate treatment.

2. Fish Hatcheries:

Canyon Trout Farm, Inc.

Type of Operation: Fish culture; hatching and rearing of Rainbow trout.
Treatment: None at present. Shall meet final effluent limitations of permit by July 1, 1976. The final effluent limitations are:

Effluent Characteristic	Daily Average	Daily Maximum	Instantaneous Maximum
Suspended Solids			
Kg/day	400	519	N/A
(lbs/day)	(880)	(1,144)	N/A
mg/l	0.1	N/A	15
Settleable Solids ml/l	N/A	N/A	2.2
Cleaning Effluent and/or Treated Effluent			
Suspended Solids mg/l	N/A	N/A	15
Settleable Solids ml/l	N/A	N/A	0.2
Floating Solids or Foam	No visible permitted other than trace amounts		

Twin Falls State Fish Hatchery

Type of Operation: Spawn, hatch, rear, and release trout and salmon.
Treatment: None at present. Must meet final effluent limitations by July 1, 1977. The final effluent limitations are:

Effluent Characteristic	Daily Average	Daily Maximum	Instantaneous Maximum
Suspended Solids			
Kg/day	277	360	N/A
(lbs/day)	(611)	(795)	N/A
mg/l	N/A	N/A	25
Settleable Solids	0.1	N/A	N/A
Cleaning Effluent			
Suspended Solids (mg/l)	N/A	N/A	25
Settleable Solids (ml/l)	N/A	N/A	0.2
Floating Solids and Foam	No visible permitted except in trace amounts		

3. Feedlot:

Olmstead Cattle Company (About 3 miles SE of Twin Falls)

Type of Operation: Cattle feeding
Treatment: Retention pond and irrigation facility. Presently no discharge.

4. Agricultural Return Flow:

Twin Falls Canal Company

Type of Operation: Diverts 1,250,000 acre feet annually from Milner Lake to irrigate privately owned land in Twin Falls County.
Irrigated Acreage: 202,000 acres (199,000 irrigated by gravity, 3,000 by sprinkler). Crops Grown: Row crops (potatoes, sugar beets, beans), hay, grain, pasture.
Treatment: None

B. Nonpoint Sources: "Nonpoint agricultural pollutants are organic and inorganic materials entering surface and ground water from nonspecific or unidentified sources in sufficient quantity to constitute a pollution problem. They include sediment, plant nutrients, animal wastes, and pesticides from cropland, rangeland, pastures and farm woodlots," (EPA, 1973b). Nonpoint sources may also include the above from any nonspecific or unidentified sources.

1. Resulting from human activity: Spring runoff from the upper reaches of Rock Creek in the Sawtooth National Forest, especially

in areas recently logged or areas of road construction, could be a source of excessive sediments. Agricultural runoff in the lower areas undoubtedly contribute pesticides, fertilizers, and sediments to Rock Creek. Storm runoff from Twin Falls contributes unknown amounts of petroleum products plus sediment and organic material.

2. Naturally occurring events: Normal soil erosion contributes a background of physical and chemical conditions to Rock Creek.

General Water Quality:

Generally the water quality above Twin Falls is good and relatively free of pollution. The stream below Twin Falls is substantially polluted with industrial wastes. (IDH, 1960, EPA, 1973a.)

A. Chemical and Physical Water Quality:

1. Field Observations (1970 to 1974, from field notebook of Gene L. Ralston, Idaho Department of Health and Welfare)

Date	Station	Rock Creek Condition Observed
10/13/70	2	Slime, sludge, odor, turbid, gray color
10/13/70	3	Gray color, quite turbid
12/28/70	3	Slime
12/18/70	4	Strong NH_3 odor, detergent foam on water
4/13/71	1	Turbid (runoff)
4/13/71	5	Slime, turbid
8/17/71	1	Turbid
8/17/71	2	Turbid
8/17/71	3	Turbid
8/17/71	4	Turbid
8/17/71	5	Floating pea wastes
10/04/71	4	Muddy, high water
10/06/71	1	Turbid (due to dredging directly upstream)
10/06/71	3	Turbid, high water
2/02/72	1	Anchor ice, turbid
2/02/72	2	No ice, turbid
2/02/72	3	Turbid, slime
2/02/72	4	Turbid, slime
2/02/72	5	Turbid, slime
5/11/72	S. Hansen	Slightly turbid, high water
5/11/72	1	Very turbid, high water
5/11/72	3	Turbid, high water, high in solids
5/11/72	5	Very turbid
11/14/72	1	Clear, no slime
11/14/72	2	Turbid, long red slime on bottom, some floating downstream
11/14/74	5	Red slime
2/14/74	2	Turbid, white and red slime
2/14/74	3	Turbid, slime
2/14/74	4	Turbid, slime

Date	Station	Rock Creek Condition Observed
2/04/74	5	Slime, more turbid than above
1/23/75	2	Burlap sacks and boxes of entrails, bones and meat scraps in creek. Gray slime present.
1/23/75	5	Very dense gray slime, water very turbid (much suspended gray matter).

Field observations of temperature, pH and dissolved oxygen can be found in Table I.

Temperature

The temperature of Rock Creek ranged from -0.5 to 17.5° C. for the dates examined and was measured with the YSI Model 40 DO Meter. The temperature was always higher on the lower stations and often was raised between station 1 and 2 due to cooling water being discharged to the Creek from the Amalgamated Sugar Company. IDH (1960) showed that temperatures increased between the upstream and downstream stations in April and December, but remained about the same in August. Temperature differences varied between the stations as little as 0.5°C. (August 17, 1971) to as much as 8.7° C. (December 28, 1970). See Fig. 3 for water temperatures. In many cases it appears that the present State of Idaho Water Quality Standard for temperature was violated at or above station 2.

The Idaho State Board of Health (1968) Water Quality Standards state that an increase in temperature of more than 2° F. (approximately 1.1° C.) when the stream temperatures are less than 66° F. (approximately 18.9° C.) shall constitute a violation of these standards. The 1973 Water Quality Standards for the State of Idaho retain the above temperature limitations.

On the following dates, it appears that State of Idaho Standards for temperature were violated at stations 2 (below the Amalgamated Sugar Company, and 4 (below Idaho Frozen Foods, Inc.):

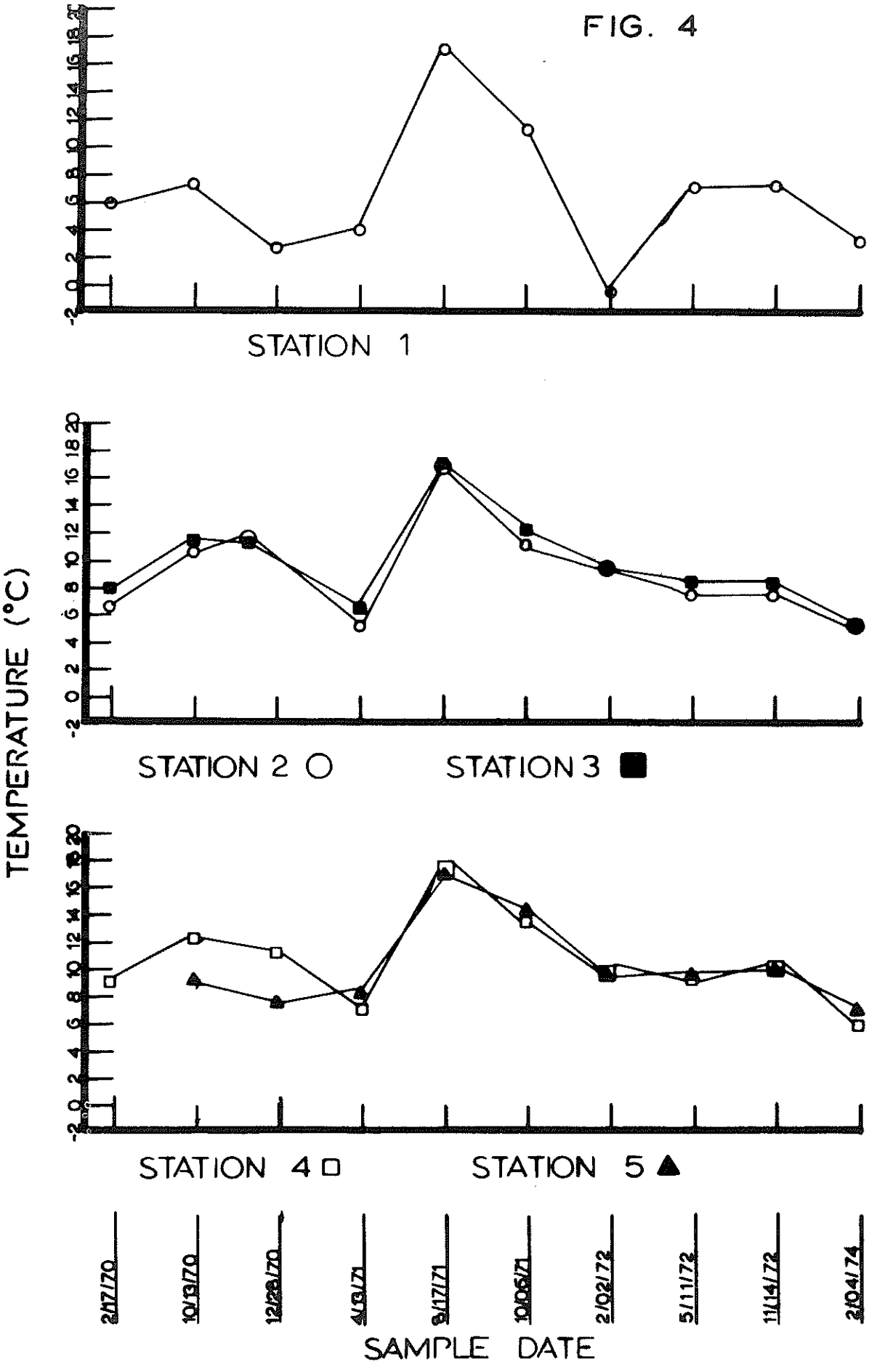
Date	Station 1	Station 2	Station 3	Station 4
October 13, 1970	7.5	10.4	10.9	12.2
December 28, 1970	2.8	11.5	--	--
February 2, 1972	-0.5	9	--	--
November 14, 1972	--	--	8.5	10
February 4, 1974	3	5	--	--

Figure 4 shows the water temperature of the Rock Creek Stations.

pH

Field pH was taken with an Orion Model 401 meter and was only taken on February 4, 1974 because a meter was not available prior to that date. The pH ranged from 7.6 to 8. A slightly higher pH was found above the industries.

FIG. 4


TEMPERATURE (°C)
-2 0 2 4 6 8 10 12 14 16 18 20
STATION 1
STATION 2 ○
STATION 3 ■
STATION 4 □
STATION 5 ▲
2/17/70
10/13/70
12/28/70
4/13/71
9/17/71
10/06/71
2/02/72
5/11/72
11/14/72
2/04/74
SAMPLE DATE

Dissolved Oxygen

Field measurement of dissolved oxygen was taken on all sample dates at most stations with a YSI Model 54 DO meter. The dissolved oxygen in mg/l was always less at station 5 than at station 1 and the percentage saturation of DO was usually lower at station 5. The same trend is shown by the 1959 data of DHW and to a lesser degree by EPA (1973). The dissolved oxygen ranged from a high of 12.4 mg/l recorded at station 1 (February 2, 1972 to a low of 5.6 mg/l at station 3 (December, 1970).

The State standards (Idaho State Board of Health, 1968) for percentage saturation of dissolved oxygen (75%) were violated on December 28, 1970 (at stations 2, 3, and 4), February 2, 1972, and February 4, 1974. See Table 1a for a listing of percentage saturation of dissolved oxygen for stations 1-5 sampled during this study. See Figs. 5 and 11 for percentage saturation of dissolved oxygen for this study.

The importance of dissolved oxygen is summarized by Mancy and Jaffe (1966), "...Those who are concerned with control of water pollution strive to maintain maximum solubility of atmospheric oxygen in water. In water quality characterization, the analysis for dissolved oxygen is extremely important. Oxygen levels in streams are directly dependent on the physical, chemical, biochemical, and biological activities occurring in the water body; therefore, the analysis for dissolved oxygen is used as a primary indicator in pollution abatement ..."

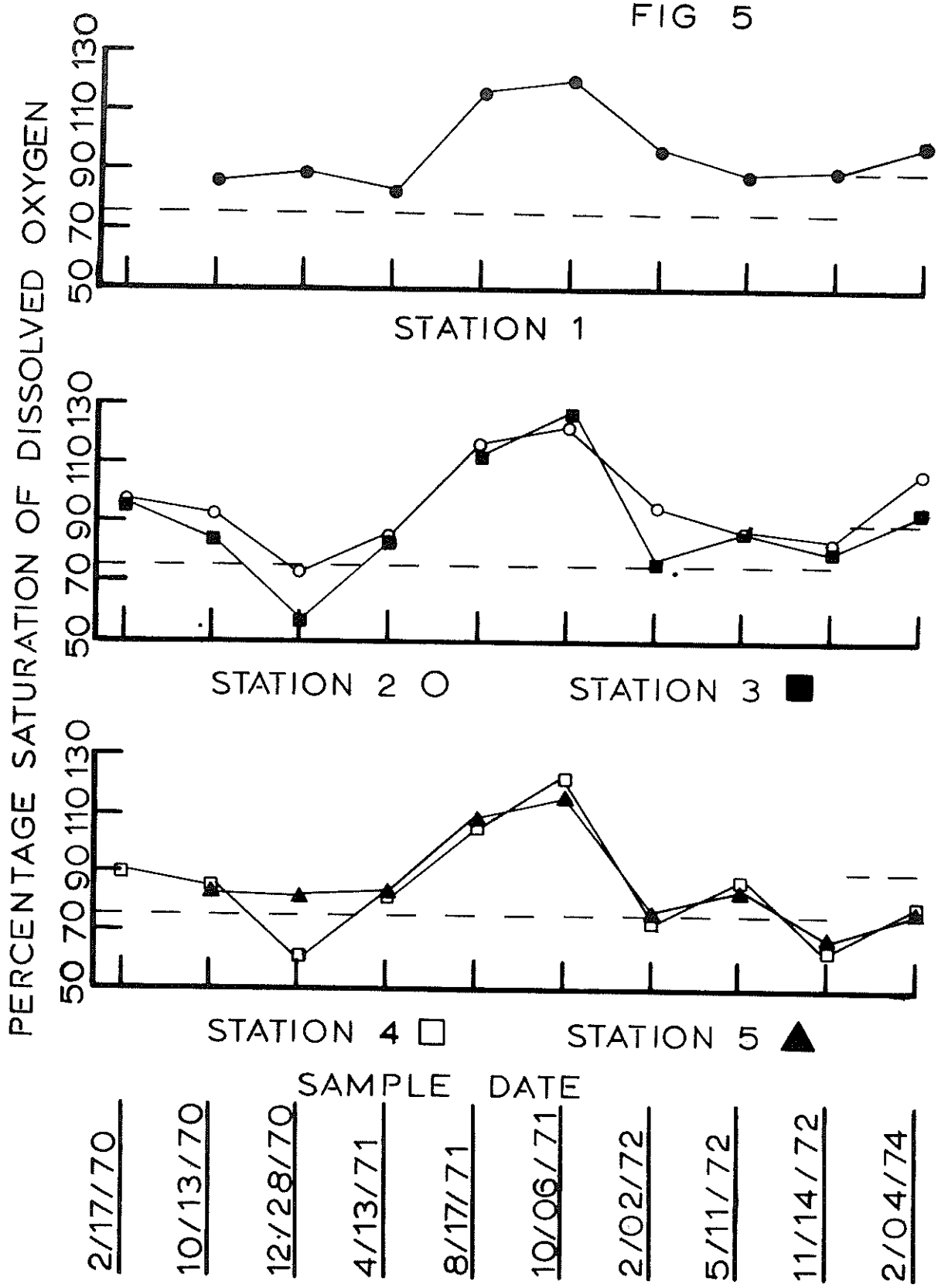
Laboratory Results

Samples for laboratory analysis were taken in 1 liter polyethylene screw cap containers. The samples were preserved by cooling to 4° C. on ice. Laboratory analyses were made by the State of Idaho Laboratory following Standard Methods (1965 and 1971) for the examination of water and wastewater. See Table 1 for complete listing of laboratory results for stream water quality. Table 2 lists chemical analyses of major industrial effluents and Table 3 shows the results of heavy metals analyses of samples taken in Rock Creek. IDH (1960) reported some analytical data for April 21-22, August 17-18, and December 8-10, 1959, for a series of stations along Rock Creek. USGS (1972) listed chemical analyses for January 21, March 26, and September 24, 1971 at Twin Falls (Lat. 42° 32' 57", Long. 114° 28' 27"). EPA (1973) listed analytical results and heavy metal data for November 12-16, 1971 for several Rock Creek stations.

pH

The pH analyses in the laboratory for February 4, 1974 agreed with the field tested pH within 0.1 SU. Present Water Quality Standards for the State of Idaho (induced variation not to be more than 0.5 pH unit) appear to have been violated on the following dates:

FIG 5


PERCENTAGE SATURATION OF DISSOLVED OXYGEN
50 70 90 110 130
STATION 1
STATION 2 O
STATION 3 ■
STATION 4 □
STATION 5 ▲
SAMPLE DATE
2/17/70
10/13/70
12/28/70
4/13/71
8/17/71
10/06/71
2/02/72
5/11/72
11/14/72
2/04/74
STATE STANDARD

Date	Station No.	pH
10/31/70	1	8
	2	6.6
12/28/70	1	8.1
	2	7.1
10/06/71	3	8.2
	4	7.6
11/14/72	1	8.1
	2	6.8

The standard states that the pH must remain between 6.5 and 9.0 (all stations sampled were within this range) and that induced variations shall not exceed 0.5 pH units. The 0.5 maximum was exceeded on the four dates listed above. Hem (1970) states that river water not influenced by pollution generally has a pH between about 6.5 and 8.5. EPA (1973) recommends a pH range of 5.0 to 9.0 for public water supplies and for fresh water aquatic life 5.5 to 9.5 for a low level of protection, and 6.5 to 8.5 for a nearly maximum level of protection. See Figure 6 for pH values of the Rock Creek stations.

