PREIMPOUNDMENT WATER QUALITY OF RAYSTOWN BRANCH JUNIATA RIVER AND SIX TRIBUTARY STREAMS, SOUTH-CENTRAL PENNSYLVANIA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 76-57

Prepared in cooperation with the

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Baltimore District

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UNITED STATES DEPARTMENT OF THE INTERIOR

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CONTENTS

ILLUSTRATIONS

TABLES

FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

English	*Multiply by*	*Metric*
Feet (ft)	.3048	Metres (m)
Miles (mi)	1.609	Kilometres (km)
Acres	.4047	Hectares (ha)
Square Miles (mi^2)	2.590	Square Kilometres (km^2)
Acre-feet (acre-ft)	.001233	Cubic hectometres (hm^3)
Cubic feet per second (ft^3/s)	.02832	Cubic metres per second (m^3/s)

PREIMPOUNDMENT WATER QUALITY OF

RAYSTOWN BRANCH JUNIATA RIVER AND SIX

TRIBUTARY STREAMS, SOUTH-CENTRAL PENNSYLVANIA

By Donald R. Williams

ABSTRACT

The Raystown Branch Juniata River watershed, which is the main water source for Raystown Lake, is a 960-square-mile (2,490 square kilometres) drainage basin in south-central Pennsylvania. Preimpoundment water-quality data were collected on the Raystown Branch and six tributary streams in the basin. Specific conductance values varied inversely with water discharge. The pH values were extremely low only at the Shoup Run site. Dissolved oxygen concentrations observed at all sites indicated a relatively high oxygen saturation level throughout the year. Seasonal variations in nitrate-N and orthophosphate-P levels were measured at the main inflow station at Saxton, Pa. The highest concentrations of nitrate-N and orthophosphate-P occurred in the winter and spring months and the lowest concentrations were measured during the summer and fall. Bacteriological data indicated no excessive amounts of fecal matter present at the inflows.

Soil samples collected at four sites in the impoundment area were predominantly of the Barbour, Philo, and Basher series, which are considered to be highly fertile soils with silt-loam and sandy-loam textures. Morphological features of the lake basin and low nutrient levels at the inflows should prevent excessive weed growth around the lake perimeter.

INTRODUCTION

Purpose and Scope

This interim report presents the preimpoundment water-quality of the Raystown Branch Juniata River and six tributary streams that have perennial flow into the impoundment area. Information collected on water quality, bacteria, sediment, and soils are used to describe the preimpoundment environmental condition and to predict the physical, chemical, and biological characteristics of the reservoir.

Background Information

The Raystown Branch Juniata River drainage basin is shown in figure 1. The 960 mi^2 (2,490 km^2) basin lies in south-central Pennsylvania in Huntingdon, Bedford, and Fulton Counties. The nearest large city is Altoona, Pa. The watershed is approximately 57 mi (92 km) long with a maximum width of about 35 mi (56 km). It is bounded by the drainage divide of the Frankstown Branch to the north, the Allegheny Front to the west, the Potomac River divide to the south, and the Augwick Creek divide to the east.

The Raystown Branch rises on the west side of the Allegheny Front near Roxbury, Pa., and flows in an easterly direction for about 48 mi (77 km), then northerly in a generally sinuous course for about 76 mi (122 km) to its confluence with the Juniata River.

The Raystown Branch watershed is in the Ridge and Valley section of the Appalachian Highlands physiographic province and is underlain principally by shale and sandstone. The watershed is mostly wooded with only a small part in cultivation.

Construction of the dam was completed by the U.S. Army Corps of Engineers, Baltimore District, in November 1973. The dam is on the Raystown Branch, 5.5 mi (8.8 km) upstream from its confluence with the Juniata River. Raystown Lake was designed to provide flood control, recreation, and water-quality control of the outflowing water and to enhance the fishery resource. The recreation pool at elevation 786 ft (240 m) above mean sea level will have an area of 8,300 acres (3,360 ha) and will extend 30 mi (48 km) upstream. The flood control pool at elevation 812 ft (247 m) above mean sea level, with a surface area of 10,800 acres (4,370 ha) will extend 34 mi (55 km) upstream.

The Raystown Branch Juniata River at Saxton, Pa., (1-5620) has a drainage area of 756 mi^2 (1,958 km^2) which is 79 percent of the drainage area controlled by the dam. The quality of water at this site is essentially the quality of water that is filling the lake. The six tributary sites have a combined drainage area of 155 mi^2 (401 km^2), which is only 16 percent of the controlled drainage area.

