A REPORT FROM

The State Hygienic Laboratory

MEDICAL LABORATORIES BUILDING

THE UNIVERSITY OF IOWA

IOWA CITY, IOWA 52242

Water Quality Survey of A Coal Mining Watershed Muchakinock Creek

#78 - 14

Prepared for the Iowa Department of Environmental Quality by the University of Iowa, State Hygienic Laboratory.

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October 26, 1977

ABSTRACT

A water quality survey of Muchakinock Creek was conducted July 16, 1977, shortly after a 1.5 inch rainfall in the watershed. The purpose of the survey was to assess the effects of runoff from coal mine areas on the receiving stream. Results of the survey indicate the typical changes associated with runoff--dramatic increases in fecal coliform levels, turbidity, phosphates and BODs. In addition, the high sulfate soils in the mining areas caused stream pH values to decline and dissolved solids to increase. One stream station having a pH of 3.6 virtually destroyed all of the fecal coliform organisms at that station. High acid runoff is expected to occur from these areas until vegetation and other management tools are utilized to reduce erosion of the high sulfate soils.

INTRODUCTION

At one time south central Iowa produced large amounts of coal for domestic and industrial purposes. Mahaska County is one of several south central Iowa counties dotted with debris piles, remnants of that era. The general coal removal procedure at that time was to strip off the overburden covering the coal, remove the coal, and then move on to other deposits. This process left mounds of overburden and pits scattered throughout the countryside. Overburden associated with Iowa coal usually has a high sulfate content. The sulfate may react with water to form sulfuric acid, making a very difficult environment for plant life to invade. As a result, most of the coal debris piles are barren of vegetation. Many of these are still evident in the area today. The purpose of this survey was to study the effects of rainfall runoff from the abandoned coal mines and their debris piles on the receiving stream.

Muchakinock Creek is a small creek (drainage area 78.8 square miles) located in Mahaska County which merges with the Des Moines River near Eddyville, Iowa. The stream is narrow, and shallow except during periods of heavy runoff with a silty-sand stream bottom. Most of the Muchakinock watershed is agricultural in usage with pasture, hay ground and some row crop production. Muchakinock Creek was selected for study because of the numerous old coal mines located in its watershed (Fig. 1).

Muchakinock Creek is classified as a class B fresh warm water stream from its mouth to near Leighton, Iowa, with the appropriate standards applying to that reach.

On July 15 and 16 the study area received approximately 1.5 inches of rainfall. Sample collection was performed on July 16 and the samples returned to the Des Moines Branch Laboratory for analysis. A complete list of the sampling locations will be found in Table 1.