Specific Conductance

Specific conductance was only analysed during this survey for the dates November 14, 1972 and February 4, 1974. The specific conductance always increased at each station going downstream. Conductance ranged between 460 and 840 micromhos per centimeter (umhos/cm).

EPA (1973) found conductivity ranged from 650 to 900 umhos/cm with variations at a single station of 250 umhos/cm during November 12-16, 1971. According to Hem (1970) the conductance of surface waters has a wide range. McKee and Wolf (1963) state that specific conductance values of less than 250 to 750 umhos/cm is excellent to good for irrigation waters.

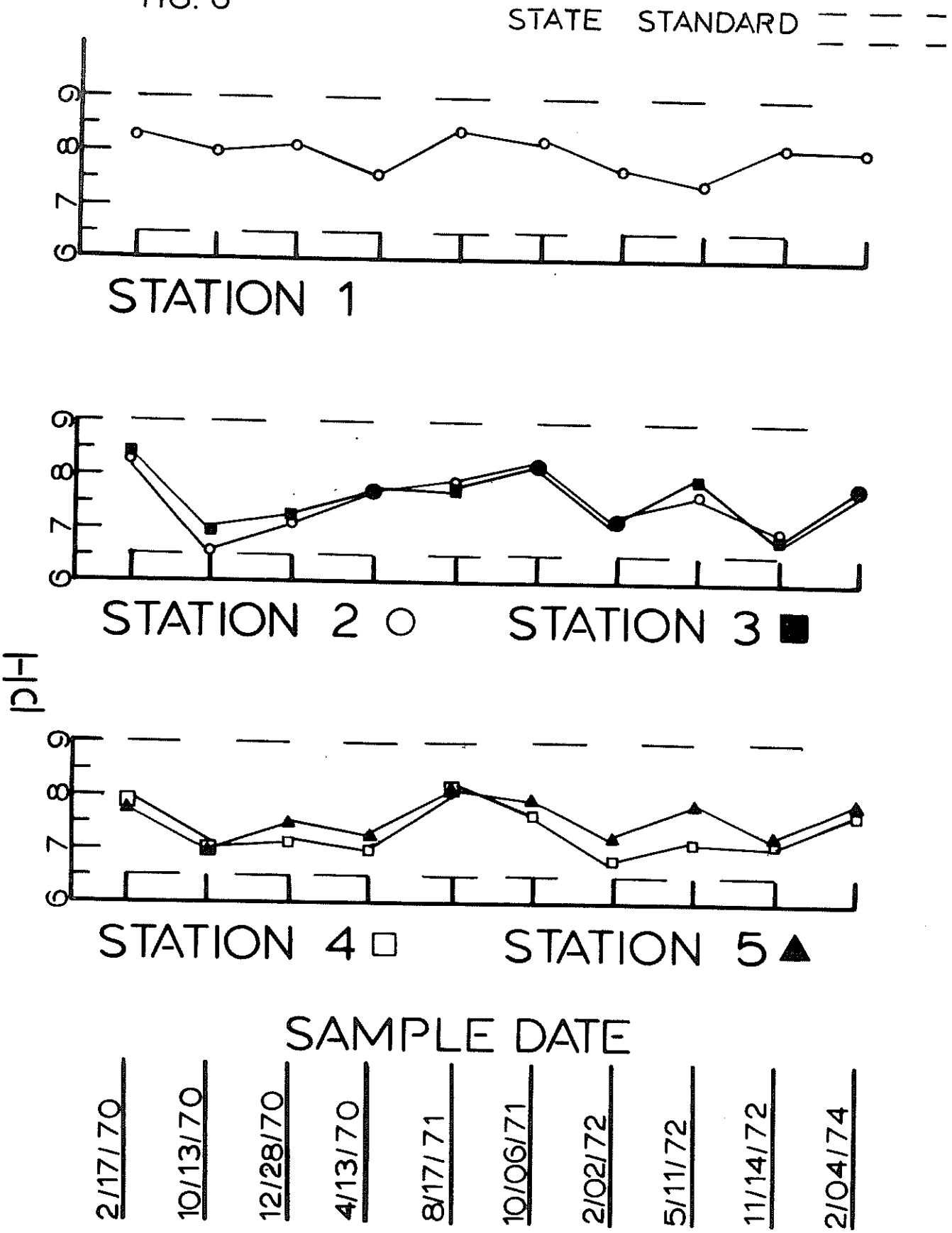
Turbidity

Turbidity is the reduction of transparency of a sample due to the presence of particulate matter (ASTM, 1975). According to Hynes (1974) there are two effects of the inert solids portion of turbidity:

1. If they are light or very finely divided they do not settle readily but make the river water opaque to light, thus influencing algal and other plant growth.
2. When inert solids settle out of the water onto the stream bed they may adversely effect both plant and animal life by covering the organisms, by destroying habitat, and by abrasion.

According to Idaho's Water Quality Standards (1968) turbidity other than that of natural origin shall not exceed the background turbidity by more than 10 Jackson Turbidity Units. The 1973 Standards reduce this limit to 5 Jackson Turbidity Units. Dates on which this standard would have been exceeded were:

FIG. 6


STATE STANDARD
9
8
7
6
STATION 1
STATION 2 ○
STATION 3 ■
pH
STATION 4 □
STATION 5 ▲
SAMPLE DATE
2/17/70
10/13/70
12/28/70
4/13/70
8/17/71
10/06/71
2/02/72
5/11/72
11/14/72
2/04/74

Date	Station No.	Turbidity (Jackson Turbidity Units)
2/17/70	1	<25
2/17/70	2	35
	5	80
4/13/71	4	45
	5	100
8/17/71	2	25
	3	75
10/06/71	2	25
	3	40
2/02/72	1	15
	2	45
11/14/72	1	4
	2	12

Turbidity was quite variable between stations perhaps largely depending on specific effluents being discharged into Rock Creek on the sampling date.

Biological Oxygen Demand (5 day)(BOD_5)

The biochemical oxygen demand test (BOD) compares dissolved oxygen levels of the water to levels in the same water after 5 days of storage in the dark. The drop in dissolved oxygen concentration, due to decomposition in the water, predicts the dissolved oxygen loss possible in natural waters. Thus, BOD is a means of measuring the organic content and the potential of a system to develop low oxygen.

The BOD varied greatly bwtween stations and sampling dates ranging from less than 2 to 180 mg/l. IDH (1960) found ranges from 1.3 to 590 mg/l with the highest readings being in December, 1959. EPA (1973) found ranges of 1 to 140 mg/l in November, 1971. Their ranges for the several day survey varied greatly at individual stations, as much as 118 mg/l. See Figure 7 and 11 for BOD_5 at Rock Creek stations 1-5.

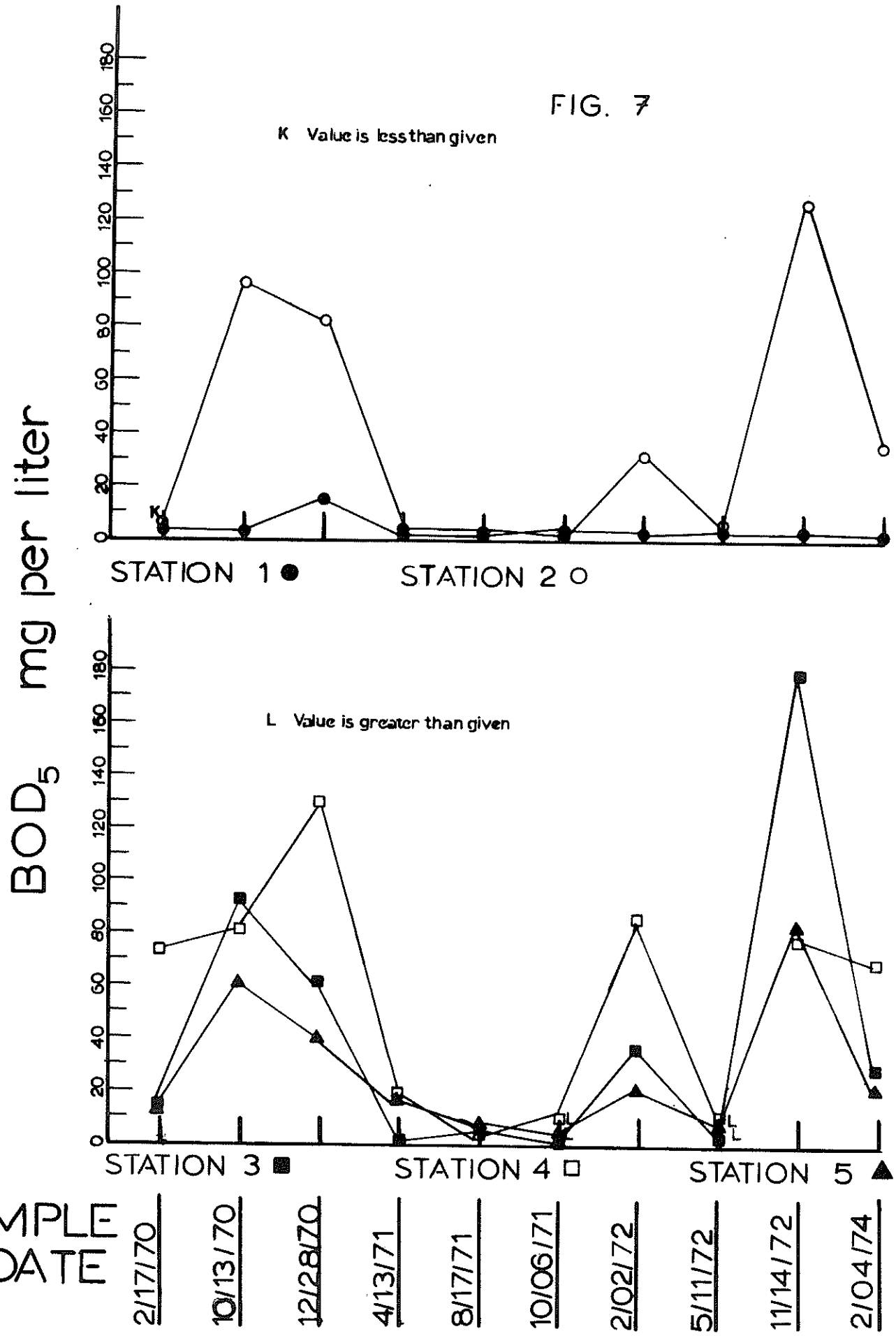
Chemical Oxygen Demand (COD)

The chemical oxygen demand (COD) determination provides a measure of the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. The COD level usually increased downstream from station 1, with the greatest increase normally occurring between station 1 and 2. COD values ranged from 12 to 234 mg/l.

Alkalinity

Alkalinity is not a polluting substance but is a combined effect of several substances and conditions. According to McKee and Wolf (1963) alkalinity is not considered to be detrimental to humans but it is generally associated with high pH values, hardness and excessive dissolved solids, all of which may be deleterious. These authors mention that alkalinity is beneficial to some industrial water supplies and detrimental to others;

FIG. 7


K Value is less than given
L Value is greater than given
BOD5 mg per liter
0
20
40
60
80
100
120
140
160
180
STATION 1 ●
STATION 2 ○
STATION 3 ■
STATION 4 □
STATION 5 ▲
SAMPLE DATE
2/17/70
10/13/70
12/28/70
4/13/71
8/17/71
10/06/71
2/02/72
5/11/72
11/14/72
2/04/74

excessive alkalinity in irrigation water is detrimental as it adds to total salinity and often accompanied by high pH values; high alkalinities may be detrimental to livestock; and that high alkalinities do not seem to have deleterious effects on fish and other aquatic life. They also mention that in a pH range between 7 and 8, a total alkalinity of 100 to 120 mg/l supports a diversified aquatic life. The Environmental Studies Board (1972) makes no recommendations for alkalinity because of its close association with pH and hardness; however, they suggest that for public water supply treatment that there be no sudden variations in the alkalinity.

The alkalinity on Rock Creek ranged between 96 to 256 at station 1 and 160 to 360 at station 5. On the same sampling date, the alkalinity was always higher at station 5 as compared with station 1 and usually progressively so. IDH (1960) tested alkalinity only at their upper and lower station. They found in April, 1959, it was 102 and 200 mg/l and in August, 201 and 238 mg/l. EPA (1973) did not find much variation in alkalinity, reporting a difference only 31 mg/l between their uppermost and lower most sampling stations in November, 1971.

Hardness

Hardness is expressed as the equivalent quantity of calcium carbonate. Acceptable levels of hardness seem to be based on consumer preference and the main detrimental effects are economic. McKee and Wolf (1963) note that hardness of over 100 mg/l results in a waste of soap and incrustation of utensils. They define "good water" as usually being below 250 mg/l, and that hardness in excess of 300 mg/l may be indicative of pollution. These authors state that recommended values of hardness for the food processing industry in general range from 10 to 250 mg/l. Hem (1970) describes a hardness of over 180 as "very hard," and mentions that water used for ordinary domestic purposes is often softened to less than 100 mg/l. ACOG (1975) states that, "the dividing line between soft and hard water from the biological point of view is 20 mg/l calcium."

The present study found hardness values ranging from 156 to 372 for station 1 and from 192 to 404 for station 5. Hardness usually increased downstream; often in a progressive manner but not always.

IDH (1960) checked hardness at upper and lower stations only and on both dates (April and August, 1959) found higher values on the lower station.

Calcium

Calcium is the principle cation in most fresh natural water (Hem, 1970) and may be the result of natural leaching from the soil or may be contained in sewage or industrial wastes (McKee and Wolf, 1963). These authors recommend from 0 to 30 mg/l calcium for laundry, washing, drinking and cooking purposes.

Our data show variations for calcium of 29 to 86 at station 1 and 32 to 88 at station 5. Calcium values usually increased at the lower stations except for the two winter samples (December, 1970 and November, 1972) when station 1 had the highest concentration.

USGS (1972b) found values of 35, 23, and 26 for January, March and September, 1971 at their upper Rock Creek station (#13092730).

Total Organic Carbon

The total organic carbon value is the total amount of carbon in a sample. The final usefulness of the carbon measurement is in assessing the potential oxygen-demanding load of organic material in a stream.

According to Hem (1970) total organic carbon (TOC) seems likely to be a more comprehensive indication of organic pollution loads, but like BOD is not a potential pollutant per se. Measurement of total organic carbon was done only on February 4, and showed its greatest increase between Station 1 and 2, an increase from 4.6 to 26.4 mg/l. The TOC concentration was 30 mg/l at station 3 and decreased to 5.6 mg/l at station 5.

Chloride

Hem (1970) states that chloride is present in all natural waters but that concentrations are usually low. Environmental Studies Board (1972) recommends that chloride in public water supply sources not exceed 250 mg/l. This is based on taste preferences and not toxic considerations.

In Rock Creek chloride levels ranged from 13 to 37 mg/l at station 1, to 26 to 50 mg/l at station 5. The chloride level always increased downstream.

USGS (1972b) found levels of 12, 10, and 25 mg/l during January, March and September, 1971 at their upper Rock Creek station.

Iron

Iron is abundant and widespread and according to Hem (1970) concentrations of only a few tenths of a milligram/liter can make water unsuitable for some uses. The Environmental Studies Board (1972) recommends that 0.3 mg/l soluble iron not be exceeded in public water supply sources.

Of 35 samples tested for iron between 1970 and 1971, 20 exceeded the general recommendation of 0.3 mg/l. The values for iron were quite variable.

Magnesium

Hem (1970) notes that in most natural fresh water, the magnesium concentration is much lower than the calcium concentration. Our Rock Creek data substantiates this statement. Magnesium ranged from 14 to 42 mg/l at station 1, to 22 to 61 mg/l at station 5. Much variation was evident but levels were always higher at the lowest station. The USGS (1972b) found significantly lower concentration upstream at their Rock Creek station reporting 9.5, 6.2, and 26 mg/l for January, March, and September, 1971. The increase between the USGS station and our station 1 may be due to runoff and agricultural return flow.

Manganese

Manganese is an essential element in plant metabolism. Aquatic plants have been noted as accumulators of manganese (Hem, 1970). Hem (1970) and the Environmental Studies Board (1972) note that water quality standards proposed by the U.S. Public Health Service recommended an upper limit of 0.05 mg/l.

Manganese is objectionable in public water supplies because of its effect on taste, staining of laundered clothes and plumbing fixtures, and accumulation of deposits in distribution systems. EPA (1975) concludes that, "managanese pollution of water does not appear to be a problem except possibly in isolated cases of waste disposal."