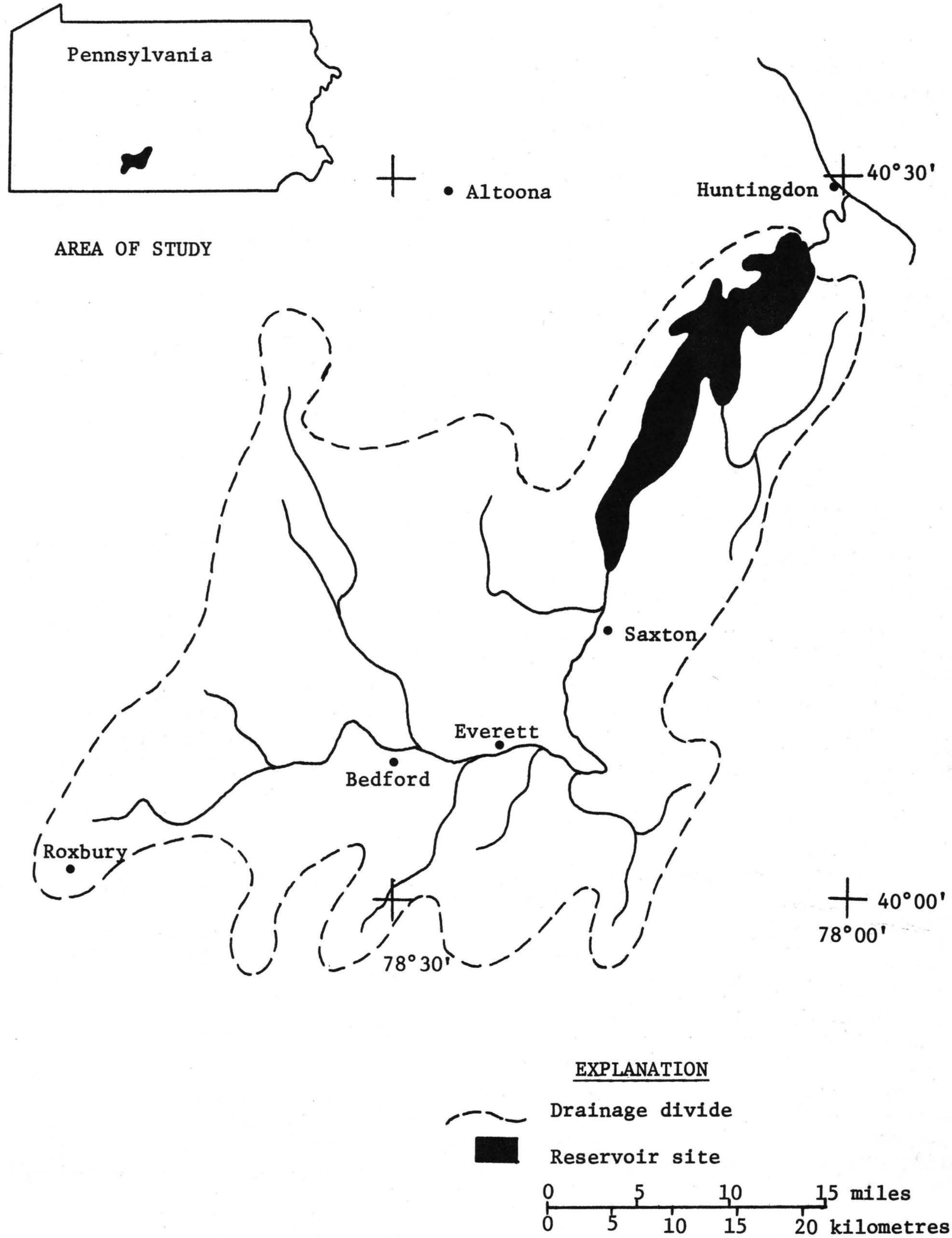

Figure 1.--*Raystown Branch Juniata River drainage basin.*

In July 1972, water-quality data collection was begun at 12 sampling sites. The name, station number, and drainage area for each water-quality site is listed in table 1. The locations of all sampling sites are shown in figure 2. Six water-quality sites were located on the main stem, four of which will become the primary impoundment sites when inundated. The other two main-stem sites were at the inflow and outflow. The six remaining sites were the principle tributary streams to the impoundment. Preimpoundment data collection at the four impoundment sites and the James Creek site was discontinued in May 1973 because of inaccessibility caused by backwater created by partial filling of the lake. Preimpoundment water-quality data collected at all 12 sites are listed in table 2.

WATER QUALITY

Inorganic and Physical

pH

Values for pH at the Saxton site (1-5620.) ranged from 6.2 to 8.4 with a median value of 7.1. This pH range was generally the same at all of the other sites with the exception of Shoup Run (1-5620.1), Great Trough Creek (1-5625.), and Coffee Run (1-5623.5). Shoup Run had a pH range of 3.2 to 4.4 with a median value of 3.7. This is an acid-bearing stream draining a coal mining area east of Saxton. The comparatively small amount of acid from Shoup Run does not adversely effect the main stem water quality, because of the relatively high buffering capacity of the main stem and the factor of dilution. Great Trough Creek was slightly acidic with a pH range of 5.4 to 7.3. The upper reaches of this stream drain the same coal fields as Shoup Run, but the acid effect is much less, as demonstrated by the pH values. Coffee Run contained waters that were alkaline, having a median pH of 8.1.

Specific Conductance

An inverse relationship existed between stream discharge and specific conductance at the main inflow station at Saxton. Specific conductance was low during the winter and spring months, when surface water runoff increased the water discharge. Specific conductance was high throughout the summer and fall, when ground water had major effect on streamflow and water discharge decreased, indicating a higher concentration of dissolved solids during summer and fall. This indirect relationship between discharge and specific conductance is depicted in Figure 3.

Seasonal variations in specific conductance values at Saxton are illustrated in Figure 4. Specific conductance values at the other five main-stem sites paralleled those at Saxton, indicating no appreciable amount of dissolved solids entering the impoundment area through ground water or from surface water runoff.

Alkalinity

At the Saxton site a direct relationship existed between specific conductance and total alkalinity. As the alkalinity of the water increased, the specific conductance increased proportionately. Likewise, with a decrease in alkalinity, specific conductance decreased. This relationship is illustrated in figure 5.

Only 1 out of 17 samples collected at Saxton had a pH exceeding 8.3, indicating little or no carbonate ion concentration in the water. Therefore, the alkalinity was caused primarily by the bicarbonate ion concentration. A seasonal variation in alkalinity, similar to the seasonal variation in specific conductance was observed at Saxton and is illustrated in figure 4.

Dissolved Oxygen

The dissolved oxygen concentration of samples collected at the six mainstem sites ranged from 7.2 to 14.0 mg/l (milligrams per litre). The percentage saturation range was from 85 to 121. At the six tributary sites, measured dissolved oxygen concentrations were from 7.0 to 13.8 mg/l with a saturation range from 79 to 106. These data indicate adequate dissolved oxygen concentrations for sustaining diverse aquatic communities, or at least a good oxygen recovery from any polluted reach upstream from the sampling sites.

Nitrogen and Phosphorous

Three forms of nitrogen, nitrate nitrogen (NO_3-N), ammonia nitrogen (NH_4-N), and organic nitrogen were analyzed at the Saxton site. The concentration range and median value for each form were as follows:

	range (mg/l)	median value (mg/l)
nitrate-N	0.10-1.5	1.1
ammonia-N	.02- .38	.07
organic nitrogen	.06- .92	.45

There is some indication of seasonal variation in nitrate-N concentrations, with higher concentrations in the winter and lower concentrations in the summer. The increase in the winter can be attributed to increased runoff, and lower concentrations in the summer can be due to nitrate-N assimilation by aquatic plants, phytoplankton, and bacteria. Ammonia-N concentrations were generally less than 0.10 mg/l, and organic nitrogen concentrations were all less than 0.92 mg/l. Low concentrations of these two nitrogen compounds indicate the stream to be mostly free of organic pollution.

Only on one occasion did the total phosphorous concentration exceed 0.10 mg/l. The range was from 0.01 to 0.17 mg/l, and the median was 0.03 mg/l. The orthophosphate-P concentration range was from 0.0 to 0.08 mg/l, and the median was 0.02 mg/l. As with nitrate-N, the highest orthophospate-P concentrations at the Saxton site occurred during the winter and the lowest concentrations during the summer. This seasonal variation in nitrate-N and orthophosphate-P concentrations is depicted in figure 4.

Table 1.--The twelve water quality sampling sites in the Raystown Branch study area.

Station Number	Drainage area (m^2)	Station Name
1-5620.	756	Raystown Branch Juniata River at Saxton, Pa.
1-5623.	-	Raystown Branch Juniata River near Entriken, Pa.
1-5624.	-	Raystown Branch Juniata River near Marklesburg, Pa.
1-5627.	-	Raystown Branch Juniata River near Hesston, Pa.
1-5630.	957	Raystown Branch Juniata River near Huntingdon, Pa.
1-5632.1	963	Raystown Branch Juniata River at Ardenheim, Pa.
1-5620.1	21.8	Shoup Run at Saxton, Pa.
1-5622.	12.0	Shy Beaver Creek near Entriken, Pa.
1-5622.5	7.9	Tatman Run near Entriken, Pa.
1-5623.5	7.2	Coffee Run near Entriken, Pa.
1-5625.	85.4	Great Trough Creek near Marklesburg, Pa.
1-5626.	20.5	James Creek near Marklesburg, Pa.