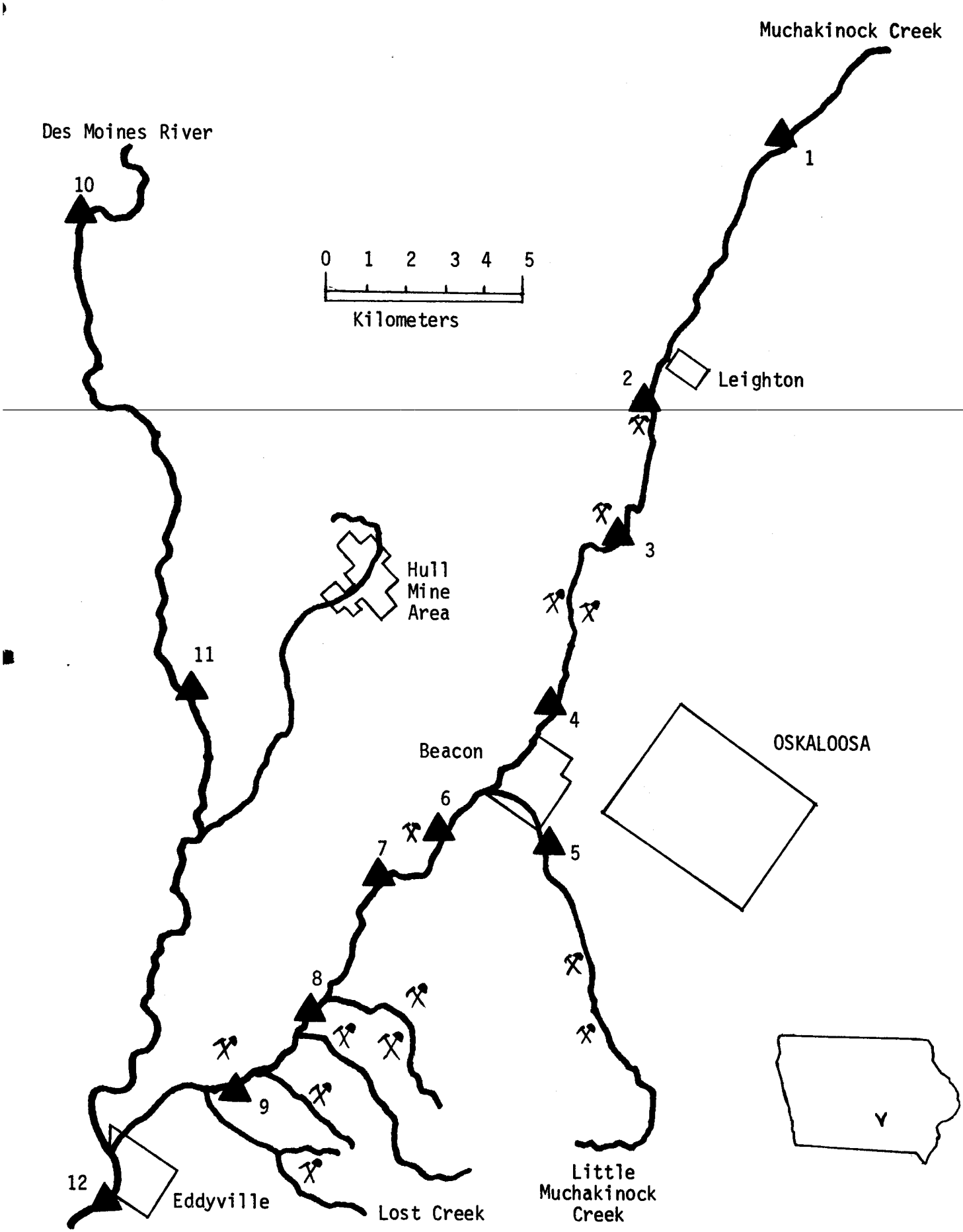

Figure 1. Map of Muchakinock Creek showing Sampling Locations
(⚒ indicates mining area)

TABLE 1

Muchakinock Creek Sampling Stations
16 July 1977

Station		Location
1	Muchakinock Creek	Mahaska County Road Bridge T76N, R17W, Sec. 17
2	Muchakinock Creek	Mahaska County Road Bridge T75N, R17W, Sec. 1
3	Muchakinock Creek	Mahaska County Road Bridge T75N, R16W, Sec. 7
4	Muchakinock Creek	Mahaska County Hwy 92 Br. T75N, R16W, Sec. 22
5	Little Muchakinock Creek	Mahaska County Road Bridge, T75N, R16W, Sec. 26
6	Muchakinock Creek	Mahaska Co. Rd. Bridge T75N, R16W, Sec. 35
7	Muchakinock Creek	Mahaska Co. Rd. Bridge T74N, R16W, Sec. 2
8	Muchakinock Creek	Mahaska Co. Rd. Bridge T74N, R16W, Sec. 13
9	Muchakinock Creek	Mahaska Co. Rd. Bridge T74N, R16W, Sec. 25
10	Des Moines River	Mahaska Co. Hwy 92 Bridge T75N, R17W, Sec. 19
11	Des Moines River	Mahaska Co. Rd. T39 Bridge T73N, R15W, Sec. 6
12	Des Moines River	Mahaska County Hwy 137 Bridge

Flow data on very small streams such as Muchakinock Creek is limited if it exists at all. Unfortunately, no flow data was available on Muchakinock Creek although stream flow during the survey was not quite bank-full, indicating a temporary high flow condition.

RESULTS AND DISCUSSION

Table 2 represents selected chemical and bacteriological data collected from Muchakinock Creek on July 16, 1977. All data collected may be found in the Appendix.