It appears that manganese levels exceeded recommended levels in 24 out of 35 samples. Manganese levels usually increased downstream from station 1, Levels at station 1 ranged from 0.01 to 0.12 mg/l and levels at station 5 from 0.02 to 0.37 mg/l. The largest concentrations and changes occurred in 1971. On April 13, the level changed from 0.05 to 0.37 mg/l and October 6 from 0.03 to 0.25 mg/l for stations 1 and 5 respectively.

Nitrate

Nitrogen in the form of nitrate is a major nutrient for vegetation and is the element essential to all life. Nitrates can be leached from the soils into streams. Leaching of nitrate from livestock confinement areas can be great.

The Environmental Studies Board (1972) recommends a nitrate concentration in public water supply sources not to exceed 10 mg/l. During the present study the 10 mg/l recommendation was only exceeded once, on February 4, 1974 at station 4, when a value of 13.5 mg/l was found. All of the stations were higher than normal on this date possibly due to runoff. Usually all stations had nitrate values less than 5 mg/l. IDH (1960) reported much lower nitrate concentrations than the present study. Figures 8 and 11 show nitrate concentrations for Rock Creek stations 1 to 5.

Nitrite

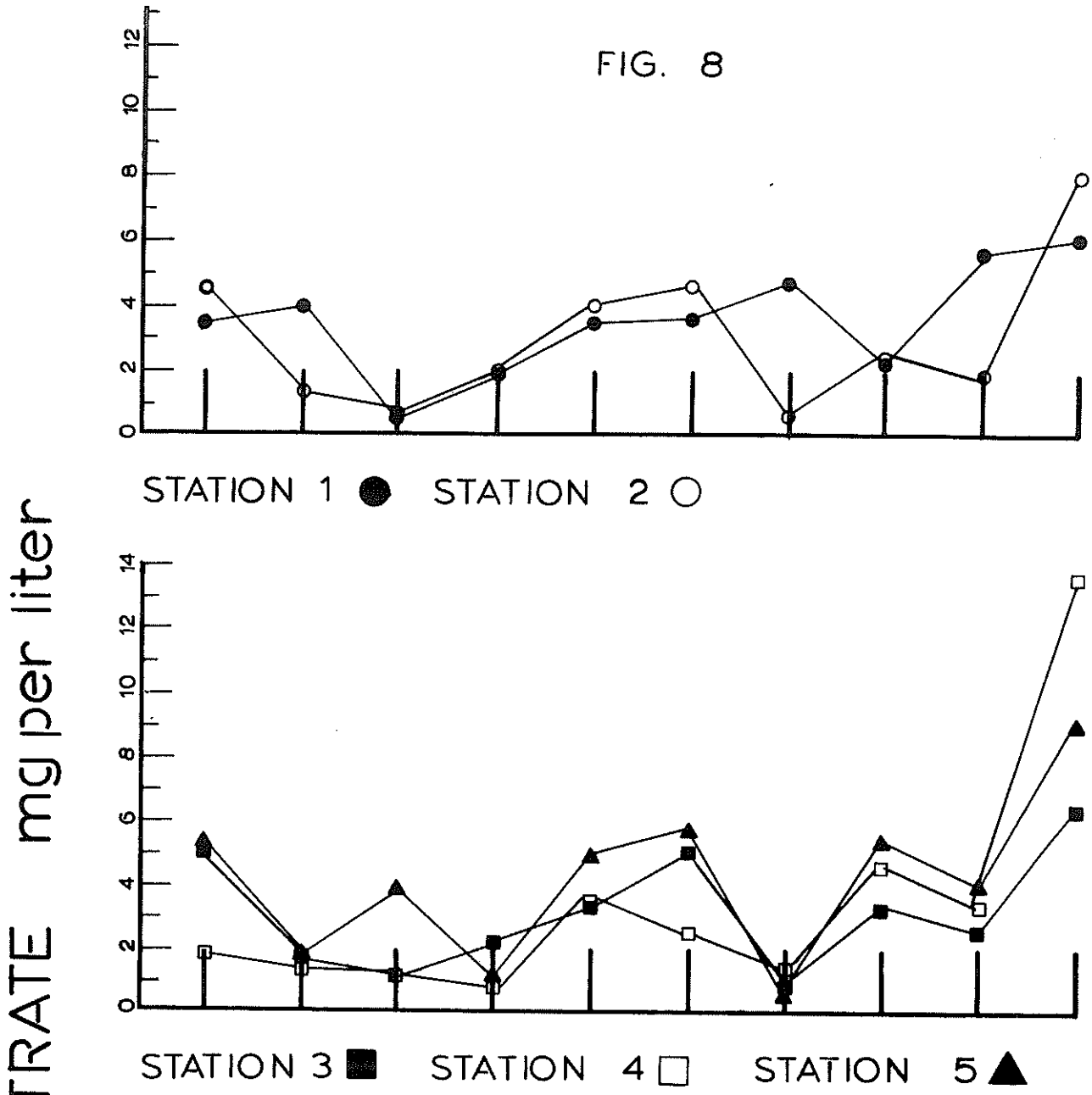
Nitrites are generally formed by the action of bacteria upon ammonia and organic nitrogen. Since they are quickly oxidized to nitrates, they are seldom present in surface waters in significant concentrations.

Environmental Studies Board (1972) recommends that concentrations of nitrite not exceed 1 mg/l in public water supply sources. None of the samples run for nitrite exceeded the recommended 1 mg/l and were usually much less.

Nitrogen (Total Kjeldahl)

Nitrogen occurs abundantly in nature and is a major part of the atmosphere. McKee and Wolf (1963) note that the concentration of total

FIG. 8


NITRATE mg per liter
0
2
4
6
8
10
12
14
STATION 1 ●
STATION 2 ○
STATION 3 ■
STATION 4 □
STATION 5 ▲
SAMPLE DATE
2/17/70
10/13/70
12/28/70
4/13/71
8/17/71
10/06/71
2/02/72
5/11/72
11/14/72
2/04/74

nitrogen should be less than 10 mg/l for most beneficial uses. Increased concentrations of nitrogen may result in algal blooms, possibly leading to eutrophication.

Total nitrogen always increased downstream from station 1. At several stations the recommended 10 mg/l was exceeded. Nitrogen ranged from 1.6 to 5.6 mg/l at station 1 and from 3.7 to 20.8 mg/l at station 5.

Ammonia

Ammonia may be a natural constituent of surface waters, but is normally 0.1 mg/l or less. McKee and Wolf (1963) note that higher levels may be indicative of sewage or industrial contamination. Because of this, the Environmental Studies Board (1972) recommends that ammonia nitrogen in public water supply sources not exceed 0.5 mg/l. They also recommend that for protection of all aquatic life the concentration never exceed 0.02 mg/l. All of the Rock Creek values exceeded this recommended limit. Out of the 45 samples taken during the survey, 28 exceeded the 0.5 mg/l recommendation. Ranges of 0.3 to 0.89 mg/l for station 1 and 0.2 to 17 mg/l for station 5 were found. These high ammonia values may be because of the elapsed time between sample collection and analysis.

Phosphate (inorganic)

Small amounts of phosphate occur in natural waters but the concentrations are increased by the use of phosphate fertilizers and phosphorus based detergents. Phosphates are used by plants and excessive phosphate levels may result in an overabundant growth of algae. Environmental Studies Board (1972) stated that "no recommendation can be made because of the complexity of relationships between phosphate concentrations in water, biological productivity, and resulting problems such as odor and filtration difficulties." Phosphates usually increased downstream from station 1. Only one station (#4, February 2, 1972) was found to be more than 1 mg/l; it had a value of 1.5 mg/l. Our data appears to show slightly higher concentrations of phosphate as compared with data obtained in 1959 by IDH (1960). The December, 1959 survey indicated that no phosphate was present in the upper stations, but was present at the lowest stations.

Figures 10 and 11 show inorganic phosphate concentrations for Rock Creek stations 1 to 5.

Phosphorus

Phosphorus does not occur free in nature, hence appears in various other forms in natural water. Phosphorus is an essential nutrient for aquatic plant growth. Increased concentrations of phosphorus may result in algal blooms, possibly leading to eutrophication. The Environmental Studies Board (1972) recommends on available data that concentrations of elemental phosphorus equal to or less than 1 mg/l constitute a hazard to the marine environment. Recommendations were not made for fresh water.

FIG. 9

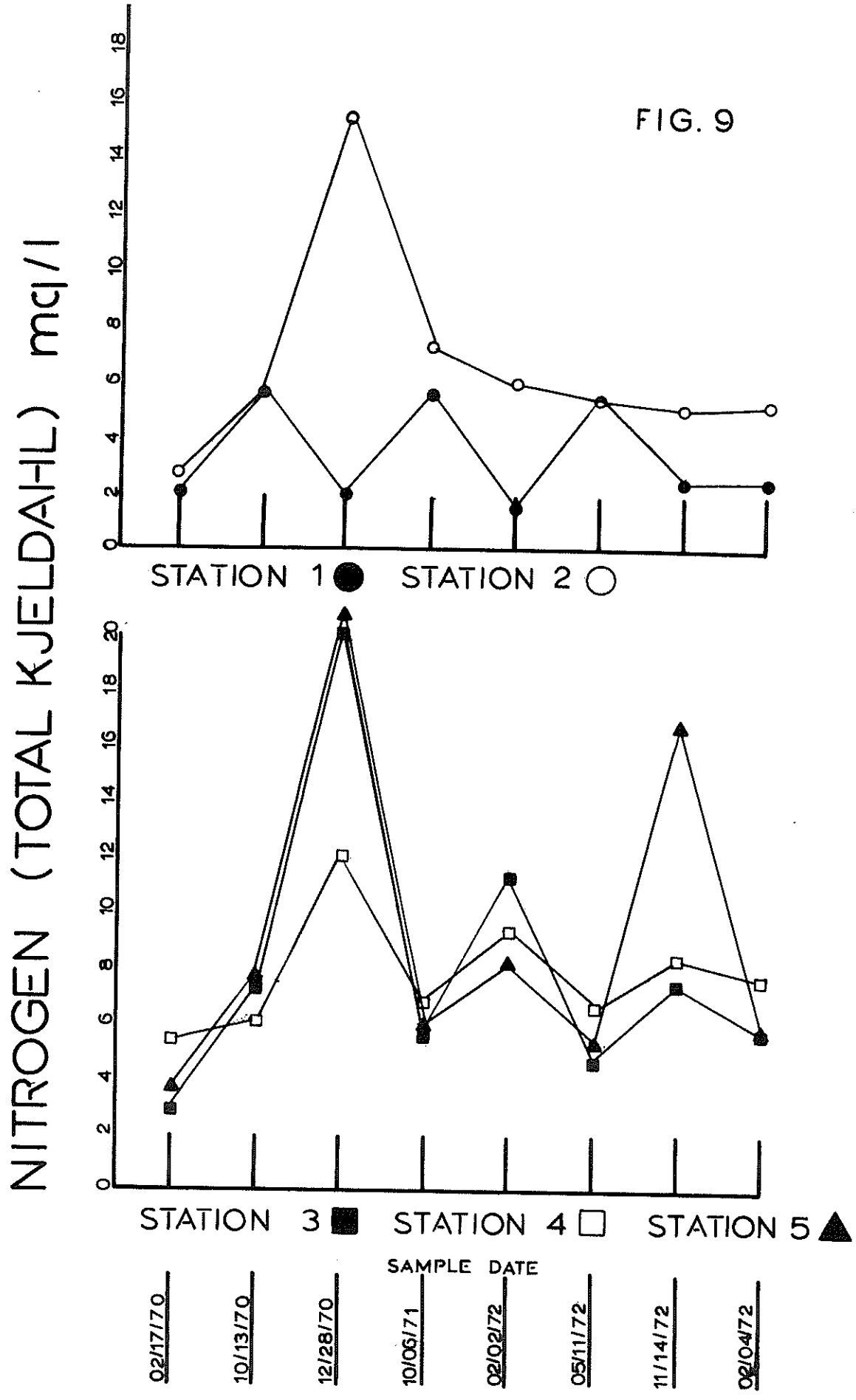
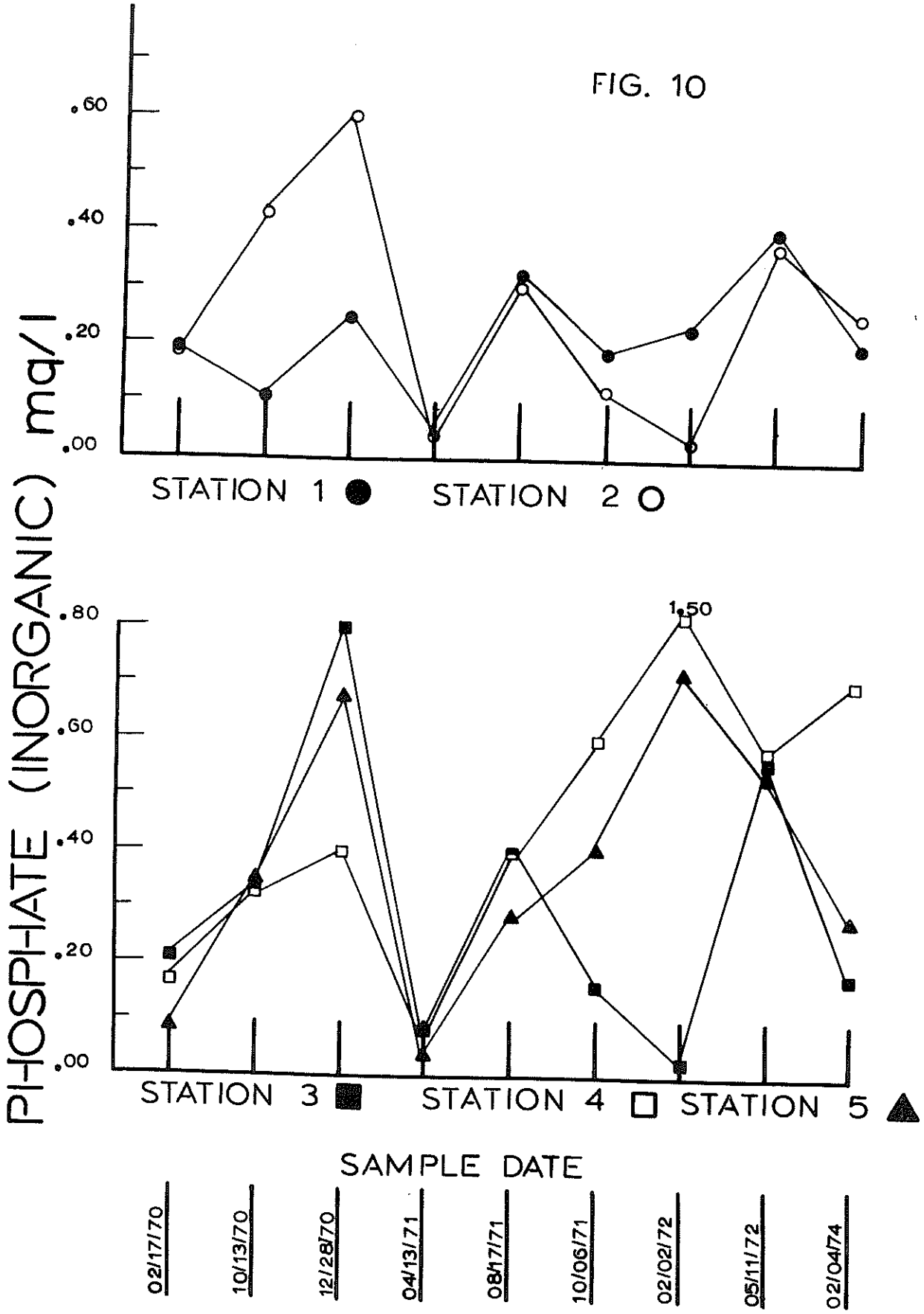

NITROGEN (TOTAL KJELDAHL) mg/l
0
2
4
6
8
10
12
14
16
18
20
STATION 1 ●
STATION 2 ○
STATION 3 ■
STATION 4 □
STATION 5 ▲
SAMPLE DATE
02/17/70
10/13/70
12/28/70
10/06/71
02/02/72
05/11/72
11/14/72
02/04/72

FIG. 10


PHOSPHATE (INORGANIC) mg/l
.60
.40
.20
.00
STATION 1
STATION 2
.80
.60
.40
.20
.00
1.50
STATION 3
STATION 4
STATION 5
SAMPLE DATE
02/17/70
10/13/70
12/28/70
04/13/71
08/17/71
10/06/71
02/02/72
05/11/72
02/04/74