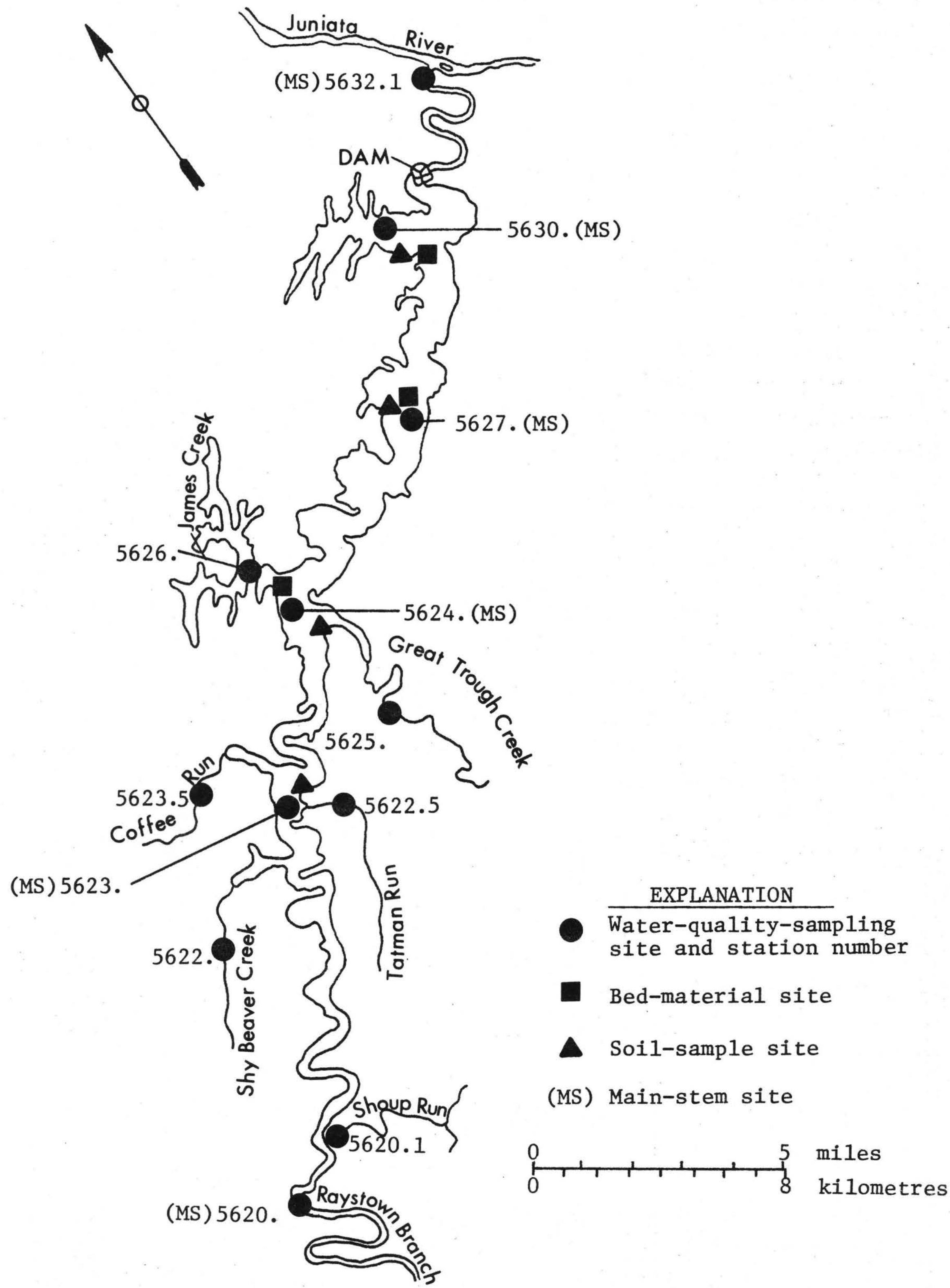

Figure 2.--*Sampling sites in the Raystown Lake study area.*

Table 2.--Physical, chemical, and bacteriological analyses of streams.

(Chemical analyses in milligrams per litre, except as noted)

Date	Time	Discharge (cfs)	Temperature (°C)	pH	Specific conductance (micromhos per cm at 25°C)	Dissolved oxygen	Oxygen saturation (percent)	Total alkalinity	Fecal Coliform (no/100 ml)	Fecal streptococcus (no/100 ml)	Total Kjeldahl nitrogen	Organic nitrogen	Ammonium nitrogen (N)	Nitrate-nitrogen (N)	Orthophosphate (P)	Total phosphorous (P)	Total organic carbon
1-5620. Raystown Branch Juniata River at Saxton, Pa.																	
7-25-72	1145	343	27.0	7.9	315	7.8	97	110	23	280	0.96	0.89	0.07	1.5	0.08	0.10	3.5
9-12-72	1045	197	19.0	8.0	320	8.0	85	110	64	100	.64	.57	.07	1.3	.01	.02	3.0
11- 8-72	1030	1030	9.0	7.6	230	10.4	93	82	4600	15,000	.98	.92	.06	.77	.06	.17	10
1-23-73	1230	1960	1.0	7.3	150	13.8	95	58	350	7300	.55	.46	.09	.97	.07	.09	5.5
3-20-73	1130	1800	4.0	7.1	165	13.2	100	38	60	20	.94	.56	.38	1.4	.02	.03	2.5
5-15-73	1045	928	12.5	7.7	175	10.4	97	54	100	20	.48	.38	.10	.99	.01	.02	4.0
7-16-73	1230	201	24.0	7.8	285	8.6	101	115	17	40	.28	.22	.06	.10	.01	.02	-
9-12-73	1300	134	21.0	8.4	265	10.2	113	120	720	69	.17	.10	.07	1.1	.01	.01	1.0
11-13-73	1015	432	6.5	7.0	240	12.2	99	65	21	10	.49	.35	.14	1.4	.02	.02	2.0
1-17-74	1100	2670	5.0	6.2	160	12.8	100	39	5400	1300	.46	.39	.07	1.5	.03	.08	1.5
3-19-74	1130	815	7.0	6.8	185	12.3	101	54	3	11	.63	.53	.10	1.0	.01	.02	-
5-15-74	1130	1530	16.5	6.8	120	9.0	91	81	210	100	.76	.58	.18	1.0	.03	.07	-
7-15-74	1430	267	25.5	6.7	230	8.0	96	93	4	48	.40	.37	.03	.68	.01	.03	13
9-20-74	1200	144	20.0	7.3	298	11.1	121	120	21	24	.40	.34	.06	.56	0	.01	-
11-19-74	1200	263	4.0	6.9	265	13.3	101	84	33	44	.47	.45	.02	1.2	.01	.01	6.8
1- 7-75	1130	893	2.0	6.6	165	13.3	96	40	67	37	.84	.79	.05	1.4	.02	.03	4.8
3-21-75	1030	6530	7.0	7.1	125	11.7	96	28	320	420	.08	.06	.02	1.4	.04	.04	4.8
1-5623. Raystown Branch Juniata River near Entriken, Pa.																	
7-25-72	1530	-	29.5	8.3	315	9.0	116	93	23	44	0.36	0.31	0.05	1.2	0.01	0.02	4.0
9-12-72	1415	-	20.5	7.8	350	8.4	92	102	82	170	.62	.57	.05	1.2	0	.02	2.5
11- 8-72	1400	-	9.5	7.0	250	10.6	92	87	710	1500	1.1	1.0	.09	.72	.04	.13	12
1-23-73	1600	-	2.0	7.3	162	13.0	92	56	680	1600	.98	.94	.04	.99	.05	.08	5.5
3-20-73	1400	-	5.0	7.2	150	13.9	108	35	60	16	1.8	1.2	.56	1.3	.03	.03	2.5
5-15-73	1315	-	13.0	7.8	180	11.6	109	52	53	19	.63	.55	.08	.84	.01	.02	3.5

1-5624. Raystown Branch Juniata River near Marklesburg, Pa.

7-25-72	1215	-	26.0	8.1	320	9.0	109	95	20	50	0.33	0.29	0.04	1.2	0.01	0.01	3.0
9-13-72	0945	-	20.0	7.7	340	8.2	89	106	61	170	.70	.65	.05	1.2	0	.02	2.5
11- 9-72	1250	-	8.5	8.0	203	10.8	92	72	3800	9000	1.5	1.4	.12	.79	.10	.28	13
1-24-73	1200	-	.5	7.2	148	12.8	88	47	800	1700	.92	.78	.14	.88	.05	.11	4.5
3-21-73	1300	-	5.5	7.7	155	13.2	104	32	20	4	3.4	2.9	.45	1.1	.02	.02	2.0
5-16-73	1230	-	16.0	7.2	180	9.0	90	50	29	350	.56	.44	.12	.77	.02	.04	3.5

1-5627. Raystown Branch Juniata River near Hesston, Pa.