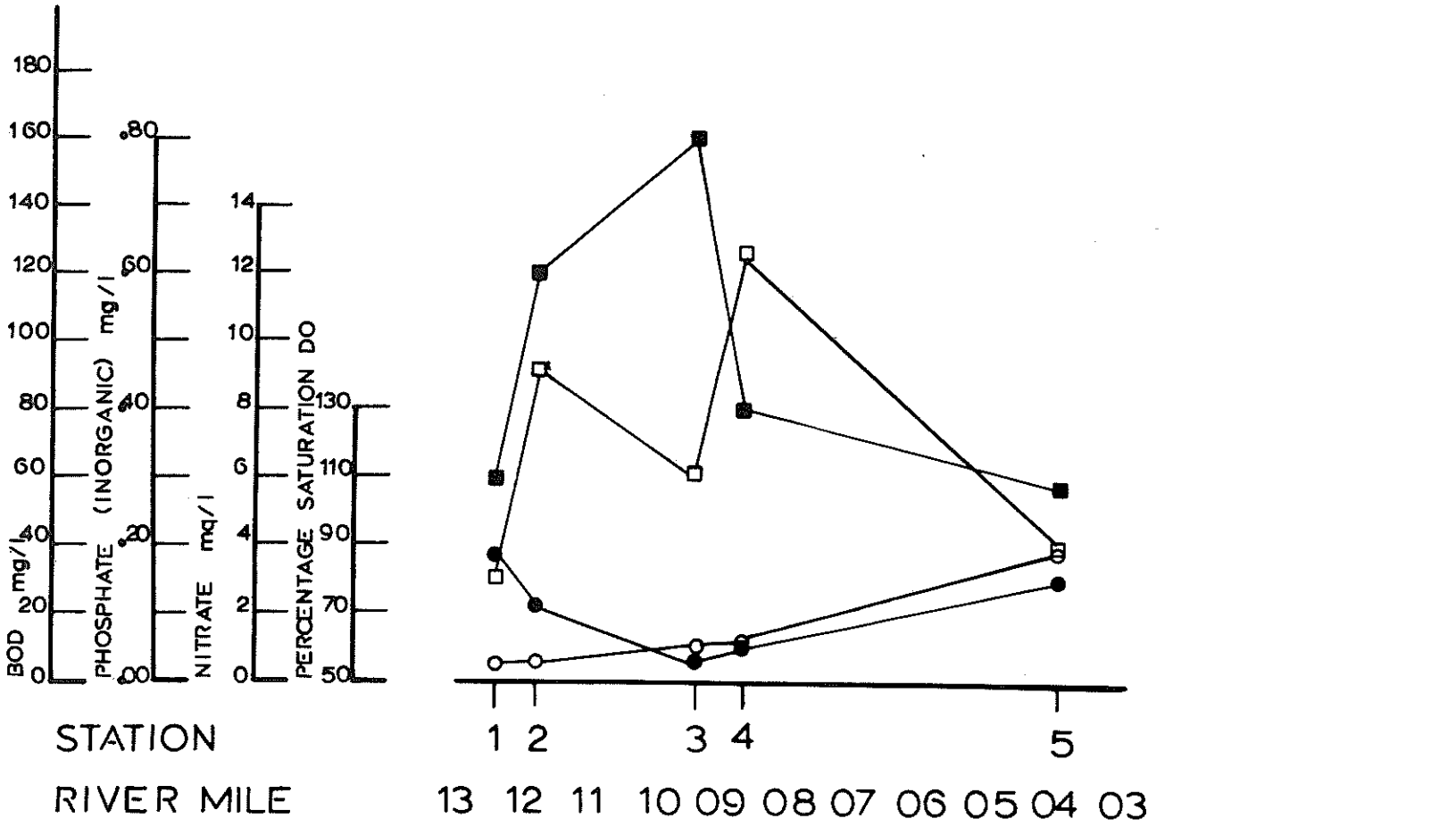

BOD mg/l
PHOSPHATE (INORGANIC) mg/l
NITRATE mg/l
PERCENTAGE SATURATION DO
STATION
1 2 3 4 5
RIVER MILE
13 12 11 10 09 08 07 06 05 04 03
BOD5
PHOSPHATE
NITRATE
PERCENTAGE SATURATION DISSOLVED OXYGEN
SAMPLE DATE 12/28/70

FIG. 11 a.

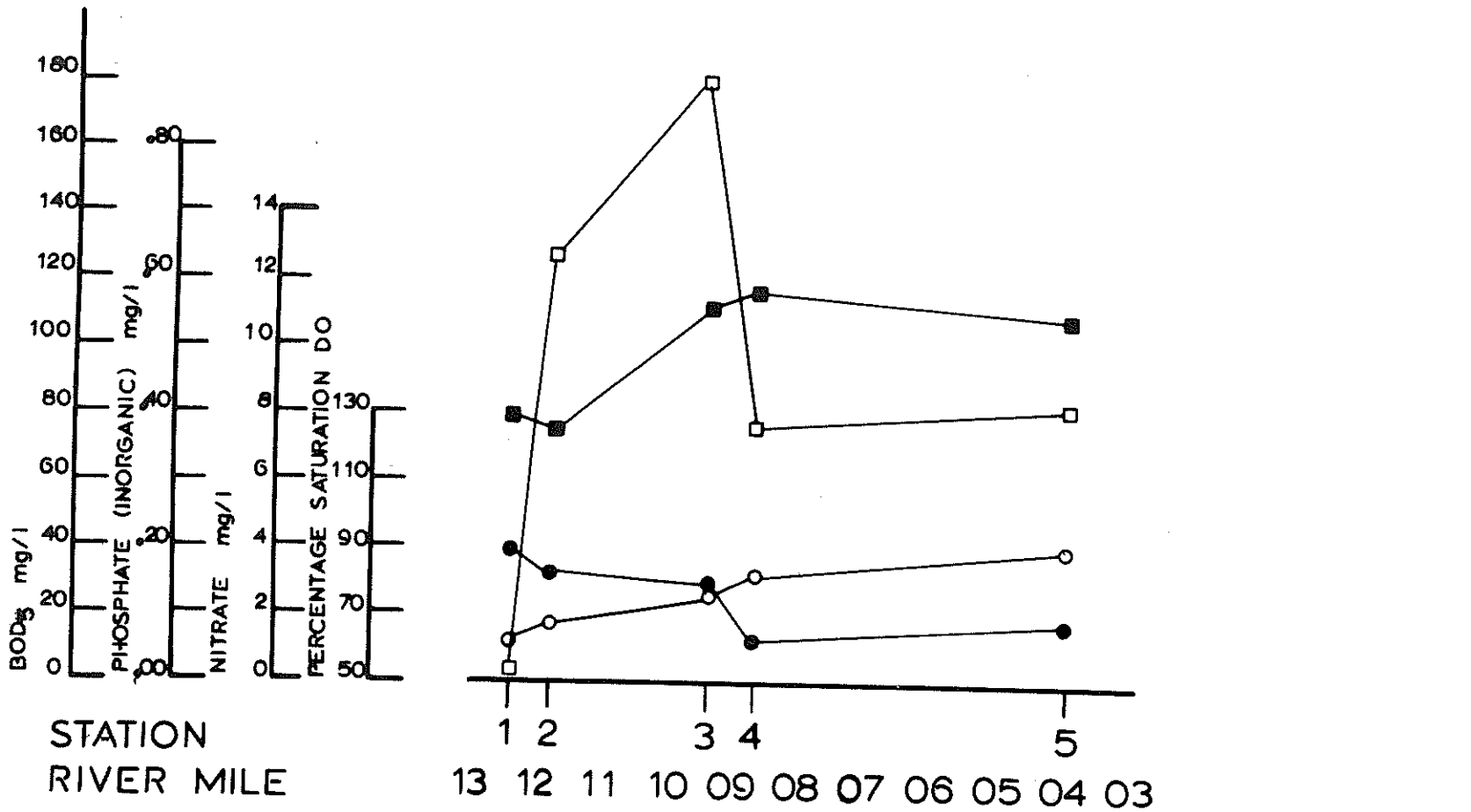


FIG. 11b.

BOD_5	□	SAMPLE DATE	11/14/72
PHOSPHATE	■		05/11/72
NITRATE	○		11/14/72
PERCENTAGE SATURATION DISSOLVED OXYGEN	●		11/14/72

Total phosphorus always increased between stations 1 and 5 on days sampled. There was usually an increase between stations 1 and 2 and always a sharp increase in phosphorus between stations 3 and 4. Evidently Idaho Frozen Foods was adding phosphorus since a high of 48.9 mg/l was found in Rock Creek below their outfall. Phosphorus ranges for the rest of the stations were from 0.042 to 2.119 mg/l. Table 2 indicates that the effluents of the Independent Meat Company and Idaho Frozen Foods, Inc. are major contributors of phosphorus to Rock Creek.

Potassium

Potassium is an essential plant nutrient and is usually less abundant than sodium in natural waters. Hem (1970) states that, "concentrations of potassium more than a few tenths of milligrams per liter, however, are decidedly unusual except in water with very high dissolved solids concentrations or in water from hot springs."

According to McKee and Wolf (1963), "1,000 to 2,000 mg/l is regarded as extreme limit of potassium permissible in drinking water. Potassium levels increased between stations 1 and 2 and varied, but usually increased, down through the lower stations. Potassium levels were low, the maximum found was 20.4 mg/l at station 4 (December 28, 1970).

Sodium

Sodium is the most abundant member of the alkali-metal group. According to the Environmental Studies Board (1972) other than natural sources of sodium can be sewage, industrial effluents and de-icing salts. The Board does not recommend a limit for sodium.

On dates sampled during this study the sodium level always increased between stations 1 and 5. Values for station 1 ranged from 18 to 66 mg/l and station 5 from 44 to 78 mg/l. The highest sodium value, 107 mg/l, was recorded at station 2.

Sulphate

The element sulfur when dissolved in water generally occurs in the sulphate state. In addition to sulphate entering water from leaching from soil and rock, Hem (1970) states that sulphate is found in rainfall. This is especially true in areas of air pollution from combustion of fossil fuel.

Sulphate was analyzed during 1970-1971 and found to increase downstream from station 1. On several sample dates the concentration at station 5 was more than double that of station 1. Station 1 had values ranging from 17 to 127 mg/l and station 5 from 54 to 155 mg/l.

Trace Metals

Hem (1970) notes that very little is known concerning the concentrations of heavy (trace) metals in natural waters.

According to the Environmental Studies Board (1972), various River Boards in England have "specified that heavy metals, individually or in total, shall not exceed 0.5 mg/l and 1.0 mg/l in sewage or industrial effluents discharged to the watershed." The total heavy metal concentration is suggested because of the synergistic effect of heavy metals in combination.

Trace metals were analyzed on two dates for Rock Creek, December 29, 1970 and April 13, 1971 (see Table 3). At no time did the concentrations exceed the recommended 0.5 mg/l. EPA (1973) analyzed trace metals for their upstream and mouth stations during November 12-16, 1971.

Standards for trace metals have not been established because of a lack of data and the synergistic effect of these metals in combination. The following suggested levels for these trace metals are taken from Garton (1975). Garton summarized EPA proposed water quality criteria for selected heavy metals to protect freshwater aquatic life. These are to be finalized in a 1976 publication.

Cadmium

EPA proposed limits:

0.03 mg/l - hardness over 100
0.004 mg/l - hardness under 100
0.003 mg/l - in hard water or
0.0004 mg/l - in soft water

Cadmium is a rare metal insoluble in water. It is used in metallurgy as an alloy, in electroplating, photography and nuclear reactors (McKee and Wolf, 1963). All stations were found to contain less than 0.001 mg/l except for station 5 on April 13, 1971, which had a value of 0.002 mg/l. EPA (1973) found levels of cadmium to be less than 0.01 mg/l for the two stations during their sampling period.

Copper

EPA proposed limits:

0.1 x 96-hr LC50 of most sensitive important species in receiving water

McKee and Wolf (1963) state that copper is insoluable and may occur in natural waters because of pollution of various types or corrosion of water pipes. A suggested level for copper is 0.02 mg/l. All stations had levels less than 0.001 mg/l. EPA (1973) reported levels less than 0.02 mg/l.

Mercury

EPA proposed limits:

Total in unfiltered water not to exceed 0.2 mg/l at any time or place. Average total in unfiltered water not to exceed 0.05 mg/l.

Hem (1970) notes that few natural waters contain detectable levels of mercury. Much mercury is introduced into waters in mining or other industrial wastes. Since mercury is toxic to life, low levels are suggested, perhaps 0.005 mg/l. Samples collected by the Idaho Department of Health in 1970 and 1971 ranged from 0.001 to less than 0.1.

EPA (1973) found levels ranging from less than 0.2 to 0.9 mg/l for the upstream station and less than 0.2 to 1.1 mg/l for the Rock Creek mouth station. These higher levels would appear to violate any recommended concentrations for mercury in natural waters.

Lead

EPA proposed limit:

0.03 mg/l

Lead is a cumulative poison to the human body. Lead may enter the body through food, air, tobacco smoke and water (McKee and Wolf, 1963). In 1962 the U.S. Public Health Service set a drinking water standard of 0.05 mg/l. All of the Rock Creek stations contained less than 0.01 mg/l. EPA (1973) reported levels less than 0.03 mg/l.

Zinc

EPA proposed limit:

0.005 x 96-hr LC50 of most sensitive important species in receiving water

Zinc may occur in trace amounts in natural waters and may enter as a pollutant from metal plating works or mine activities. A suggested level for zinc has been 0.05 mg/l. The Rock Creek stations were below this amount and on December 29, 1970 varied considerably. EPA (1973) showed concentrations of zinc ranging from less than 0.01 mg/l at their upstream station to a range of less than 0.01 to 0.03 mg/l at the mouth of Rock Creek.

Total Solids

The total solids content of wastewater is defined as all the matter that remains as residue upon evaporation at 103 to 105° C.

Sawyer and McCarty (1967) state that, "total-solids determinations are ordinarily of little value in the analysis of polluted waters and domestic wastewaters because they are difficult to interpret with any degree of accuracy." Total solids include suspended solids and dissolved solids.

McKee and Wolf (1963) after a review of the literature give the following limits for dissolved solids:

Domestic Water Supply	1000 mg/l
Irrigation	700 mg/l
Stock Watering	2500 mg/l
Fresh-water Fish and Aquatic Life	200 mg/l

Limits concerning suspended solids are listed in the following section.

Total solids analyses were made on all dates at all stations. Only 3 cases of the total solids value exceeding 1000 mg/l were found and those were for lower stations. The total solids generally increase slightly downstream from station 1.

Idaho Department of Health (1960) also reported an increase in total solids downstream from station 1. Their findings are similar to the ones reported here except that they found higher values below station 1 in December, 1959. Station 2 showed a high value of 1536 mg/l.

Suspended Solids

Suspended solids are now commonly referred to as nonfiltrable residue. Suspended solids are a portion of total solids and defined as that amount, excluding gases, existing in the nonliquid state which is dispersed in water to give a heterogeneous mixture. In natural waters suspended solids consist normally of organic detritus and plankton. Man's activities often add to the solids in water through the discharge of municipal and industrial wastes and by disturbing the soil.

High concentrations of suspended solids may result in sludge banks in streams. EPA (1973) reported such sludge banks below Amalgamated Sugar Company and Idaho Frozen Foods, Inc. Suspended solids decline in amount as one proceeds downstream from the source because they settle out of the water. The rate of settling depends on the density and size of the particles and the turbulence of the water. Oxidizable solids are steadily broken down by bacteria and may result in deoxygenation of the water.

Suspended solids may limit aquatic life by a depletion of oxygen, by shading out some or all plant life, by inhibiting certain processes of organisms or by physically covering bottom dwelling plants and animals. The Environmental Studies Board (1972) has the following maximum concentrations of suspended solids that would give the following degrees of protection to aquatic communities:

High level of protection	25 mg/l
Moderate protection	80 mg/l
Low level of protection	400 mg/l
Very low level of protection	over 400 mg/l

Table 4 shows the suspended solids analysis for Rock Creek. With the exception of May 11, 1972, out of 25 samples analyzed for suspended solids, 9 fall into the high level of protection, 10 in the moderate level of protection and 6 in the low level of protection categories for aquatic life. On May 11, 1972, Rock Creek was flowing very high and quite turbid. All stations except for the station south of Hansen showed sus-

pended solids values exceeding 400 mg/l. The large increase between the Hansen station and station 1 is probably due to runoff from agricultural lands. Not much in the way of trends is expressed by the data except that when high values were found they were below station 1.

Idaho Department of Health (1960) reported an increase in suspended solids downstream that varied similar to that of the present study except for December, 1959. On this date they reported values of 42, 844, 680, 496, and 430 mg/l for stations 1-5 respectively. These levels far exceed any found by the current study and may have been detrimental to aquatic life.

B. Bacteriological Water Quality:

Total Coliform Bacteria

Coliform bacteria have long been used as indicators of sewage pollution, although the group includes bacteria from diverse natural sources. Members of the coliform group may come from soil, water, and vegetation as well as from feces (Slack, et al, 1973).

The State of Idaho Water Quality Standards (1973) for Class A_2 waters relate to total coliform bacteria only where they can be associated with a fecal source.

Our data indicate that the total coliform bacteria counts (see Table 5) in Rock Creek usually increased greatly below station 1. On the two days that the station south of Hansen was sampled, all stations below it showed higher counts. The increase in coliform counts between the station south of Hansen and station 1 may be due to nonpoint sources. The large increase below station 1 indicates that the industries along the creek were contributing to the background coliform counts. Figure 12 shows the total coliform bacteria densities for the two dates when the station near Hansen was sampled. On the two dates that total and fecal coliform analyses were made, both increased below station 1.

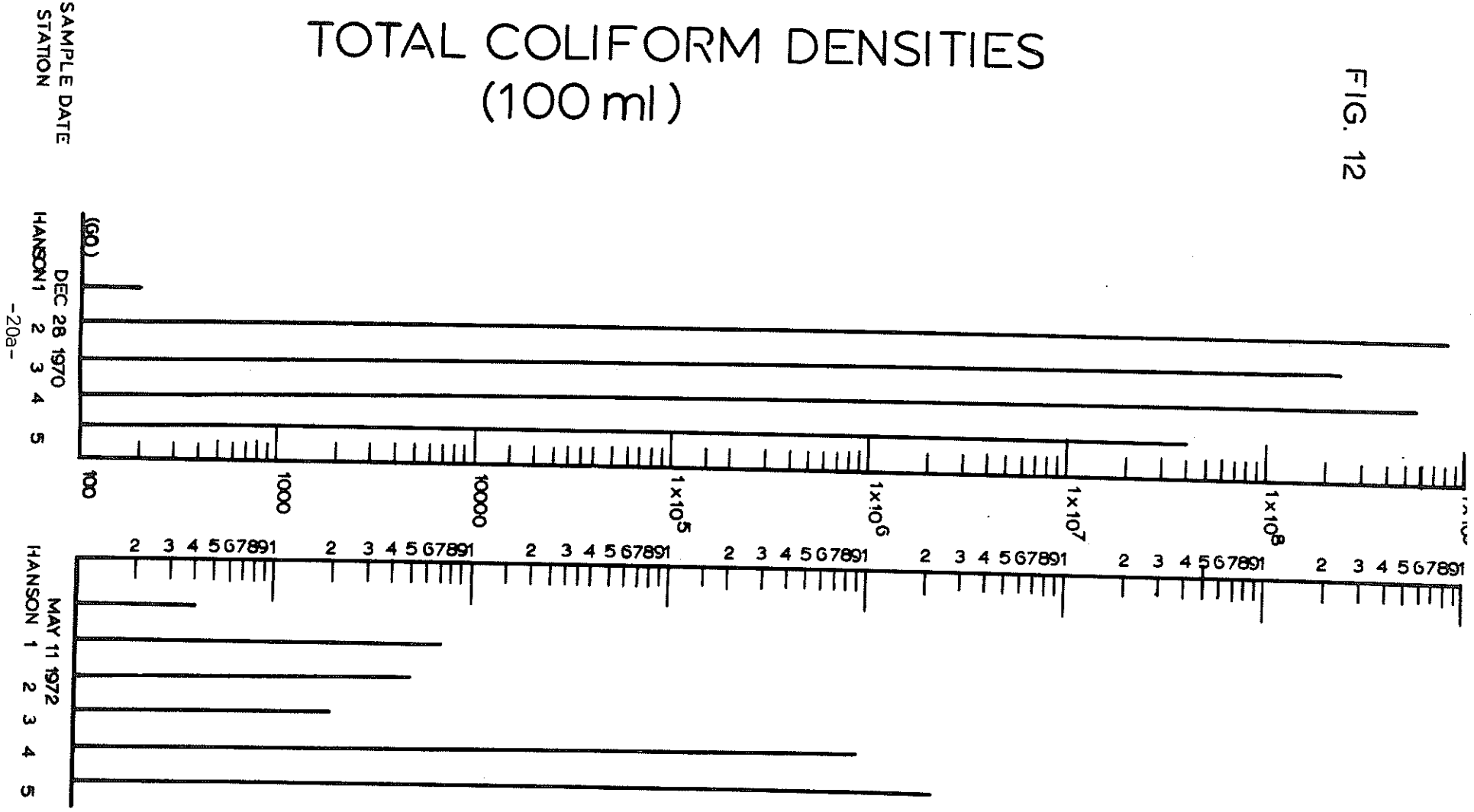
Table 6 shows total coliform counts from effluent samples of the three major industries on Rock Creek. These data indicate that the industries have been a major contribution to the bacteriological degradation of Rock Creek. EPA (1973) also showed very high values for these industries.

Idaho Department of Health (1960) reported total coliform bacterial analyses although they are not directly comparable with data obtained by the present study due to methodology. Their data agree with ours by showing a dramatic increase in bacteria numbers below station 1 to the mouth of the creek.

EPA (1973) also showed a great increase in total coliform bacteria from RM 606.8/14.7 to the mouth of Rock Creek. Large increased counts were found below our station 1. For November 12-16, 1971, they reported 40-400/100 ml for their upstream station and 80,000-22,100,000/100 ml for the mouth of Rock Creek.

TOTAL COLIFORM DENSITIES
(100 ml)

FIG. 12



These data indicate a significant amount of pollution entering Rock Creek from the several industries below station 1.

Fecal Coliform Bacteria

Fecal coliforms are that fraction of the coliform group present in the gut or feces of warm blooded animals. High fecal coliform counts probably indicate contamination from either human sewage, livestock operations or both. Exceptions to this have been reported by FWPCA (1969) indicating that in certain high carbohydrate wastes such as from sugar beet refineries, fecal coliforms can live and multiply. This may account for the increase in fecal coliforms below station 1.

Fecal coliform bacteria were analyzed on February 17, 1970 and February 4, 1974. Two different methods were used for analysis, hence the data are not directly comparable. The data does indicate that there is a substantial increase in fecal coliforms below station 1. The greatest increase was noted at station 4 on both dates. The 1970 sample for station 4 was 18,800/100 ml higher than station 3 and the 1974 sample was 1,660/100 ml higher. These data correspond with higher total coliform counts. The State of Idaho Water Quality Standards (1973) would probably have been violated at most sample stations.

EPA (1973) found that the fecal coliform counts at their most upstream station ranged from 10 to 80/100 ml. The remainder of the stations appear to have had fecal coliform densities in violation of Idaho's Water Quality Standards. The EPA report also showed very high fecal coliform values for the three major industries as follows for November 9-15, 1971:

	Nov. 9, 1971	Nov. 15, 1971
Amalgamated Sugar Company (combined effluent)	100,000	350,000/100 ml
Independent Meat Company (anaerobic lagoon effluent)	40,000	62,000/100 ml
Idaho Frozen Foods, Inc. (combined effluent)	17,000	1,600,000/100 ml

C. Status of Biological Community:

The use of benthic macroinvertebrates as indicators of stream pollution is important because they indicate longer term conditions in the stream. Chemical analysis of a given water sample indicates the condition of a body of water only at the moment the sample is taken.

Aquatic macroinvertebrates "are animals that are large enough to be seen by the unaided eye and can be retained by a U.S. Standard No. 30 sieve (28 meshes per inch, 0.595 mm openings) and live at least part of their life cycles within or upon available substrates in a body of water or water transport system," (Weber, 1973).

Table 7 lists the number of macroinvertebrates per station for the dates sampled. The samples were taken with a 1-foot2 (0.093 m2) Surber sampler and preserved in alcohol.

Gaufin (1973) states that, "the assessment of water pollution is principally a biological problem in that its primary effect is on living organisms."

Ideas concerning an ideal pollution indicator species are diverse and probably not realistic. A balance of many techniques yields the best description of stream condition - population sizes, species compositions, and the physical-chemical environments to which they are exposed.

Population sizes are shown in Table 7 with totals of all species present per station on a given date shown on the last page of the Table. Most of the samples were identified by G.L. Ralston, Idaho Department of Health and Welfare. The February 2, 1972 - February 4, 1974 collections were identified by W.H. Clark. A few groups were identified by appropriate specialists and acknowledgement is made in those cases.

Gastropoda

Few living gastropods were collected. The largest numbers 7.5 and 13/ft.^{2} were found at station 1. At least four species of gastropods were found living in Rock Creek. Many empty shells and parts of shells were found in the stream sediments indicating that at least small populations have lived in the stream for some time. Gastropods previously were reported by IDH (1960) from Rock Creek.

Harman (1974) reported that the majority of the snails found in a recent study occurred within a pH range such as that found in Rock Creek.

Alkalinity (as $CaCO_3$) may have been a limiting factor for the gastropods in Rock Creek. Harman (1974) found most snails living between 20-180 ppm alkalinity. Only one Rock Creek sample had less than 100 ppm alkalinity, most were above 200 and many lower stations had concentrations higher than 300 ppm.

The Basommataphora can tolerate low dissolved oxygen levels because they can utilize atmospheric oxygen for respiration, but dissolved oxygen is needed for completion of their life cycle. The dissolved oxygen in Rock Creek was probably adequate for the adult snails but may have been inadequate for the immatures.

Temperature does not appear to be a detrimental factor to the snails. Harman (1974) notes that temperature seldom eliminates species living within their normal geographic ranges. It does not appear that any increases in temperature were significant factors for the gastropods.

Pelecypoda

Pelecypods are clams or mussels and feed on plankton and organic detritus. According to Pennak (1953) they occur in unpolluted waters. Pelecypods were found too infrequently in the upstream stations to draw any significant conclusions concerning the effects of pollution on their distribution. Several living specimens were found at stations 1 and 2 and empty shells were found at some lower stations IDH (1960) noted that pelecypods were found in Rock Creek but specific locations were not given. It was also noted that clams are pollution intolerant.

According to Fuller (1974) two factors which have been observed in Rock Creek could have been responsible for the scarcity of the pelecypods: potassium in concentrations upwards of 4 and 7 ppm and ammonia in excess of 6 ppm. Potassium in Rock Creek often exceeded 7 ppm at the lower stations. On two sample dates, December 28, 1970 and February 2, 1972, ammonia concentrations greatly exceeded 6 ppm below station 1.

Oligochaeta

Oligochaeta are well known as inhabitants of organically polluted water. They occurred in greatest numbers at station 2 below the Amalgamated Sugar Company. Oligochaeta, like other pollution tolerant organisms, do occur in unpolluted streams but their numbers are greatest in polluted situations.

Goodnight and Whitley (1961) concluded from a study on a small stream in Indiana, "that whenever the pollution of oligochaetes constituted more than 80% of the total population of macroinvertebrates," a high degree of pollution was indicated. They also concluded percentages between 60% and 80% indicated doubtful conditions; below 60% indicated good conditions.

A comparison of the percentage of oligochaetes to total macroinvertebrates for Rock Creek showed the greatest increase between stations 1 and 2. Percentages for different dates ranged between 0% and 7% for station 1, and from 8% to 98% at station 2. The only example of a highly polluted situation in terms of oligochaetes according to Goodnight and Whitley (1961) was at station 2 on December 28, 1970, when the percentage of oligochaetes was 98%. The remaining stations had relatively low numbers of oligochaetes (see Table 7).

Nematoda

Nematodes live in stream bottom sediments and can tolerate low dissolved oxygen concentrations. Nematodes were collected only on December 28, 1970 and were present in small numbers.

Ferris et al, (1973) indicates that nematodes can be of value in understanding disturbances to aquatic habitats. Too few were collected to be of much significance in evaluating Rock Creek. IDH (1960) did not report any specimens of nematoda from Rock Creek.

Hirudinea

Leeches are commonly called "blood suckers" but most are scavengers and predators.

Leeches are another group of organisms which are considered pollution tolerant. According to Sawyer (1974) leeches require a pH of 7 or above and an alkalinity above 60 ppm $CaCO_3$. As can be seen from Table 1, the pH and alkalinity of Rock Creek meet these requirements. Sawyer (1974) also notes that most leeches require temperatures above 11° C. for reproduction. On several sample dates the temperature of Rock Creek was near 11° C. The highest populations of leeches occurred on August 17, 1971 at which time the highest temperatures (17° to 17.5° C.) were recorded for Rock Creek.

Amphipoda

Amphipods feed on a large variety of plant material. Amphipods are considered to be intolerant to pollution and normally occur in clear waters. Pennak (1953) states that they require an abundance of dissolved oxygen. Amphipods were found at least once in Rock Creek on all sample dates except February 17, 1970. Amphipods were found at station 1 on most dates sampled but only in large numbers on October 6, 1971 (Table 7). Very few to none were found at the downstream stations. The only stations having a higher population than station 1 were station 3 (October 13, 1970, 46.5/ft^2), and station 4 and 5 (August 17, 1971, 1/ft^2 and 9/ft^2 respectively). Except for the two dates mentioned above, the number of amphipods decreased below station 1 suggesting higher levels of pollution in those portions of Rock Creek.

According to Pennak (1953) most amphipod species are restricted to soft water. ACOG (1975) notes that a hardness concentration of over 20 mg/l is biologically considered hard water. Table 1 indicates that Rock Creek water is relatively hard (ranging from 136-404 ppm) and may partly explain the low populations of amphipods in Rock Creek and the decline in numbers below station 1. The alkalinity of Rock Creek ranged from 96-380 mg/l. McKee and Wolf (1963) state that a range of 100-120 mg/l is best for aquatic life, hence, Rock Creek may be unfavorable for most amphipods. However, Pennak (1953) states that Hyalella azteca is sometimes found in alkaline waters and, as can be seen from Table 1, Rock Creek is alkaline. He also states that an abundance of dissolved oxygen appears to be a necessity for most amphipods. Rock Creek did show relatively good dissolved oxygen levels on the dates sampled. According to the data presented by Smith (1973) temperatures in Rock Creek should be adequate for Gammarus.

Isopoda

Isopods are scavengers feeding mostly on dead organic matter and are inhabitants of unpolluted shallow waters (Pennak, 1953). Isopods were only collected on two dates in Rock Creek. On December 28, 1970, one specimen was found at station 4; on August 17, 1971, many were found at station 1 and a few were found at stations 1 and 3.

This data may indicate that conditions below station 1 were not generally well suited for isopods. According to Williams (1972), "the ecological status of Asellus in North America is not clear." Williams also notes that the European literature reports Asellus from organically polluted rivers and that in America the genus has been found in the zone of recovery.

IDH (1960) did not report any members of the Isopoda from Rock Creek.

INSECTA

Aquatic insects of almost entirely immature stages formed the bulk of the macroinvertebrates collected in Rock Creek.

Roback (1974) notes that insects made up from 19-52% (mean 38%) of the total fauna of 13 "undamaged stations" and in 10 "damaged stations" insects made up from 0-55% (mean 22%) of the total fauna, indicating the relative importance of the insects in the aquatic environment.

Ephemeroptera

Mayflies were the most common and abundant organism found in the bottom samples taken. Most mayflies are algal or detritus feeders. Roback (1974) recently concluded that in general mayflies are not as sensitive to pollution as has been assumed in the past. He found some mayflies in very, "highly damaged (organic and chemical) river."

Roback (1974) reports that most mayfly species studied so far occur in a BOD_5 level less than 5.9 ppm. He reports 1 Beatis found in water with a BOD_5 level of 15.4 ppm. In Rock Creek, station 1 showed the highest populations of ephemeroptera with a maximum of 100/ft^2 on December 28, 1970. The BOD_5 at station 1 on that date was 15 ppm. As pointed out previously the BOD_5 concentrations increased downstream from station 1. As can be seen from Table 7, there was an associated decrease in mayfly numbers, but many still survived in very high BOD_5 levels. Mayflies were present in water with BOD_5 levels near 100 ppm, and at station 4 on December 28, 1970, 36.5/ft^2 were found with BOD_5 concentration of 130 ppm.

Pennak (1953) states that mayflies need an abundance of oxygen and Rock Creek seems to supply an adequate amount; but, Roback (1974) reports at least some flies that can survive levels below 4 ppm. Jensen (1966) states that temperature, "is undoubtedly the most important single factor influencing mayfly distribution." As mentioned earlier, the temperatures of Rock Creek do not appear to be extreme. On December 28, 1970, there was a rise in temperature below station 1 from 2.8° C. to 11.5° C. and 11° C at stations 2 and 3 respectively. This may partly account for the sharp drop from 100/ft^2 at station 1 to 8/ft^2 at station 3 for that date.

Odonata

The nymphal stages of Odonata are predaceous. Pennak (1953) states that the aquatic immature stages of dragonflies and damselflies are rare in polluted waters.

Roback (1974), however, states that the, "Odonata are not, as a whole, a sensitive group," (to chemical parameters). He states that pH and BOD may be limiting to the Odonata, only one damselfly being found where the BOD exceeded 10 ppm. From data presented by Roback the pH of Rock Creek appears to be conducive to Odonata populations. It would seem that the BOD_5 levels of Rock Creek may have been the factor limiting the Odonata. Dragonflies were found at station 1 on October 13, 1970 where a BOD_5 reading of 96 mg/l was obtained. These could have drifted downstream. On October 6, 1971, when Odonata were found at stations 1 and 3, Rock Creek had nearly minimum BOD_5 concentrations for the study period. All stations were below 10.9 mg/l BOD_5. IDH (1960) also reported odonata from Rock Creek.

Plecoptera

Stoneflies may be carnivorous or may feed on algae or vegetable debris. Plecoptera appear to be sensitive to most chemical parameters except high pH (Roback, 1974), which has not been a problem in Rock Creek. They are normally found where there is an abundance of oxygen (Pennak, 1953) and their presence indicates good water quality.

In Rock Creek stoneflies were found on four dates (see Table 7) and only one of the occurrences was below station 1, that was station 2 on February 4, 1974. This particular collection could have resulted from drift.

Roback (1974) states that no Plecoptera were found in waters with alkalinities greater than 210 ppm. Plecoptera were found in Rock Creek on two dates where alkalinities exceeded 210 ppm, December 28, 1970 and October 6, 1971, which had concentrations of 240 and 256 ppm, respectively.

The absence of stoneflies at most sample stations and dates indicates poor water quality, especially below station 1. Plecoptera were not reported from Rock Creek by IDH (1960).

Hemiptera

Since Hemiptera were collected on only one date at one station, no significant conclusions can be drawn concerning their habits. The absence of Hemiptera may indicate an overall low quality of water for Rock Creek. However, since many genera swim in the water or on the water surface, they may have been missed by our Surber sampler.

Roback (1974) does, "not consider them to be a really significant group in the evaluation of damaged situations."