7-26-72	1030	-	24.5	8.1	300	8.2	97	89	43	50	0.33	0.29	0.04	0.99	0.01	0.02	4.0
9-12-72	1130	-	22.0	8.0	340	8.4	95	99	40	230	.68	.59	.09	1.1	0	.02	3.5
11- 9-72	1100	-	8.5	7.7	220	10.6	90	70	5100	12,000	1.5	1.4	.08	.97	.11	.33	16
1-24-73	0945	-	0.5	6.6	135	13.4	92	44	450	500	.54	.49	.05	.99	.05	.07	4.5
3-21-73	1130	-	5.5	7.2	135	13.0	102	34	20	4	.68	.56	.12	2.1	.01	.02	2.0
5-15-73	1600	-	13.5	7.3	165	11.0	109	45	-	15	.52	.49	.03	.77	.01	.03	3.0

1-5630. Raystown Branch Juniata River near Huntingdon, Pa.

7-26-72	0930	397	27.5	7.9	285	7.8	97	83	10	33	0.44	0.37	0.07	1.0	0.03	0.04	5.0
9-13-72	1515	230	22.5	7.2	340	8.2	94	97	5	40	.72	.51	.21	.86	.02	.04	4.0
11- 9-72	0900	1300	9.0	7.2	225	11.6	100	83	2100	9000	.57	.48	.09	.79	.04	.12	10
1-24-73	0900	2180	.5	6.6	128	14.4	100	50	320	460	.44	.44	0	.90	.04	.05	4.0
3-21-73	1015	1970	5.5	7.2	140	13.6	107	33	20	8	.85	.59	.26	2.3	.02	.03	3.0
5-15-73	1630	1060	15.5	7.5	160	11.0	109	46	-	100	.97	.86	.11	.68	.01	.02	4.0

1-5632.1 Raystown Branch Juniata River at Ardenheim, Pa.

7-26-72	0800	452	26.0	7.6	270	7.2	87	81	23	67	0.52	0.44	0.88	1.1	0.10	0.11	4.0
9-13-72	1400	192	23.0	7.6	330	9.2	104	95	15	96	.39	.34	.05	.77	.01	.03	4.0
11- 9-72	0800	1050	9.0	7.7	265	11.2	96	98	100	560	.45	.38	.07	3.3	.02	.06	9.0
1-25-73	0645	1700	0.0	7.1	115	13.8	95	62	340	520	.92	.70	.22	.90	.04	.06	5.5
3-21-73	0830	2090	5.0	7.4	170	13.0	101	35	200	64	.46	.42	.04	1.1	.03	.07	3.0
5-16-73	0900	32	12.5	7.2	150	10.4	97	37	23	68	.36	.27	.09	.57	.01	.03	3.5
7-17-73	0815	130	13.5	7.2	135	9.4	90	51	15	73	.15	.14	.04	.74	0	.01	-
9-13-73	0830	128	18.5	7.2	157	8.0	85	48	40	35	.28	.16	.12	.15	0.02	.02	5.0
11-14-73	0830	5610	12.0	6.7	220	10.2	94	64	3	16	.49	.27	.22	.40	0	.01	3.0
1-18-74	0845	3930	2.0	6.3	160	14.0	101	34	20	5	.34	.28	.06	1.3	.01	.03	.5
3-20-74	0845	72	4.5	6.7	155	11.8	91	44	1	11	.65	.30	.15	.12	0	.01	-
5-15-74	0930	111	17.5	6.0	168	8.2	85	65	8	37	.46	.34	.12	.13	0	.02	-
7-15-74	1200	141	21.5	7.0	150	8.8	99	44	7	60	.47	.38	.09	.68	0	.01	5.3
9-20-74	1000	214	18.0	6.9	185	9.2	96	48	73	540	.35	.26	.09	.43	0	.02	-
11-19-74	1400	123	9.0	7.2	175	12.0	104	24	< 1	5	.52	.48	.04	.99	0	0	5.4
1- 7-75	1400	1160	6.0	6.7	190	12.0	96	53	< 1	2	.46	.39	.07	.81	0	.01	3.3
3-20-75	2000	12,000	4.5	7.1	180	13.3	103	60	< 1	1	.33	.32	.01	.99	.01	.02	1.9

Table 2.--Physical, chemical, and bacteriological analyses of streams--Continued.

(Chemical analyses in milligrams per litre, except as noted)

Date	Time	Discharge (cfs) a/	Temperature (°C)	pH	Specific conductance (micromhos per cm at 25°C)	Dissolved oxygen	Oxygen saturation (percent)	Total alkalinity	Fecal Coliform (no/100 ml)	Fecal streptococcus (no/100 ml)	Total kjeldahl nitrogen	Organic nitrogen	Ammonium nitrogen (N)	Nitrate-nitrogen (N)	Orthophosphate (P)	Total phosphorous (P)	Total organic carbon
1-5620.1 Shoup Run at Saxton, Pa.																	
7-25-72	1310	10	19.0	3.2	800	8.6	91	-	0	100	0.27	0.17	0.10	0.56	0.04	0.08	12
9-12-72	1130	22	15.0	3.3	900	9.6	94	-	4	140	.24	.13	.11	.27	.01	.01	3.0
11- 8-72	1120	52	9.0	4.4	215	11.0	80	-	3600	1600	.78	.70	.08	2.5	.03	.12	11
1-23-73	1315	38	4.0	3.8	240	13.6	102	-	7	80	.41	.29	.12	.25	.01	.02	3.0
3-20-73	1145	36	7.5	3.6	260	12.1	100	-	0	32	.33	.21	.12	.23	0	.05	1.5
5-15-73	1100	21	10.5	3.7	300	10.0	89	-	10	12	.13	.09	.04	.18	0	.02	2.0
7-16-73	1300	8.0	18.0	3.9	430	9.0	94	-	1	10	.10	.03	.07	.14	.01	.02	-
9-12-73	1330	8.0	17.0	3.3	460	9.6	98	-	0	6	.06	0	.06	.09	.01	.02	0
11-13-73	1100	37	9.0	3.4	450	11.2	97	-	2	36	.14	.09	.05	.10	0	0	3.5
1-17-74	1130	45	6.0	4.1	190	12.5	100	-	34	150	.26	.19	.07	.43	0	.04	.5
3-19-74	1200	37	8.5	3.9	270	11.6	99	-	0	10	.18	.10	.08	.20	.01	.01	-
1-5622. Shy Beaver Creek near Entriken, Pa.																	
7-25-72	1645	1.1	24.0	8.1	300	8.2	96	122	270	740	0.26	0.22	0.04	0.79	0.02	0.02	4.0
9-12-72	1640	1.2	18.0	7.7	340	9.4	98	139	490	130	.25	.18	.07	.59	.01	.03	4.0
11- 8-72	1600	31	9.0	7.3	143	10.2	88	39	2600	8900	.49	.43	.06	3.5	.02	.06	9.5
1-24-73	1420	12	2.5	7.3	138	13.0	95	55	410	1200	.48	.38	.10	.66	.02	.03	4.5
3-20-73	1500	12	9.0	7.8	165	12.2	105	56	10	20	.28	.19	.09	.50	.01	.03	2.0
5-15-73	1400	8.0	13.0	7.4	180	11.2	106	72	260	34	.24	.17	.07	.41	.01	.02	3.5
7-16-73	1630	3.0	22.0	8.1	280	8.7	98	137	190	500	.23	.18	.05	.47	.02	.02	-
9-12-73	1700	1.6	18.0	8.2	305	9.4	98	142	150	570	.09	.04	.05	.47	.01	.02	0
11-13-73	1545	6.4	9.0	7.4	310	12.0	104	115	29	44	.27	.19	.08	.40	0	.01	1.5
1-17-74	1615	50	5.0	5.0	155	11.8	92	31	220	240	.45	.36	.09	.77	.01	.03	2.0
3-19-74	1630	12	9.5	6.4	185	11.4	99	67	10	18	.32	.22	.10	.40	.01	.02	-
1-5622.5 Tatman Run near Entriken, Pa.																	
7-25-72	1500	0.87	24.5	7.6	120	7.8	92	39	180	260	0.19	0.12	0.07	0.47	0.01	0.02	3.5