Coleoptera

Of the three groups of aquatic beetles collected (Elmidae, Haliplidae, and unidentified) only the Elmidae are of water quality significance. The

Elmidae are truly aquatic while other beetles such as the Haliplidae are mobile as adults and can enter or leave a body of water at will (Roback, 1974).

Young (1961) and Sinclair (1964) also agree that members of the family Elmidae are very sensitive to pollution and disappear from polluted waters.

Roback (1974) does state that no beetles were found where BOD was greater than 10 ppm. In Rock Creek at least three samples containing beetles were found in concentrations exceeding the 10 ppm: adult Elmidae, October 13, 1970, station 3 at 93 ppm; adult Elmidae, December 28, 1970, station 1 at 15 ppm; and Coleoptera larvae, December 28, 1970, station 5 at 40 ppm BOD_5.

Since only one collection of Elmidae was made below station 1, it is possible that the water quality of the lower segment of Rock Creek was not suitable for them. This indicates a higher level of pollution than found above station 1.

Trichoptera

Caddisfly larvae are usually omniverous and are interesting because many construct either nets or cases to live in. Trichoptera were collected on all dates that Rock Creek was sampled and IDH (1960) reported Tricoptera from the creek.

The family Hydropsychidae was the largest group of identified caddisflies, with the genus Hydropsyche dominant. The group "unidentified Trichoptera" probably consisted mainly of Hydropsychidae. Ross (1944) indicates that these Hydropsychidae are usually found in fast water and riffles, on or under stones or on wood substrate. The Hydropsychidae construct a net-like retreat.

In Rock Creek most of the Trichoptera were found at station 1 (Table 7). The relative absence of Trichoptera below station 1 indicate a polluted condition. Roback (1974) notes that no Trichoptera were found in waters, "where BOD exceeded 10.0 ppm." Of the 22 Rock Creek samples that contained Trichoptera, exactly 50% had BOD levels above 10 ppm, some as high as 93 and 96 ppm.

Invertebrate drift is one possible answer for finding the Trichoptera below station 1. However, Kroger (1974) presents data for the Snake River in Wyoming which indicates that very little drift occurs during the day. Hydropsyche drifted mainly between sunset and sunrise, with a peak at about 3:00 AM. When Hydropsyche did drift during the day, not more than one per hour was collected in the drift net. This may indicate that these Trichoptera are not drifting through the area, but some may be able to tolerate higher BOD levels than previously reported in the literature.

Lepidoptera

Lepidoptera larvae were not abundant and were found only at station 1 on two different dates in Rock Creek. These larvae feed on algae and other aquatic vegetation.

Roback (1974) indicates that not much is known concerning the ranges of chemical analysis of waters in which Lepidoptera have been found. He does indicate that out of 14 records of Paragyractis, none were found in waters exceeding 6 ppm BOD_5. The Paragyractis collected at station 1 on December 28, 1970 was found in water with a BOD level of 15 ppm. The other larvae were in BOD levels of 2.5 ppm (October 13, 1970). Evidently the high BOD levels below station 1 have excluded the Lepidoptera from that section of Rock Creek.

IDH (1970) did not report any Lepidoptera from Rock Creek.

Diptera

Three families of true flies were found in Rock Creek. Only one of these families, the Chironomidae (Tendipedidae) was reported from Rock Creek by IDH (1970).

The Psychodidae are also known as "moth flies" or "filter flies" and commonly are found associated with Septic conditions (Usinger & Kellen, 1955).

Two species of Psychoda were found February 2, 1972, one at station 3 and one at station 4. This indicates some pollution at these areas but the number found is probably too small to be significant.

Psychoda alternata was treated by Roback (1974) but only one collection with chemical analysis has been made. He reported Psychoda alternata as living under the following conditions:

pH	5.6
D.O.	4 ppm
Ammonia	0.1 ppm
Nitrite	0.01 ppm
Turbidity	49 JTU
BOD	2.2 ppm

The station at Rock Creek indicates that Psychoda alternata may also be found under the following conditions.

pH	7.2
D.O.	7.7 ppm
Ammonia	2.5 ppm
Nitrite	0.008 ppm
Turbidity	47 JTU
BOD	38 ppm

One species of Maruina was found at station 1 on April 13, 1971. Pennak (1953) states that, "all species of Maruina inhabit rapid, clear streams." This habit of Maruina probably explains its absence at other stations.

Chironomidae

According to Mason (1973) the larvae of the family Chironomidae exhibit a wide range of tolerance to environmental factors and live in both clean and polluted waters. Hence, it is necessary to carry identifications beyond the

family level to gain maximum information concerning the effects of pollution on the midge fauna. Because of time limitations during this study, the midges were not identified beyond the family level except that all of the larvae were without ventral gills. Some species contain hemoglobin in their respiratory system giving them a red color and, thus, the common name "bloodworms." These larvae can live in anerobic conditions and high numbers of them may indicate organic pollution, anerobic conditions or both.

Roback (1974) in Table XIII shows a wide variety of conditions in which various species of midges have been found The highest BOD in which a midge larva has been reported appears to be 15.44 ppm. On Rock Creek midges were found on all dates at all stations except station 4. More than half of the collections were made from waters with a higher BOD than 15.44 ppm. The maximum BOD found was 130 ppm. As mentioned earlier, IDH (1960) reported midges from Rock Creek also.

ACOG (1975) describes the Chironomidae as the most important single group in the ecology of aquatic environments.

Simuliidae

The Simuliidae larvae usually occur in the shallows of streams where the current is especially swift (Pennak, 1953). Black flies are well known to man because of their biting habits. The larvae are generally considered to be tolerant of a wide range of environmental conditions (ACOG, 1975).

On about half of the dates that Rock Creek was sampled, Simuliidae were found. The highest numbers were on station 1. Only on one date, February 4, 1974, were black flies found at station 2.

In Rock Creek there was a decrease in numbers of Simuliidae below station 1. ACOG (1975) attributed this same trend in the Boise River, in part, to water quality degradation.

Acarina

Aquatic mites were only found at station 3 on October 13, 1970. These are extremely small and may pass through the net of the Surber sampler or be lost in backwash from the net. Pennak (1953) and Barr (1973) state that aquatic mites are usually found in shallows on aquatic vegetation. Most of the sample sites in Rock Creek contained little rooted aquatic vegetation and may also be responsible for the lack of mites in the samples. Mites were not reported from Rock Creek by IDH (1960).

Status of Biological Comminity in Rock Creek -- Discussion

Examination of the macroinvertebrate community indicates that all of the segment of Rock Creek studied was polluted to some extent. The analysis of the total benthic macroinvertebrate population also indicates that conditions below station 1 are worse than at station 1 itself. The biological community appears to be able to withstand a greater amount of pollution than

that previously reported for many species by Roback (1974). Apparently Rock Creek moves fast enough through the canyon where the sample stations are located to allow some organisms to survive. For example, as shown above, even though a BOD at many stations was high, the level of dissolved oxygen was usually adequate for most organisms. This is an area that could use additional study. Even though Kroger (1974) and others have shown that drift of aquatic invertebrates occurs mainly at night, studies on Rock Creek could be made to determine if the organisms sampled during the daytime drifted to that location at night. Invertebrate drift could account for the presence of many macroinvertebrates in what appears to be quite unfavorable conditions.

Diversity indices can be a useful tool for measuring the quality of the aquatic environment and the effects of induced stresses on the structure of the macroinvertebrate community. Undisturbed waters support macroinvertebrate populations that have a large number of species and no great abundance of any one species. A disturbed situation generally has fewer species and more numbers of the species present. The highest species diversity value on Rock Creek was reported from station 1 (2.37) and the lowest value was found at station 3 (0.21). Weber (1973) indicates that the species diversity of unpolluted waters is generally between 3 and 4 and that polluted waters are generally less than 1. No station on Rock Creek had a diversity of 3 or 4 and the average value was slightly over 1 (Table 8). These indices indicate that while all Rock Creek stations examined appear polluted or disturbed, the ones below station 1 generally show a more disturbed condition.

IDH (1960) reported pollution effects also on the stations below station 1. EPA (1973) did not sample the benthic community but made the general observation that Sphaerotilus was present downstream from station 1 to the mouth. In late January, 1975, the Sphaerotilus growth was still present below station 1 at least to station 5. They also noted that industrial waste solids "blanketed portions of the stream bottom damaging aquatic life in these stream sections, including fish propogation."

Quinn (1965) studied a river in Utah that received sugar beet wastes. His conclusions were that the wastes contributed to three factors in the stream:

- Greatly increased turbidity
- High biochemical oxygen demand
- Blanketing sewage growth which covered the river bed

Effects on the Snake River

An attempt was made to assess the effects of Rock Creek on the Snake River. Due to the presence of rapids below the confluence of Rock Creek and the number of springs entering the Snake River, the desired data could not be obtained. It was possible to estimate the loadings of the Snake River just above Rock Creek and Rock Creek (see Table 10). On three dates samples were taken at the Fish and Game access above Auger Falls. Flows for

this station were estimated using USGS (1971a, 1972a and 1973a) by subtracting Rock Creek Flows (Table 9a) and Niagra Springs.

It appears that Rock Creek is a significant influence on the Snake River. The available data (Table 10) shows that Rock Creek can contribute up to 22% of the BOD_5 load of the Snake River up to 58% of total solids, 14% of the nitrate and 15% of the phosphate loadings.

Discussion:

Trend Analysis, With Time:

Rock Creek has been polluted for some time. IDH (1960) reported pollution in the creek and it appears that it may have only slightly improved by the time of the present study and the study conducted by EPA (1973). It appears that the condition of Rock Creek will greatly improve when the major industries greatly reduce their pollutant loading or are not longer discharging their effluent into it.

Trend Analysis, With Distance:

The upper reaches of Rock Creek (about RM 606.8/20) are relatively unpolluted by human activities. As Rock Creek flows towards the canyon at Twin Falls, material is picked up from runoff from agricultural lands and livestock confinement areas. As the creek enters the area near Twin Falls it receives periodic storm runoff and human litter and garbage, but the main contributors are the several industrial dischargers in Twin Falls discussed above. Stations 2, 3 and 4 are probably the most affected by pollution. As Rock Creek enters the Snake River it is still polluted, perhaps to a lesser degree than directly upstream. Figure 11 shows four parameters (BOD_5, phosphate, nitrate, and D.O.) plotted in relation to river mile.

Conclusions:

Rock Creek is still highly polluted. Changes in pH, high temperature, high concentrations of BOD_5 and nutrients along with high coliform densities are major factors influencing the poor condition of the creek.

Recommendations:

It appears that Rock Creek will improve significantly when some of the major industries are connected with and discharging to the Twin Falls Sewage Treatment Plant and the remaining industries eliminate their discharges to Rock Creek or meet EPA discharge requirements for their effluents, waste materials from confined livestock operations, and agricultural return flows should be eliminated or greatly reduced. Available technology concerning nonpoint sources should be utilized to reduce these contributions to Rock Creek.

It is expected that when the control technology is fully implemented, this segment of Rock Creek will become a fishable, swimmable water, thus meeting the goals of Public Law 92-500.

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TABLE I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, February 17, 1970

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Poleline Road
Temp. °C	6.0°	6.5°	8.0°	9.0°	**
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	8.3	8.3	8.4	7.9	7.8
Sp. Cond. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	K 25	35	**	**	80
D. O.	**	10.4	10.0	9.1	**
BOD_5	K 2	6.0	15	74	15
COD	**	**	**	**	**
Alkalinity (as $CaCO_3$)	180	196	192	248	276
Hardness	232	240	272	308	340
Calcium	55	67	67	65	80
Carbon (tot. org.)	**	**	**	**	**
Chloride	24	24	28	40	50
Iron	0.60	0.79	0.96	1.07	0.70
Magnesium	14	27	25	35	34
Manganese	0.12	0.15	0.17	0.19	0.19
Nitrate	3.5	4.3	5.0	1.7	5.2
Nitrite	**	**	**	**	**
Nitrogen (tot. Kjel.)	2.2	2.8	2.9	5.3	3.7
Ammonia	.89	1.21	1.72	2.20	1.21
Phosphate (inorg.)	0.19	0.18	0.21	0.17	0.08
Phosphorus (tot. P.)	**	**	**	**	**
Potassium	**	**	**	**	**
Sodium	33	27	38	60	42
Sulphate	62	85	90	105	155

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, October 13, 1970

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Poleline Road
Temp. ^{o}C	7.5°	10.4°	10.9°	12.2°	9.8°
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	8.0	6.6	6.9	7.0	7.0
Sp. Cond.. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	K 25	K 25	K 25	K 25	K 25
D. O.	8.8	9.1	8.2	8.1	8.6
BOD_5	2.5	96	93	81	60
COD	53	207	177	167	113
Alkalinity (as $CaCO_3$)	**	**	**	**	**
Hardness	**	**	**	**	**
Calcium	**	**	**	**	**
Carbon (tot. org.)	**	**	**	**	**
Chloride	**	**	**	**	**
Iron	**	**	**	**	**
Magnesium	**	**	**	**	**
Manganese	**	**	**	**	**
Nitrate	4.0	1.3	1.7	1.4	1.7
Nitrite	**	**	**	**	**
Nitrogen (tot. Kjel.)	5.6	5.6	7.2	6.0	7.6
Ammonia	**	**	**	**	**
Phosphate (inorg.)	0.11	0.43	0.34	0.33	0.35
Phosphorus (tot. P.)	**	**	**	**	**
Potassium	**	**	**	**	**
Sodium	**	**	**	**	**
Sulphate	**	**	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, December 28, 1970

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Poleline Road
Temp. ^{o}C	2.8°	11.5°	11.0°	11.0°	7.5
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	8.1	7.1	7.2	7.2	7.5
Sp. Cond. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	**	**	**	**	**
D. O.	10.6	7.0	5.6	5.9	8.4
BOD_5	15	92	63	130	40
COD	61	195	195	234	107
Alkalinity (as $CaCO_3$)	240	304	208	380	360
Hardness	372	180	376	320	404
Calcium	86	35	45	40	59
Carbon (tot. org.)	**	**	**	**	**
Chloride	37	37	40	46	42
Iron	0.27	1.24	0.79	0.39	0.28
Magnesium	37	22	63	53	61
Manganese	0.12	0.28	0.20	0.12	0.11
Nitrate	.5	.6	1.1	1.1	3.9
Nitrite	**	**	**	**	**
Nitrogen (tot. Kjel.)	2.0	15.2	20.0	12.0	20.8
Ammonia	0.7	15.0	9.5	11.0	17.0
Phosphate (inorg.)	0.25	0.60	0.80	0.40	0.68
Phosphorus (tot. P.)	0.183	2.119	0.381	0.547	0.277
Potassium	6.1	12.8	11.2	20.4	8.0
Sodium	39	43	44	54	74
Sulphate	100	45	50	120	140

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, April 13, 1971

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Below Canyon Hatch.
Temp. ^{o}C	4.0°	5.0°	5.5°	6.5°	8.0°
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	7.6	7.7	7.7	7.0	7.2
Sp. Cond. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	43	45	45	45	100
D. O.	9.6	9.4	9.2	8.9	8.6
BOD_5	1.8	2.0	1.5	20	17
COD	68	36	88	212	152
Alkalinity (as $CaCO_3$)	96	100	104	144	160
Hardness	156	180	148	136	192
Calcium	29	30	40	37	40
Carbon (tot. org.)	**	**	**	**	**
Chloride	13	13	11	20	26
Iron	0.77	0.81	0.99	0.28	0.13
Magnesium	20	25	12	11	22
Manganese	0.05	0.04	0.09	0.15	0.37
Nitrate	1.9	2.0	2.1	0.8	1.1
Nitrite	**	**	**	**	**
Nitrogen (tot. Kjel.)	**	**	**	**	**
Ammonia	0.2	0.3	0.3	0.3	0.3
Phosphate (inorg.)	0.04	0.04	0.08	0.08	0.04
Phosphorus (tot. P.)	**	**	**	**	**
Potassium	5.1	5.3	5.5	9.4	8.1
Sodium	18	20	21	38	44
Sulphate	17	17	21	30	54

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, August 17, 1971

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Below Canyon Hatch.
Temp. ^{o}C	17°	17°	17.2°	17.5°	17.0°
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	8.4	8.4	8.3	8.2	8.2
Sp. Cond. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	50	25	75	60	30
D. O.	9.9	10.0	9.4	8.8	9.2
BOD_5	1.0	1.3	2.3	1.8	2.7
COD	12	31	39	27	35
Alkalinity (as $CaCO_3$)	256	264	260	276	264
Hardness	308	312	276	284	296
Calcium	61	51	48	22	32
Carbon (tot. org.)	**	**	**	**	**
Chloride	32	34	32	34	46
Iron	0.25	0.15	0.33	0.30	0.26
Magnesium	37	44	37	55	52
Manganese	0.01	.02	.01	K .01	K 0.01
Nitrate	3.4	4.0	3.3	3.4	5.0
Nitrite	**	**	**	**	**
Nitrogen (tot. Kjel.)	**	**	**	**	**
Ammonia	0.3	0.3	0.4	0.3	0.3
Phosphate (inorg.)	0.32	0.30	0.40	0.40	0.28
Phosphorus (tot. P.)	**	**	**	**	**
Potassium	6.5	6.4	5.9	5.9	5.7
Sodium	58	60	60	70	75
Sulphate	127	95	140	127	125

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, October 6, 1971

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Below Canyon Hatch.
Temp. ^{o}C	11°	11°	12°	13°	14°
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	8.2	8.2	8.2	7.6	7.8
Sp. Cond. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	20	25	40	30	25
D. O.	11.8	11.8	12.0	11.2	10.2
BOD_5	1.5	0.8	1.7	L 10.9	L 4.9
COD	18.5	17.5	13.3	47.9	21.8
Alkalinity (as $CaCO_3$)	256	232	244	284	276
Hardness	280	280	312	300	312
Calcium	42	37	34	74	43
Carbon (tot. org.)	**	**	**	**	**
Chloride	30	32	28	36	40
Iron	0.23	0.48	0.63	0.54	1.03
Magnesium	42	45	55	52	49
Manganese	0.03	0.03	0.11	0.11	0.25
Nitrate	3.7	4.5	5.0	2.5	5.7
Nitrite	0.014	0.014	0.025	0.340	0.065
Nitrogen (tot. Kjel.)	5.6	9.2	5.6	6.8	6.0
Ammonia	0.2	0.2	0.2	0.2	0.2
Phosphate (inorg.)	0.18	0.12	0.16	0.60	0.41
Phosphorus (tot. P.)	0.13	0.10	0.19	0.30	0.25
Potassium	4.9	5.1	5.1	7.2	5.7
Sodium	66	68	70	64	78
Sulphate	91	107	106	112	130

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

L Value is greater than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, February 2, 1972

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Below Canyon Hatch.
Temp. ^{o}C	-.5°	9.0°	9.0°	9.0°	9.0°
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	7.6	7.2	7.2	6.7	7.1
Sp. Cond. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	15	45	47	35	20
D. O.	12.4	9.7	7.7	7.2	7.6
BOD_5	2.5	32	38	89	21
COD	15.9	76.9	85.3	83.7	61.8
Alkalinity (as $CaCO_3$)	**	**	**	**	**
Hardness	**	**	**	**	**
Calcium	**	**	**	**	**
Carbon (tot. org.)	**	**	**	**	**
Chloride	**	**	**	**	**
Iron	**	**	**	**	**
Magnesium	**	**	**	**	**
Manganese	**	**	**	**	**
Nitrate	?4.7?	0.5	0.7	1.6	0.5
Nitrite	0.045	0.009	0.008	0.070	0.006
Nitrogen (tot. Kjel.)	1.6	6.0	11.2	9.2	8.4
Ammonia	0.4	8.5	2.5	14.0	6.0
Phosphate (inorg.)	0.23	0.03	0.05	1.50	0.72
Phosphorus (tot. P.)	0.134	0.333	0.336	48.90	0.515
Potassium	**	**	**	**	**
Sodium	**	**	**	**	**
Sulphate	**	**	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, May 11, 1972

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Below Canyon Hatch.
Temp. ^{o}C	7.5°	7.5°	8.0°	9.0°	9.5°
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	7.4	7.6	7.8	7.1	7.7
Sp. Cond. (umhos/cm)	**	**	**	**	**
Turbidity (J.T.U.)	**	**	**	**	**
D. O.	9.4	9.4	9.2	9.0	8.6
BOD_5	2.2	3.1	2.1	L 8.6	L 7.7
COD	35.8	33.7	39.1	58.6	46.7
Alkalinity (as $CaCO_3$)	**	**	**	**	**
Hardness	**	**	**	**	**
Calcium	**	**	**	**	**
Carbon (tot. org.)	**	**	**	**	**
Chloride	**	**	**	**	**
Iron	**	**	**	**	**
Magnesium	**	**	**	**	**
Manganese	**	**	**	**	**
Nitrate	2.2	2.3	3.2	4.4	5.2
Nitrite	0.016	0.021	0.054	0.470	0.080
Nitrogen (tot. Kjel.)	5.2	5.2	4.6	6.6	5.2
Ammonia	0.5	0.7	0.8	1.0	0.4
Phosphate (inorg.)	0.40	0.38	0.56	0.58	0.54
Phosphorus (tot. P.)	0.336	0.388	0.499	0.603	0.541
Potassium	**	**	**	**	**
Sodium	**	**	**	**	**
Sulphate	**	**	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

L Value is greater than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, November 14, 1972

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Below Canyon Hatch.
Temp. °C	7.0°	7.5°	8.5°	10.0°	10.0°
pH (field)(S.U.)	**	**	**	**	**
pH (Lab(S.U.)	8.1	6.8	6.7	7.1	7.2
Sp. Cond. (umhos/cm)	660	720	740	810	840
Turbidity (J.T.U.)	4	12	15	22	24
D. O.	9.5	8.6	8.3	6.3	6.8
BOD_5	4.0	128	180	76	82
COD	17.7	195.2	215.1	163.2	139.4
Alkalinity (as $CaCO_3$)	224	276	292	328	340
Hardness	292	328	336	340	348
Calcium	85	91	91	86	88
Carbon (tot. org.)	**	**	**	**	**
Chloride	**	**	**	**	**
Iron	0.11	0.31	0.25	0.26	0.82
Magnesium	19	24	26	30	31
Manganese	0.05	0.06	0.07	0.19	0.19
Nitrate	5.7	1.9	2.5	3.3	4.0
Nitrite	0.013	0.041	0.029	0.021	0.023
Nitrogen (tot. Kjel.)	3.4	5.1	7.4	8.0	16.8
Ammonia	0.7	0.5	0.7	7.4	4.6
Phosphate (inorg.)	**	**	**	**	**
Phosphorus (tot. P.)	0.042	0.176	0.228	0.515	0.434
Potassium	7.7	8.3	6.5	8.0	8.7
Sodium	52	58	46	55	60
Sulphate	**	**	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E I

RESULTS OF FIELD AND LABORATORY ANALYSES*

Rock Creek Survey, February 4, 1974

	Above Amal. S.F.	Below Amal. S.F.	Below St. Hatchery	Below Ida.Froz.Fds.	Below Canyon Hatch.
Temp. ^{o}C	3.0°	5.0°	5.0°	6.0°	7.0°
pH (field)(S.U.)	8.0	7.7	7.7	7.6	7.8
pH (Lab(S.U.)	8.0	7.6	7.8	7.5	7.7
Sp. Cond. (umhos/cm)	460	550	570	670	680
Turbidity (J.T.U.)	10	14	8	11	7
D. O.	11.7	12.0	10.5	8.3	8.3
BOD_5	1.6	49	30	70	22
COD	45	96	81	127	58
Alkalinity (as $CaCO_3$)	208	212	252	260	288
Hardness	**	**	**	**	**
Calcium	**	**	**	**	**
Carbon (tot. org.)	4.6	26.4	30.0	16.2	5.6
Chloride	**	**	**	**	**
Iron	0.25	0.67	0.034	0.49	0.14
Magnesium	**	**	**	**	**
Manganese	0.02	0.04	0.09	0.10	0.02
Nitrate	6.0	8.0	6.5	13.5	9.0
Nitrite	0.038	0.079	0.115	0.050	0.018
Nitrogen (tot. Kjel.)	3.5	5.3	5.7	7.6	5.6
Ammonia	0.8	2.9	1.5	2.6	0.8
Phosphate (inorg.)	0.20	0.26	0.18	0.70	0.29
Phosphorus (tot. P.)	0.078	0.124	0.101	0.408	0.127
Potassium	5.8	10.7	9.5	13.5	7.4
Sodium	49	107	52	80	72
Sulphate	**	**	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E Ia

PERCENTAGE SATURATION OF DISSOLVED OXYGEN*

Rock Creek Station Number

DATE	1	2	3	4	5
2/17/1970	**	97	97	90	**
10/13/1970	86	94	84	86	86
12/28/1970	89	74	57.5	60	80.5
4/13/1971	83	85	83	83	83
8/17/1971	116	118	112	106	109
10/06/1971	122	122	127	121	113
2/02/1972	97	95	76	71	75
5/11/1972	89	89	89	89	86
11/14/1972	90	82	80.5	63	68
2/04/1974	99	108	94	76	78

*Calculated using Welch, 1948

**Data Not Taken

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
February 17, 1970

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C			**
Flow, MGD			**
pH, Lab			12.0
Turbidity, JTU			210
Total Solids			6120
Settleable Solids			**
Suspended Solids			**
BOD_5			2160
COD			**
Ammonia			18.50
Nitrate			80.0
Nitrite			**
Nitrogen, Total Kjel			98.5
Phosphorus, Total			**
Phosphate, Ortho			7.00
Phosphate, Inorganic			**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
October 13, 1970

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C	**	**	**
Flow, MGD	7.2	**	**
pH, Lab	5.2	7.2	6.4
Turbidity, JTU	310	335	260
Total Solids	1468	2728	2088
Settleable Solids	**	**	**
Suspended Solids	8	8	48
BOD_5	518	245	940
COD	865	501	1457
Ammonia	**	**	**
Nitrate	6.0	16.5	8.0
Nitrite	**	**	**
Nitrogen, Total Kjel	12.8	115.6	24.8
Phosphorus, Total	**	**	**
Phosphate, Ortho	2.55	15.50	4.15
Phosphate, Inorganic	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
December 28, 1970

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C	19	**	**
Flow, MGD	**	**	**
pH, Lab	6.3	6.9	9.5
Turbidity, JTU	**	**	**
Total Solids	1080	1984	1288
Settleable Solids	**	**	**
Suspended Solids	52	20	36
BOD_5	350	124	298
COD	525	402	716
Ammonia	30.0	134.0	11.0
Nitrate	0.7	26.5	0.5
Nitrite	**	**	**
Nitrogen, Total Kjel	32.0	140.0	16.8
Phosphorus, Total	1.108	19.560	13.855
Phosphate, Ortho	0.40	56.5	1.60
Phosphate, Inorganic	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
October 6, 1971

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C		**	**
Flow, MGD		**	**
pH, Lab		7.0	6.1
Turbidity, JTU		**	**
Total Solids		1716	3444
Settleable Solids		K 0.1	5.0
Suspended Solids		80	520
BOD_5		317	2100
COD		728	2578
Ammonia		137.5	19.0
Nitrate		85.0	4.0
Nitrite		K 0.001	0.015
Nitrogen, Total Kjel		164.4	64.8
Phosphorus, Total		22.82	16.30
Phosphate, Ortho		70.0	42.5
Phosphate, Inorganic		**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
February 2, 1972

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C	**	**	**
Flow, MGD	**	**	**
pH, Lab	7.4	7.5	7.2
Turbidity, JTU	100	200	105
Total Solids	1064	1636	2856
Settleable Solids	**	**	**
Suspended Solids	460	110	550
BOD_5	210	393	1815
COD	275	620	3175
Ammonia	33.0	174.0	40.00
Nitrate	1.0	20.0	62.5
Nitrite	0.085	0.140	0.085
Nitrogen, Total Kjel	20.4	161.6	79.2
Phosphorus, Total	5.380	28.525	12.225
Phosphate, Ortho	7.50	32.00	64.50
Phosphate, Inorganic	**	**	**

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
May 11, 1972

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C		**	
Flow, MGD		**	
pH, Lab		7.0	
Turbidity, JTU		**	
Total Solids		1768	
Settleable Solids		0.1	
Suspended Solids		110	
BOD_5		212	
COD		599	
Ammonia		45.0	
Nitrate		5.0	
Nitrite		0.150	
Nitrogen, Total Kjel		278.5	
Phosphorus, Total		14.34	
Phosphate, Ortho		31.00	
Phosphate, Inorganic		**	

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
November 13, 1972

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C	**		
Flow, MGD	**		
pH, Lab	6.5		
Turbidity, JTU	30		
Total Solids	2464		
Settleable Solids	3.8		
Suspended Solids	548		
BOD_5	670		
COD	1823		
Ammonia	3.5		
Nitrate	3.0		
Nitrite	.007		
Nitrogen, Total Kjel	80		
Phosphorus, Total	1.66		
Phosphate, Ortho	1.55		
Phosphate, Inorganic	2.96		

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

TABLE 2

RESULTS OF FIELD AND LABORATORY ANALYSES*

Major Industrial Effluents Discharged to Rock Creek
February 4, 1974

	Amalgamated Sugar Factory	Independent Meat Company	Idaho Frozen Foods
Temp, ^{o}C	12		**
Flow, MGD	4.1		1.3
pH, Lab	7.0		6.5
Turbidity, JTU	27		72
Total Solids	840		4956
Settleable Solids	1.3		12.0
Suspended Solids	124		436
BOD_5	295		1676
COD	384		3072
Ammonia	18.5		46.0
Nitrate	11.3		82.5
Nitrite	3.000		3.700
Nitrogen, Total Kjel	17.6		99.6
Phosphorus, Total	0.0349		15.58
Phosphate, Ortho	1.04		44.80
Phosphate, Inorganic	1.05		46.50

* All results are reported in parts per million unless otherwise specified.

** Parameter not analysed.

K Value is less than that given.

T A B L E 3

TRACE METALS ANALYSES - ROCK CREEK

DATE	STATION NUMBER	TRACE METAL* Cd	Cu	Hg	Pb	Zn
12/29/70	S. Hansen	<0.001	<0.001	<0.1	<0.01	0.045
	1	<0.001	<0.001	<0.1	<0.01	<0.001
	2	<0.001	<0.001	<0.1	<0.01	0.019
	3	<0.001	<0.001	<0.1	<0.01	0.028
	4	<0.001	<0.001	<0.1	<0.01	0.009
	5	<0.001	<0.001	<0.1	<0.01	0.040
4/13/71	1	<0.001	<0.001	0.0012	<0.01	<0.001
	2	<0.001	<0.001	0.0012	<0.01	<0.001
	3	**	**	**	**	**
	4	<0.001	<0.001	0.0013	<0.01	<0.001
	5	0.002	<0.001	0.0010	<0.01	<0.001

* Results in mg/l

** Station not sampled

T A B L E 4

SUSPENDED AND TOTAL SOLIDS ANALYSES FOR ROCK CREEK*

	Station Number											
	S. of Hansen		1		2		3		4		5	
DATE	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS	SS	TS
2/17/70	**	**	**	604	**	708	**	756	**	816	**	840
10/13/70	**	**	4	746	4	792	4	820	4	880	4	864
12/28/70	**	**	24	664	36	580	52	1080	48	1040	28	660
4/13/71	**	**	**	536	**	572	**	544	**	664	**	1032
8/17/71	**	**	**	620	**	568	**	616	**	644	**	636
10/6/71	**	**	**	596	**	596	**	636	**	644	**	680
2/2/72	**	**	44	520	144	640	132	760	176	796	80	832
5/11/72	148	384	444	764	436	772	536	768	400	852	480	732
11/14/72	**	**	32	684	72	900	92	912	104	928	136	980
2/4/74	**	**	24	537	24	548	28	624	44	716	16	720

*Results in mg/l

**Parameter not analyzed

TABLE 5

RESULTS OF BACTERIOLOGICAL ANALYSES

ROCK CREEK

(Expressed as number per 100 ml.)