9-12-72	1220	.30	18.0	7.5	190	9.0	95	63	97	460	.48	.40	.08	.93	.01	.02	4.0
11- 8-72	1300	8.4	8.5	7.1	110	11.0	93	33	560	4100	1.0	.77	.23	1.6	.02	.08	10
1-23-73	1515	4.8	3.0	7.1	68	12.6	93	14	190	500	1.0	.76	.27	.47	.02	.02	3.0
3-20-73	1345	11	7.5	7.4	80	11.7	97	17	160	320	.36	.19	.17	.63	.04	.08	2.5
5-15-73	1300	9.6	10.0	7.1	82	10.3	91	21	290	52	.20	.15	.05	.23	.01	.04	3.0
7-16-73	1445	1.2	22.0	7.4	155	7.0	79	76	160	130	.19	.13	.06	.60	.01	.02	-
9-12-73	1530	.45	18.5	7.1	200	8.6	91	85	57	32	.04	0	.04	.64	.01	.01	-
11-13-73	1320	5.0	6.5	6.5	120	10.3	84	37	260	69	.24	.15	.09	.40	.01	.01	4.0
1-17-74	1315	24	5.5	6.1	85	12.4	98	13	120	100	.30	.21	.09	.52	.02	.03	1.0
3-19-74	1315	8.0	6.0	7.1	85	11.0	88	24	95	47	.27	.18	.09	.30	.01	.02	-
1-5623.5 Coffee Run near Entriken, Pa.																	
7-25-72	1605	2.6	25.5	8.2	330	8.0	97	137	320	430	0.42	0.24	0.18	1.3	0.03	0.04	3.5
9-12-72	1445	1.5	18.0	8.0	390	8.6	90	158	1900	3900	.82	.77	.05	1.3	.04	.04	5.0
11- 9-72	1550	8.0	8.5	6.9	218	11.0	93	87	12,000	7900	.69	.64	.05	.79	.04	.06	8.0
1-24-73	1445	27	2.5	7.2	120	13.4	98	41	150	260	1.9	1.5	.41	.50	.02	.02	3.0
3-20-73	1530	6.0	9.5	8.1	190	11.8	102	73	930	140	.63	.45	.18	.68	.02	.04	2.5
5-15-73	1430	5.0	12.5	8.3	185	12.0	112	86	930	2200	.06	.05	.01	.57	.02	.02	3.0
7-16-73	1700	1.2	23.0	8.2	310	8.6	99	165	690	500	.30	.23	.07	1.1	.04	.05	-
9-12-73	1745	.60	19.0	8.2	360	9.4	100	171	140	1400	.05	0	.05	.59	.03	.04	0
11-13-73	1630	2.5	10.0	8.3	320	11.8	104	133	87	140	.39	.31	.08	1.2	.02	.04	1.5
1-17-74	1530	24	5.0	6.1	170	12.0	94	52	1500	820	.45	.36	.09	.95	.02	.05	2.0
3-19-74	1530	6.0	10.5	6.5	200	10.6	94	80	140	200	.46	.34	.12	.80	.02	.06	-
1-5625. Great Trough Creek near Marklesburg, Pa.																	
7-25-72	1245	29	23.5	7.2	82	9.0	104	20	10	44	0.16	0.14	0.02	0.34	0.01	0.01	4.0
9-13-72	1100	5.1	19.5	6.9	120	9.4	102	29	420	1100	.23	.17	.04	.09	.03	.04	4.0
11- 9-72	1320	132	7.5	6.9	100	11.4	94	15	1300	6900	.51	.44	.07	.77	.04	.08	10
1-24-73	1230	100	1.0	6.9	60	13.2	92	6	37	120	1.8	1.6	.23	.41	.03	.04	3.0
3-21-73	1330	80	5.0	7.0	65	13.2	103	8	20	16	.19	.13	.06	.20	.01	.01	2.5
5-16-73	1200	75	10.5	6.4	70	10.8	96	9	52	16	.21	.18	.03	.14	.01	.03	9.5
7-16-73	1500	12	23.0	6.9	72	8.8	101	19	83	320	.14	.08	.06	.10	.01	.02	-
9-12-73	1600	8.0	20.0	6.8	118	9.8	107	30	34	330	.08	.04	.04	.03	.01	.02	1.0
11-13-73	1300	90	6.5	6.4	88	12.2	99	10	10	16	.19	.10	.09	.30	.01	.03	3.0
1-17-74	1330	225	4.0	5.4	78	12.8	97	8	450	1000	.43	.33	.10	.63	.02	.06	2.0
3-19-74	1400	40	5.0	7.3	70	12.1	94	10	13	16	.26	.17	.09	.20	.01	.03	-
1-5626. James Creek near Marklesburg, Pa.																	
7-26-72	1150	10	19.5	8.1	350	9.4	101	142	690	770	0.25	0.22	0.03	1.8	0.04	0.04	4.0
9-13-72	0900	3.0	18.0	7.8	360	8.0	83	146	1700	1800	.48	.42	.06	1.3	0	.02	4.0
11- 9-72	1230	43	8.5	7.6	170	11.0	93	63	1100	2000	.50	.43	.07	.97	.02	.04	10
1-24-73	1145	40	1.5	7.3	130	13.8	98	56	90	130	.11	2.5	.42	.54	.02	.03	2.5
3-21-73	1230	20	6.0	7.9	190	12.6	101	72	13	80	3.7	3.2	.46	1.7	.01	.05	1.5
5-16-73	1100	8.0	9.0	6.8	245	11.8	102	97	85	60	.46	.41	.05	1.1	.01	.03	2.5

a/ Estimated

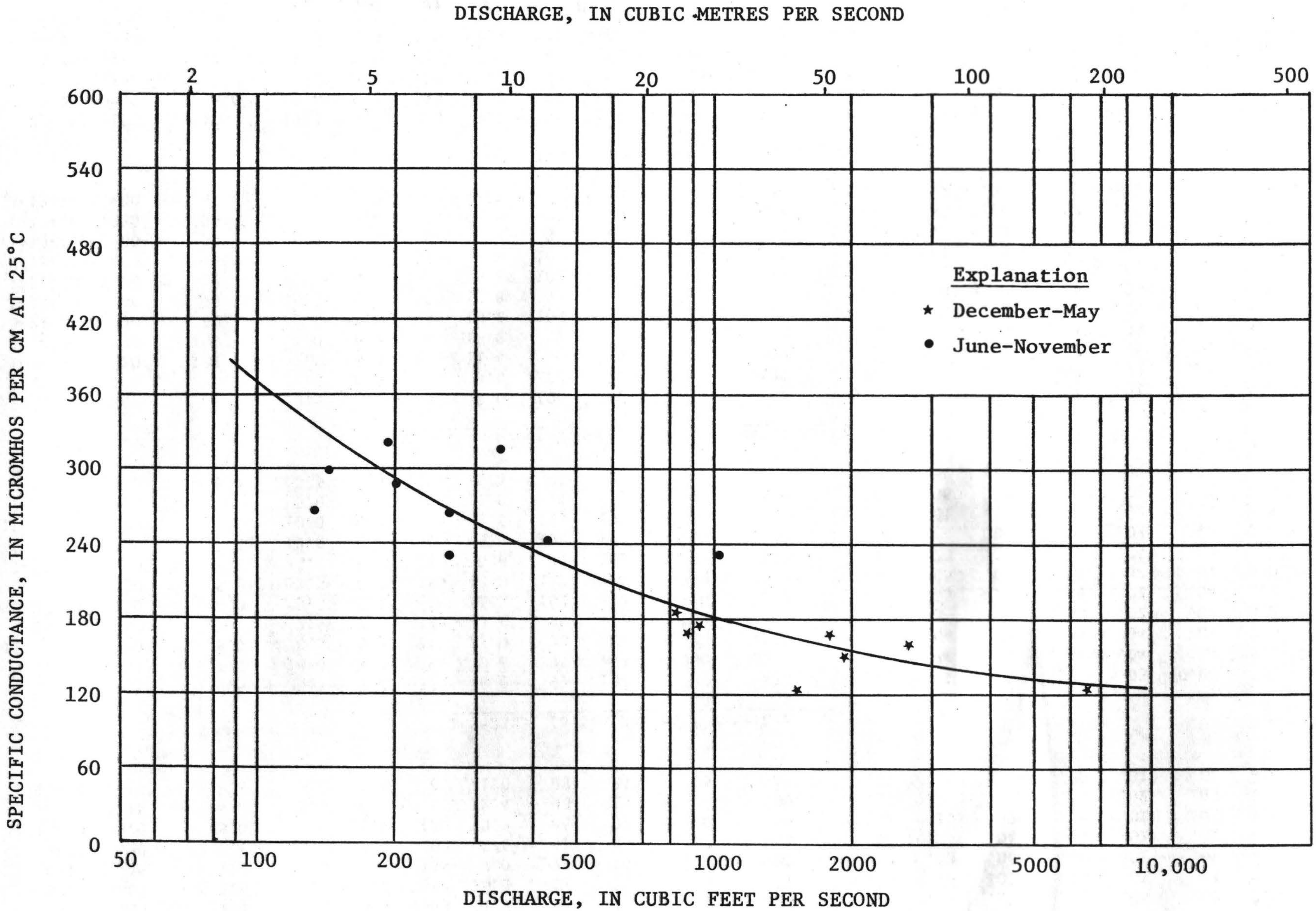

Figure 3.--*Relationship between discharge and specific conductance at Raystown Branch Juniata River at Saxton (1-5620.).*

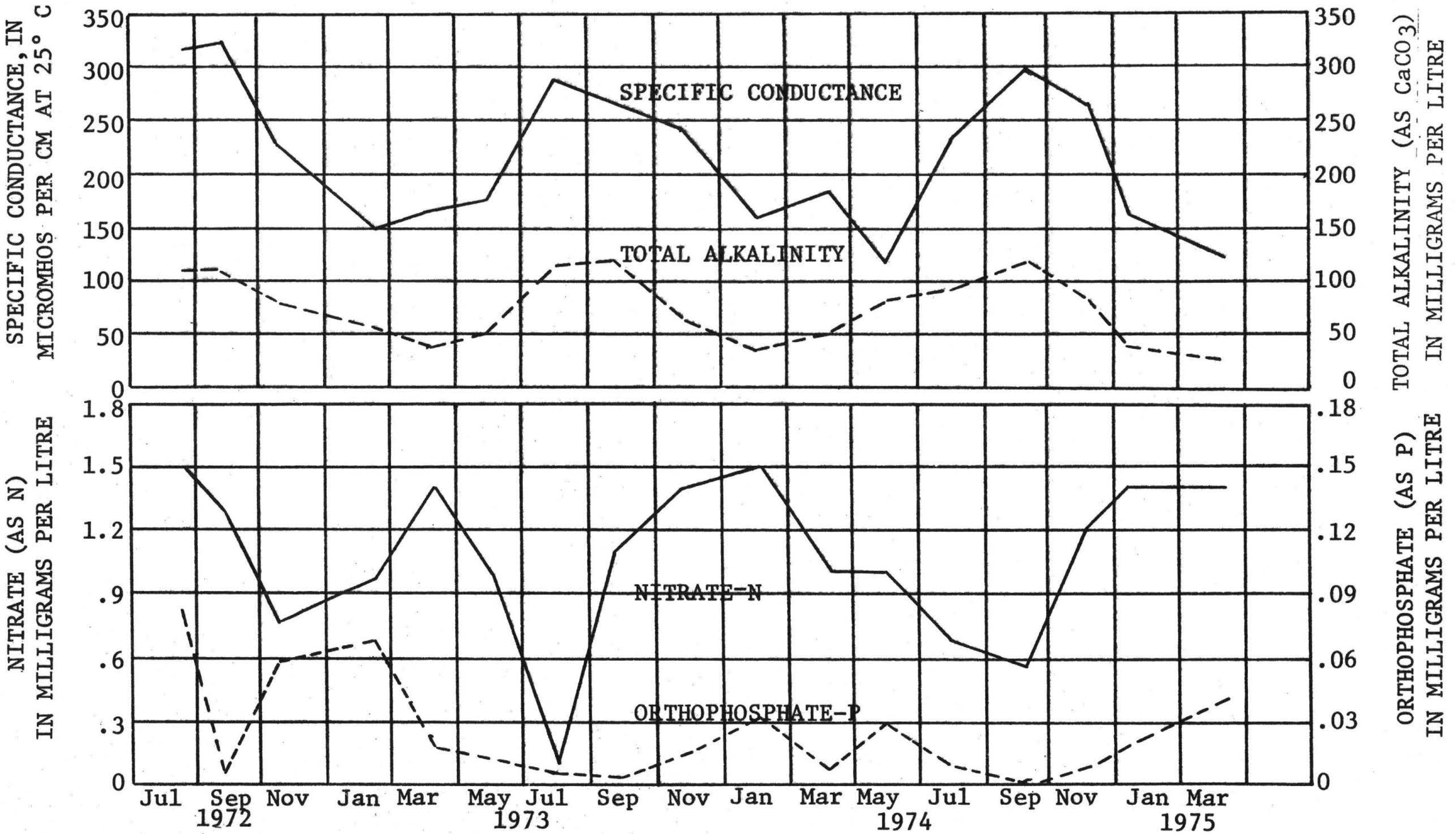

Figure 4.--*Seasonal variations between specific conductance and total alkalinity and between nitrate-N and orthophosphate-P concentrations at Raystown Branch Juniata River at Saxton (1-5620.).*