DATE		STATION NUMBER					
		South of Hansen	1	2	3	4	5
Feb. 17, 1970 (1)	T	*	>1,600	16,000	16,000	34,800	17,200
Feb. 17, 1970	F	*	1,600	9,200	16,000	34,800	< 200
Oct. 13, 1970	T	*	5,700	TNTC	TNTC	TNTC	TNTC
Oct. 19, 1970	T	*	*	250,000,000	130,000,000	11,000,000	*
Dec. 28, 1970	T	60	200	800,000,000	230,000,000	580,000,000	42,000,000
Apr. 13, 1971	T	*	TNTC	TNTC	42,000	1,200,000	76,000,000
Aug. 17, 1971	T	*	1,600	2,760	9,200	8,400	28,000
Oct. 6, 1971	T	*	3,200	2,300	7,600	28,000,000	41,000,000
Feb. 2, 1972	T	*	120	58,000	58,000	6,800,000	4,400,000
May 11, 1972	T	400	7,200	5,000	2,000	2,400,000	960,000
Nov. 14, 1972	T	*	100	220,000	560,000	680,000	760,000
Feb. 4, 1974	T	*	120	110,000	46,000	600,000	110,000
Feb. 4, 1974	F	*	94	1,200	340	2,000	2,200

(1) This date MPN, the following are MF
TNTC = Too numerous to count
T = Total Coliform
F = Fecal Coliform

T A B L E 6

TOTAL COLIFORM DENSITIES OF
EFFLUENTS ENTERING ROCK CREEK

Total Coliforms (MF)/ 100 ml

DATE	AMALGAMATED SUGAR COMPANY	INDEPENDENT MEAT COMPANY	IDAHO FROZEN FOODS INC.
October 13, 1970	*	74,000,000	110,000,000
October 19, 1970	900,000,000	*	120,000
December 28, 1970	105,000,000	460,000	90,000
January 12, 197	*	*	6,600,000
February 23, 1971	*	2,000,000	*
April 13, 1971	*	70,000,000	----
April 15, 1971	*	*	*
October 18, 1971	85,000	*	120,000,000
November 22, 1971	*	*	146,000
February 2, 1972	80,000	*	120,000
June 20, 1973	*	800,000	*
November 15, 1973	4,200,000	*	*
February 4, 1974	540,000	*	31,000,000

* Not Sampled

TABLE 7

BENTHIC MACROINVERTEBRATES - ROCK CREEK

ORGANISM	DATE	(SAMPLING STATIONS (Number/ft.^{2})					
		1	2	3	4	5	6
GASTROPODA							
MESOGASTROPODA							
Bulimidae							
Amnicola Sp.	13-X-70	13	0	0	0	P	*
BASOMMATOPHORA							
Lymnaeidae							
Lymnaea sp.	13-X-70	0	0	0.5	0	0	*
Physidae	4-11-74	0	0	P	0	0	*
Physa sp.	13-X-70	1	0	0	0	0	*
Planorbidae	13-X-70	0	0	0	0	P	*
UNIDENTIFIED GASTROPODA	13-X-70	0	P	0	0	0	*
	13-IV-71	0	0	1.5	0	*	*
	17-VIII-71	0	0	1.5	0	0	*
	6-X-71	7.5	3.5	2	0	0	*
PELECYPODA	13-X-70	0.5	P	0	0	0	*
larva	28-XII-70	0.5	0	0	0	0	*
OLIGOCHAETA	17-11-70	*	0	0	0	0	*
	13-X-70	10.5	P	1.5	1	P	*
	28-XII-70	95	182	3	19.5	P	*
	13-IV-71	3	38	1	10	*	*
	17-VIII-71	0	237	1	9	13	*
	6-X-71	38	3.5	8.5	2	0.5	*
	2-11-72	*	22	2	6	2	*
	14-XI-72	0	0	*	*	0	*
	4-11-74	19	P	P	P	0	*
NEMATODA	28-XII-70	11	0	0	0.5	0	*
HIRUDINEA	17-11-70	*	0	0	*	P	0
	13-X-70	3.5	P	0.5	2.5	0	*
	28-XII-70	3.5	2	0	0	P	*

T A B L E 7

BENTHIC MACROINVERTEBRATES - ROCK CREEK

ORGANISM	DATE	(SAMPLING STATIONS (Number/ft.^{2})					
		1	2	3	4	5	6
HIRUDINEA	13-IV-71	1.5	0	0	0	*	*
	17-VIII-71	0	4	1	9	39	*
	6-X-71	2	1	19	0.5	6	*
	2-II-72	*	0	0	1	9	*
	14-XI-72	0	0	*	*	0	*
	4-II-74	0	0	0	P	P	*
CRUSTACEA							
AMPHIPODA							
Talitridae							
Hyalella azteca (Saussure)	13-X-70	5.5	P	46.5	0	0	*
	13-IV-71	1.5	0	0	0	*	*
	4-II-74	.5	0	0	0	0	*
Gammaridae							
Gammarus sp.	28-XII-70	6	0	0.5	0	0	*
UNIDENTIFIED AMPHIPODA	17-II-70	*	0	P	*	0	0
	6-X-71	120	1.5	0.5	0	0	*
	17-VIII-71	0	0	0	1	9	*
ISOPODA							
Asellidae							
Asellus sp.	17-VIII-71	146	11	9	0	0	*
UNIDENTIFIED ISOPODA	28-XII-70	0	0	0	0.5	0	*
INSECTA							
EPHEMEROPTERA (Nymphs)							
Baetidae							
Baetis sp.	17-II-70	*	P	P	*	0	0
	13-X-70	113	P	55.5	44.5	P	*
	28-XII-70	973	P	8	36.5	P	*
	13-IV-71	6.5	1	34	251	*	*
	17-VIII-71	177	0	0	0	0	*
	2-II-72	*	78	29	13	0	*
	14-XI-72	P	*	*	*	0	*
	4-II-74	214	P	P	P	P	*
Unidentified Baetidae	17-II-70	*	P	0	*	0	*

TABLE 7

BENTHIC MACROINVERTEBRATES - ROCK CREEK

ORGANISM	DATE	(SAMPLING STATIONS (Number/ft.^{2})					
		1	2	3	4	5	6
INSECTA (continued)							
Heptageniidae	4-11-74	8	0	0	0	0	*
Ephemerellidae							
Ephemerella sp.	13-IV-71	0.5	0	0	0	*	*
	17-VIII-71	560	0	0	0	0	*
Tricorythidae							
Tricorythodes sp.	28-XII-71	29	0	0	0	0	*
	13-IV-71	4	0	0	0	*	*
Polymitancidae							
Ephoron sp.	17-VIII-71	38	0	0	0	0	*
UNIDENTIFIED EPHEMEROPTERA	17-VIII-71	0	461	30	180	117	*
	6-X-71	140	17.5	102.5	107.5	78	*
ODONATA (nymphs)							
Libellulidae							
Erythemis sp.	13-X-70	0	P	0	0	0	*
UNIDENTIFIED ODONATA	6-X-71	1	0	0.5	0	0	*
PLECOPTERA (nymphs)							
Peroldidae							
Isoperla sp	4-11-74	9	P	0	0	0	*
UNIDENTIFIED PLECOPTERA	28-XII-70	1	0	0	0	0	*
	13-IV-71	1.5	0	0	0	*	*
	6-X-71	1.5	0	0	0	0	*
HEMIPTERA	13-X-70	0	0	0	1.5	0	*
COLEOPTERA							
Elmidae (1)							
Microcylloepus sp.							
(larvae)	4-11-74	2	0	0	0	0	*
UNIDENTIFIED ELMIDAE							
(larvae)	13-X-70	2	0	0	0	0	*
" "							
(adult)	13-X-70	0	0	0.5	0	0	*
	28-VII-70	4	0	0	0	0	*
Haliplidae							
Brychius sp. (adult)	13-IV-71	0.5	0	0	0	*	*

TABLE 7

BENTHIC MACROINVERTEBRATES - ROCK CREEK

ORGANISM	DATE	(SAMPLING STATIONS (Number/ft.)					
		1	2	3	4	5	6
INSECTA (continued)							
UNIDENTIFIED COLEOPTERA							
(larvae)	28-XII-70	0	0	0	0	P	*
	6-X-71	4	0	0	0	1	*
TRICHOPTERA (larvae)							
Hydropsychidae							
Smicridea sp.	13-X-70	1	0	0	0	0	*
Cheumatopsyche sp.	13-X-70	2.5	0	0	0	0	*
Hydropsyche sp.	13-X-70	358.5	P	34.5	1	0	*
	28-XII-70	169.5	0	0.5	0	P	*
	13-IV-71	48	0.5	2	0	*	*
	17-VIII-71	314	0	0	0	0	*
	2-II-72	*	0	2	0	1	*
	14-XI-72	P	0	*	*	0	*
	4-II-74	35	P	P	0	P	*
Parapsyche almata Ross (2)	4-II-74	0	P	0	0	0	*
Hydroptilidae							
Hydroptila sp.	17-VIII-71	5	0	0	0	0	*
Limnephilidae							
Limnephilus sp.	17-VIII-71	2	0	0	0	0	*
Glossogomatidae							
Glossosoma sp.	17-VIII-71	9	0	0	0	0	*
UNIDENTIFIED TRICHOPTERA	17-VIII-71	5	45	51	31	40	*
	6-X-71	648	36	127	15	96	*
	4-II-74	1	0	0	0	0	*
LEPIDOPTERA (larvae)							
Pyralidae							
Parargyractis sp.	28-XII-70	0.5	0	0	0	0	*
Cataclysta sp.		1	0	0	0	0	*
Unidentified Pyralidae	13-X-70	4	0	0	0	0	*

TABLE 7

BENTHIC MACROINVERTEBRATES - ROCK CREEK

ORGANISM	DATE	SAMPLING STATIONS (Number/ft.^{2})					
		1	2	3	4	5	6
DIPTERA							
Psychodidae							
Maruina sp	13-IV-71	1	0	0	0	*	*
Psychoda alternata Say	2-II-72	*	0	1	0	0	*
Psychoda severini Tonnoir	2-II-72	*	0	0	1	0	*
Chironomidae (larvae, without ventral gills)	17-II-70	*	P	P	*	P	0
	13-X-70	38	P	20.5	30.5	P	*
	28-XII-70	90	0	62	5.5	9	*
	13-IV-71	6.5	1	33	42	*	*
	17-VIII-71	137	38	6	31	120	*
	6-X-71	38	1	38	10.5	59.5	*
	2-II-72	*	2	8	4	4	*
	14-XI-72	P	P	0	0	P	*
	4-II-74	79	P	P	0	P	*
Chironomidae (Pupae)	2-II-72	*	0	3	3	0	*
	14-XI-72	P	0	*	*	0	*
	4-II-72	0	0	P	P	0	*
Simuliidae							
Simulium sp. (larvae)	13-X-70	47	0	1	2	0	*
	28-XII-70	212	0	13	4.5	P	*
	13-IV-71	0.5	0	0	0	*	*
	17-VIII-71	57	0	0	2	3	*
	14-XI-72	P	0	*	*	0	*
	4-II-74	3	P	P	0	P	*
Simulium sp. (pupa)	4-II-74	1	0	0	0	0	*
UNIDENTIFIED DIPTERA (larvae)	6-X-71	12	0	4	1.5	8	*
ACARINA	13-X-70	0	0	0.5	0	*	*

* Station not sampled
P Present in qualitative sample

(1) det. H.P. Brown, 1974
(2) det. D.R. Givens, 1975

TABLE 7

BENTHIC MACROINVERTEBRATES - Rock Creek

	DATE	(SAMPLING STATIONS (Number/ft.^{2})				
		1	2	3	4	5
TOTAL NUMBER ORGANISMS	Oct. 13, 1970	597.5	*	163	83	*
	Dec. 28, 1970	1595.5	186	344	137	*
	Apr. 13, 1971	149	81	73	303	*
	Aug. 17, 1971	1450	796	101	261	338
	Oct. 6, 1971	946	45	238	130	201
	Feb. 2, 1972	*	102	45	29	16
	Feb. 4, 1974	286	*	*	*	*

* Not Sampled or Qualitative Sample Only.

TABLE 8

SPECIES DIVERSITY VALUES

ROCK CREEK

DATE	STATION NUMBERS				
	1	2	3	4	5
October 13, 1970	1.6325	*	1.5945	0.3978	0.9100
December 28, 1970	1.9462	*	1.3015	1.8309	*
April 13, 1971	1.9698	0.4103	1.4475	0.8922	*
August 17, 1971	2.3717	1.5172	1.7521	1.4624	2.1385
October 6, 1971	0.9836	2.1290	0.2085	0.9969	1.9152
February 2, 1972	*	0.8826	1.4262	1.9858	1.5917
February 4, 1974	0.7064	*	*	*	*

* Not Sampled or Qualitative Sample Only

Margalef's diversity index was used to compute species diversity values

$$\bar{H} = 3.3219 \left(\text{Log}_{10} N - \frac{\sum n_i \text{ Log}_{10} n_i}{N} \right)$$

where n_i = the number of individuals of the i^{th} species

N = the total number of individuals of all species

T A B L E 9

FLOW (CFS) FOR ROCK CREEK, 19 KM SOUTH OF HANSEN*

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
1970	28.6	23.9	19.5	37.9	243	89.4	22.6	10.1	9.31	10.2	13.2	13.5
1971	44.8	38.5	61.0	149	256	80.5	21.8	10.8	11.6	12.3	11.6	16.7
1972	43.7	34.0	96.6	136	256	94.7	30.2	13.6	12.9	15.5	16.3	18.1
1974	23.1	16.4	32.0	109	154	38.3	16.2	9.9	10.7	**	**	**

*From USGS 1971, 1972(a), 1973, 1974

**Data Not Available

TABLE 9 a

FLOW RECORDS - ROCK CREEK NEAR SNAKE RIVER, TWIN FALLS COUNTY **

Monthly Flow, CFS, (Acre-Feet)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1968							8,067 (16,000)	8,319 (16,500)	8,067 (16,000)	7,361 (14,600)	4,739 (9,400)	4,790 (9,500)	
1969	4,034 (8,000)	3,782 (7,500)	4,034 (8,000)	6,403 (12,700)	6,958 (13,800)	7,311 (14,500)	7,916 (15,700)	7,815 (15,500)	7,966 (15,800)	6,655 (13,200)	4,941 (9,800)	5,294 (10,500)	73,109 (145,000)
1970	3,403 (6,750)	4,145 (8,220)	3,297 (6,540)	3,928 (7,790)	9,161 (18,170)	6,555 (13,000)	6,817 (13,520)	7,560 (14,994)	8,737 (17,328)	6,381 (12,656)	3,077 (6,102)	4,980 (9,878)	68,041 (134,948)
1971	9,215 (18,276)	5,338 (10,588)	3,458 (6,858)	6,469 (12,831)	10,035 (19,902)	7,072 (14,026)	7,326 (14,529)	8,339 (16,540)	9,888 (19,611)	8,794 (17,441)	5,631 (11,169)	4,542 (9,008)	86,104 (170,773)
1972	5,097 (10,104)	6,325 (12,544)	8,336 (16,533)	7,207 (14,294)	11,725 (23,254)	9,576 (18,992)	7,296 (14,470)	8,738 (17,330)	10,007 (19,848)	6,542 (12,976)	5,774 (11,452)	6,069 (12,037)	92,694 (183,844)
1973	5,221 (10,356)	2,807 (5,567)	3,184 (6,314)	4,454 (8,833)	5,565 (10,839)	6,043 (11,986)	6,382 (12,658)	6,565 (13,021)	*	*	*	*	
1974	*	*	*	*	7,559 (15,388)	6,153 (12,203)	7,562 (14,998)	7,893 (15,655)	8,606 (17,068)				

(*) Recorder malfunction

Maximum and Minimum Flows

	Maximum			Minimum		
	Ft.	cfs	Date	Ft.	cfs	Date
1968	2.20	314	28 Aug	0.63	117	27 Dec
1969	2.22	317	27 June	0.94	151	28 Nov
1970	3.05	425	07 May	0.14	63	23 Nov
1971	6.24	1060	18 Jan	0.18	70	20 March
1972	3.58	534	09 June	0.68	122	06 Jan
1973	2.55	336	23 Sept	0.21	73	19 March

Current Meter measurements from July 1968 to March 1969. Recorder installed March 1969. Improved computer program for calculating flow rate and volume in August 1970. Current meter data fit to curve:

$$Q = a + bh^{1/2} + ch^{2/3} \text{ of cfs} + 39.09 + 63.77h^{1/2} + 55.30H^{3/2} \quad (r2=0.998)$$

**Date courtesy J.A. Bondurant, Snake River Conservation Research Center, Kimberly, Idaho

TABLE 10

SNAKE RIVER WATER QUALITY ABOVE ROCK CREEK COMPARED WITH STATION 5 (NEAR MOUTH OF ROCK CREEK)

Parameter	Rock Creek (Station 5) February 17, 1970		Snake River Above Rock Creek February 18, 1970	
	Concentration (mg/l)	Loadings Pounds/day	Concentration (mg/l)	Loadings Pounds/day
Calcium	80	98,746	59	1,367,443
Magnesium	34	27,122	28	648,956
Iron	0.7	588	0.12	2,781
Manganese	0.19	152	0.53	12,284
Sodium	42	33,504	40	927,080
Chloride	50	39,886	42	973,434
Sulphate	155	123,647	43	996,611
Nitrate	5.2	4,148	3.5	81,119
Ammonia	1.21	965	0.93	21,554
Nitrogen (T. Kjel.)	3.7	2,952	4.1	95,025
Phosphate	0.08	64	0.28	6,489
BOD_5	15	11,966	6	139,000
Total Solids	840	670,085	496	1,149,579
Est. Flow - 148 CFS			Est. Flow - 4300 CFS	

TABLE 10

SNAKE RIVER WATER QUALITY ABOVE ROCK CREEK COMPARED WITH STATION 5 (NEAR MOUTH OF ROCK CREEK)

	Rock Creek (Station 5) August 17, 1971		Snake River Above Rock Creek August 17, 1971	
Parameter	Concentration (mg/l)	Loadings Pounds/day	Concentration (mg/l)	Loadings Pounds/day
Calcium	32	46,397	32	310,464
Magnesium	52	75,395	43	317,186
Iron	0.26	377	0.1	970
Manganese	<0.01	<14	<0.01	<97
Sodium	75	108,743	65	630,630
Chloride	46	66,696	42	407,484
Sulphate	125	181,239	76	737,352
Nitrate	5	7,249	6.1	59,182
Ammonia	0.3	435	0.2	2,911
Nitrogen (T. Kjel.)	---	---	---	
Phosphate	0.28	406	0.28	2,717
BOD_5	2.7	3,915	1.8	17,464
Total Solids	636	922,143	524	5,083,848

Est. Flow - 269 CFS

Est. Flow - 1800 CFS

TABLE 10

SNAKE RIVER WATER QUALITY ABOVE ROCK CREEK COMPARED WITH STATION 5
(NEAR MOUTH OF ROCK CREEK)

	Rock Creek (Station 5) October 6, 1971		Snake River Above Rock Creek October 4, 1971	
Parameter	Concentration (mg/l)	Loadings Pounds/day	Concentration (mg/l)	Loadings Pounds/day
Calcium	43	65,823	32	1,466,080
Magnesium	49	75,007	21	962,115
Iron	1.03	1,577	0.38	17,410
Manganese	0.25	883	0.03	1,374
Sodium	78	119,399	28	1,282,820
Chloride	40	61,230	22	1,007,930
Sulphate	130	198,999	22	1,007,930
Nitrate	5.7	8,725	1.4	64,141
Ammonia	0.2	306	0.1	4,582
Nitrogen (T. Kjel.)	6	9,185	---	
Phosphate	0.41	628	1.14	52,229
BOD_5	< 4.9	< 7,501	2.5	114,538
Total Solids	680	1,040,917	324	14,844,060
	Est. Flow - 284 CFS		Est. Flow - 8500 CFS	