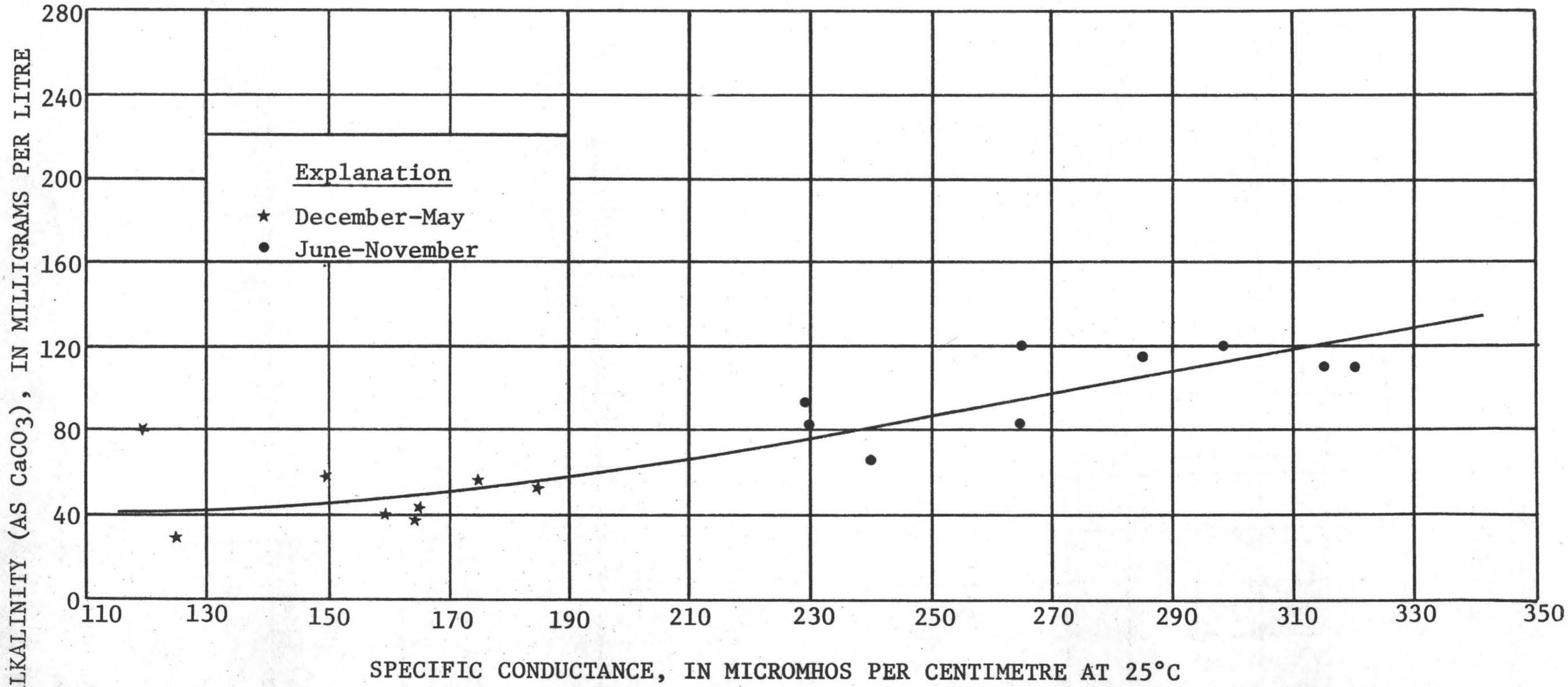

Figure 5.--*Relationship between total alkalinity and specific conductance at Raystown Branch Juniata River at Saxton (1-5620.).*

Organic

Total Organic Carbon

Total organic carbon (TOC) concentrations at the Saxton site ranged from 1.0 to 13.0 mg/l, and the median was 4.0 mg/l. Concentrations less than 6.8 mg/l occurred 85 percent of the time. These relatively low TOC concentrations together with the near-saturated dissolved oxygen content indicated no excessive quantities of organic matter present at the main inflow. TOC concentrations at the five other downstream main-stem sites approximated those at Saxton. Similarly, TOC concentrations at the six tributary sites ranged from 0.0 to 12.5 mg/l, and the median was 3.0 mg/l.

Pesticides

A suspended sediment sample was collected at a main-stem site (1-5627.) during high water on November 9, 1972, and was analyzed for the common chlorinated hydrocarbon pesticides and organophosphate. Of the 20 compounds analyzed, only trace quantities of 2,4-D and 2,4,5-T were present in the water-sediment mixture. The compound 2,4-D is the best known of present herbicides. It is a plant hormone that stimulates growth, often to the extent of causing a plant to destroy itself. It is non-poisonous but may give water an unpleasant taste. The concentration of 2,4-D found in the water-sediment sample was 0.03 ug/l (micrograms per litre). The compound 2,4,5-T is also a plant hormone that is almost insoluble in water. It has an estimated human toxicity of 0.6 g/kg (grams per kilogram). A concentration of 0.01 ug/l was found in the water-sediment mixture. A list and results of the compounds analyzed is given in table 3.

BACTERIOLOGY

Observed fecal coliform densities for the Raystown Branch at Saxton (1-5620.) ranged from 3 to 5,400 colonies per 100 ml (millilitres). The maximum densities were measured during high flow conditions. On six of nine sampling dates, the fecal coliform densities at Saxton were 100 colonies or less per 100 ml, which included three samples when the streamflow was low and temperatures were high. Fecal coliform densities tended to decrease in a downstream direction at the other five main-stem sites. Fecal coliform densities measured at five of the six tributary sites showed no appreciable amount of fecal matter entering these streams. Fecal coliform densities at the Coffee Run site (1-5623.5) indicated a greater degree of fecal contamination there than at the other sites. The town of Entriken is less than 1 mi (1.6 km) upstream from the Coffee Run sampling site, and within a 1 mi (1.6 km) radius of this small town are from 15 to 20 farms, many of which raise various types of livestock. Septic tank effluents, along with livestock pollution, are probably the main contributing factors to the higher degree of fecal contamination at this site.

Table 3.--Pesticide analyses-Raystown Branch Juniata River near Hesston, Pa. (1-5627.).

(In micrograms per litre)

Date	Time	Aldrin	DDD	DDE	DDT	Dieldrin	Endrin	Heptachlor	Lindane	Chlordane Estimate	PCB Estimate
11-09-72	1130	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Date	Time	2, 4-D	2, 4, 5, -T	Silvex	Diazinon	Ethion	Malathion	Methyl-Parathion	Methyl-Trithion	Parathion	Trithion
11-09-72	1130	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Fecal coliform densities measured at the Shoup Run site (1-5620.1) were very low, and on four occasions they were less than 1 colony per 100 ml. The low pH common to this stream is probably not conducive to growth of fecal coliform bacteria.

The highest fecal streptococcal densities were coincident with the highest fecal coliform densities. Only on a few occasions were extremely high fecal strep densities recorded, and these occurred when the streams were high and turbid.

The fecal coliform-fecal streptococcal ratio (FC/FS) is a very useful analytical tool provided that the samples taken are not more than 24 hours from the source of pollution and the range in pH of the source water falls within 4.0-9.0. A FC/FS ratio of 4 or greater indicates the water most likely contains wastes of human origin, and a ratio of 0.7 or less indicates wastes of animal, particularly livestock origin. A ratio between 0.7 and 4 represents an area of uncertain interpretation.

At the six main-stem sites, 66 percent of all samples collected had a FC/FS ratio of less than 0.7, 7 percent of the samples had a ratio greater than 4, and 27 percent of the samples had a ratio between 0.7 and 4. These data indicate the pollution to be predominantly of livestock origin. At the main-stem sites it is very difficult to determine if the sampling sites are within 24 hours flow of the pollution source; so, the reliability of these ratios are questionable.

At five of the six tributary sites 60 percent of all samples collected had a FC/FS ratio of less than 0.7, 6 percent of the samples had a ratio greater than 4, and 34 percent of the samples had a ratio between 0.7 and 4. Ratios at the Shoup Run site were not used because of the low pH range common to this stream.

At the Coffee Run site, where a higher degree of fecal contamination was evident, an FC/FS ratio of less than 0.7 occurred 55 percent of the time, and a ratio greater than 4 occurred only 9 percent of the time, indicating the pollution to be predominantly of livestock origin.

The die-off rate for fecal coliform and fecal streptococcal bacterial is rather rapid. There is less than 20 percent survival for fecal coliform bacteria after 7 days in 10° water (Millipore Corporation, 1974). The die-off rate increases more dramatically at higher temperatures. A very small percentage of the stream bacterial population will remain in the lake because of the short survival time of the fecal coliform bacteria and the relatively long retention time of the lake water.1/

1/ Theoretically, a complete exchange of water will take place in Raystown Lake every 229 days, based on an average annual inflow of 1,130 ft^3/s ($32\ m^3/s$).

SEDIMENTATION

The average-annual suspended-sediment load for the Raystown Branch Juniata River at Saxton, Pa., (1-5620.) is 68,000 tons or 90 t/mi^2 (35 t/km^2) (Williams and Reed, 1972). This is considered a relatively low yield for a drainage basin in the Valley and Ridge physiographic province.

Particle size analysis of a suspended-sediment sample collected at a main-stem site (1-5627.) during a high flow condition indicated that 4 percent of the suspended sediment is sand, 50 percent is silt, and 46 percent is clay. This corresponds to data collected by Williams and Reed (1972) indicating that the average composition of suspended sediment in the Susquehanna River basin is fairly consistent, being approximately 10 percent sand, 50 percent silt, and 40 percent clay.

Streambed samples were collected at three sites in the impoundment area (See fig. 2) and analyzed for particle size. In samples collected at two of the sites--Raystown Branch Juniata River near Marklesburg, Pa., (1-5624.) and Raystown Branch Juniata River near Hesston, Pa. (1-5627.)--64 percent of the bed material was silt and clay and 36 percent of the bed material was sand and gravel. At the third site, which is 0.8 mi (1.3 km) upstream from station 1-5630., 94 percent of the bed sample was silt and clay and 6 percent was sand and gravel. A complete breakdown of the particle size analyses at these three sites is in table 4.

Studies by Brune (1953) indicate that the trap efficiency for Raystown Lake, using the capacity-inflow ratio, should be 95 percent or greater.

The drainage area of the Raystown Branch Juniata River at Saxton is 79 percent of the total drainage area controlled by the dam. The average-annual suspended-sediment yield at this site is 68,000 tons; so, the total amount of suspended sediment entering the lake will be approximately 86,000 tons. With a trap efficiency of 95 percent, the annual loss in storage capacity of the lake will be about 62 acre-feet (0.076 hm^3) or only 0.01 percent of the total capacity.

As mentioned earlier, the watershed is primarily wooded with only a small part in cultivation. No major sediment source areas such as strip mines or other disturbances exist in the drainage. With properly supervised development of the basin, no serious sediment problem is likely to occur in Raystown Lake.

SOILS

Soil samples were collected at four sites in the impoundment area. (See fig. 2.) Results of nitrogen and phosphorous analyses performed on the samples are in table 5. The soils were predominantly of the Barbour, Philo and Basher series (U.S. Department of Agriculture, 1972), which are highly fertile soils with silt-loam and sandy-loam textures. These soils are classified as deep and moderately well drained.

Table 4.--Particle size analyses of bed material samples.

Location	Date	Percent			
		>2 mm	Sand	Silt	Clay
Raystown Branch Juniata River near Marklesburg, PA (1-5624.)	9-13-72	0	38	52	10
Raystown Branch Juniata River near Hesston, PA (1-5627.)	9-13-72	11	24	34	31
Raystown Branch Juniata River just above old Raystown Dam, .8 mile upstream from station 1-5630.	9-13-72	3	3	81	13

Table 5.--Nitrogen and phosphorous analyses of soil samples.

(Results in milligrams per kilogram)

Soil Type	Site Location	Latitude Longitude	NH_4 as N	NO_2 as N	NO_3 as N	Total N	Total P
Barbour silt loam	Near mainstem station 1-5623. (Entriken Bridge)	40°18'42" N 78°10'47"	47	0.4	5.0	440	180
Philo and Basher silt loams, high bottom	Near mainstem station 1-5624. (Trexler Bridge)	40°21'12" N 78°08'29"	43	0.2	4.7	247	190
Philo and Basher silt loams, high bottom	Near mainstem station 1-5627. (Fink Bridge)	40°22'49" N 78°03'48"	47	0.2	14	1460	220
Barbour fine sandy loam	Near mainstem station 1-5630. (Hawns Bridge)	40°25'30" N 78°01'42"	38	0.4	21	147	330

PROGNOSIS OF PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERISTICS OF RAYSTOWN LAKE

Chemical and thermal stratification are expected to occur in Raystown Lake as in most reservoirs in the temperate zone. Throughout the summer, photosynthesis and oxygen from the atmosphere will produce oxygen saturation and supersaturated conditions in the epilimnion layer of the lake. The oxygen concentration in the epilimnion will probably have a diurnal cycle, with peak concentrations occurring in the evening on clear days and minimum concentrations occurring immediately after dawn. The hypolimnion layer of the lake will probably have lower concentrations of oxygen due to organic respiration and decomposition of decaying vegetation.

Nitrate-N and orthophosphate-P concentrations in the lake would have the same seasonal variations that were observed at the main inflow station at Saxton (fig. 4), with high concentrations occurring in the late winter and low concentrations occurring in the summer. Vertical distribution of nitrate-N in the lake waters would be related to lake productivity. The lowest concentrations of nitrate-N would occur in the upper epilimnion due to plankton utilization and would be highest in the lower hypolimnion due to biochemical reduction.

Orthophosphate-P concentrations in the lake would be somewhat lower than those observed at the main inflow station because of the greater biological demand in proportion to water volume. Concentrations in the upper waters will probably be low throughout the year, becoming depleted at times during the summer.

Raystown Lake will be similar to other main-stem reservoirs in that the littoral zone around much of the lake perimeter will be very narrow, and in places this zone may be completely absent. The lake will be situated between the Tarrace Mountain range to the east and the Allegrippis Ridge to the west. Very steep slopes are common where the lake waters will intercept these two mountains. The presence of a poor substrate, together with a sharp decrease in sunlight penetration would make it difficult for the establishment of rooted aquatic plants in this area. There will be inlets and coves however, where conditions would be favorable for the growth of aquatic plants. Data collected at all of the inflow sites indicate that nutrient levels of these streams are not extremely high; thus, excessive weed growth in the inlets and other shallow areas around the lake is not expected to occur. Aquatic weed surveys taken at five other impoundments (J. L. Barker, written commun., 1975) within a 50 mi (80 km) radius of Raystown Lake give some indication of the principle plant species expected to be present in the lake. These species are: *Potamogeton diversifolius* (snailseed pondweed), *Potamogeton crispus* (curly-leaf pondweed), *Potamogeton foliosus* (leafy pondweed), *Nuphar advena* (spatterdock), *Elodea canadensis* (waterweed), and *Najas minor*.

In general, phytoplankton communities in Raystown Lake would be composed mainly of blue-green algae, green algae, and diatoms. The diatoms would be the dominant type and have the greatest diversity of the phytoplankton community. Specific genera of three classes of algae expected to occur in the lake are as follows:

Myxophyceae (blue-green algae)	Chlorophyceae (green algae)	Bacillariophyceae (diatoms)
Anacystis	*Desmidium*	*Asterionella*
Anabaena	*Pediastrum*	*Fragilaria*
Aphanizomenon	*Zygnema*	*Navicula*
Gomphosphaeria		*Gomphonema*
		Cyclotella
		Tabellaria

Zooplankton populations in the limnetic region of the lake would consist mainly of rotifers and microcrustaceans. Cladocerans and Copepods would constitute the majority of the zooplankton within the microcrustacean division. Densities of the zooplankton species would differ considerably throughout the lake, but species composition would most likely remain relatively constant in time (reid, 1961).

SUMMARY

The results of this preimpoundment study show that the Raystown Branch Juniata River and the main tributary streams flowing into the impoundment area are generally of very good quality and, therefore, conducive to forming a body of water that could support a balanced and diverse plant and animal population.

Bacterial densities at all sampling sites show no extensive amount of fecal contamination entering the impoundment area.

Unless large portions of this mostly quiescent watershed are disturbed, no serious sediment problems are likely to occur in the lake.

Total organic carbon concentrations, and the dissolved-oxygen content of all the sampled waters, show no excessive amounts of organic matter that could lead to overall oxygen depletion and a general degradation of the water quality.

Observed nutrient levels of inflowing streams together with the morphological features of the lake basin indicate the unlikelihood of cultural eutrophication occurring in the lake.

Aquatic weed and algal growth will occur in parts of the lake, but are not expected to present management problems.

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