Fecal coliform levels ranged from 100 at station 4 to 5.5 million organisms per 100 ml at station 2. The 12 station average was over one million organisms per 100 ml. The fecal coliform value at station 4 (100 organisms/100 ml) was an estimate with the actual value less than 100 organisms/100 ml. The low pH at station 4 is most probably the reason for the low coliform count.

Specific conductance ranged from 130 at station 1 to 2100 minromhos at station 4. The low conductance at station 1 is probably due to the rainwater which has a very low specific conductance. Stations 4, 5 and 6 had the higher specific conductances and some of the lowest pH values, which can be directly related to the coal mines above station 4. The three Des Moines River stations (stations 10, 11, and 12) had the highest pH values, indicating they were not being affected by the acid drainage as was Muchakinock Creek.

Alkalinity was quite low with no phenolphthalein alkalinity and very low total alkalinity (range 0 - 124 mg/L). Alkalinity is a measure of the buffering capacity of a stream, and most Iowa streams have a total alkalinity of well over 100 mg/L. At lower pHs, water loses alkalinity and thus reduces its buffering ability. No alkalinity was observed at station 4 which had a pH of 3.6

Organic nitrogen values ranged from 1.2 mg/L at station 4 to 16 mg/L at station 9. Ammonia nitrogen ranged from 0.18 mg/L to 5.2 mg/L. The nitrogen values appeared to fluctuate randomly which often occurs during a rainfall runoff event.

TABLE 2A

SELECTED CHEMICAL AND BACTERIOLOGICAL DATA

MUCHAKINOCK CREEK

16 July 1977

Station	Fecal Coliforms **	Specific Conductance ***	pH	Alkalinity		Nitrogen		Solids	
				Phenolphthalein	Total	Organic	Ammonia	Filtrable (TDS)	Nonfiltrable
1	960,000	130	6.25	0	27	3.3	0.77	164	320
2	5,500,000	530	6.85	0	116	2.0	5.2	412	2130
3	3,200,000	350	6.15	0	29	10.0	1.7	400	1920
4	100	2100	3.6	0	0	1.2	1.9	2060	316
5	150,000	600	6.7	0	51	1.8	0.91	460	436
6	96,000	1200	6.6	0	39	3.5	1.0	980	1230
7	1,600,000	330	6.95	0	60	9.7	1.0	300	3020
8	290,000	510	6.65	0	51	7.6	0.73	410	3500
9	340,000	310	6.5	0	39	16	0.74	420	8270
10*	170,000	510	7.3	0	113	1.8	0.33	376	616
11*	340,000	530	7.6	0	124	1.9	0.18	356	428
12*	190,000	470	7.15	0	91	7.5	0.59	380	3350

*Des Moines River Stations

**per 100 ml

***micromhos

TABLE 2B

SELECTED CHEMICAL AND BACTERIOLOGICAL DATA

MUCHAKINOCK CREEK

16 July 1977

Station	Phosphate Filtrable	Phosphate Total	Dissolved Oxygen	BOD	TOC	COD	Turbidity**
1	1.0	1.5	6.7	12	38.2	73	260
2	6.0	9.1	8.1	50	170	410	1200
3	1.7	3.9	5.3	25	95.9	230	1100
4	0.11	0.33	5.5	6	18.2	49	170
5	0.64	0.97	1.7	8	22.5	44	190
6	0.73	1.5	3.0	11	37.8	100	500
7	2.3	4.6	6.5	21	92.7	220	650
8	1.4	3.5	6.9	12	92.0	230	1800
9	1.8	6.6	6.3	16	179	500	1800
10*	0.28	0.73	3.9	7	20.6	51	240
11*	0.26	0.64	4.0	7	19.3	52	240
12*	1.1	2.0	4.5	15	57.8	190	600

*Des Moines River Stations

**NTUs

Except for station 4, the solid series appears average for runoff conditions when compared to turbidity values. Station 4 had the highest dissolved solids which is expected to occur at lower pH values, as discussed previously regarding the specific conductance.

Turbidity values varies from 170 NTUs (station 4) to 1800 NTUs (stations 8 and 9) The nine station turbidity average for Muchakinock Creek was 850 NTUs, considerably higher than the Des Moines River (240 NTUs). The high turbidities are a direct result of the large amounts of soil particles washed into the stream during rainfall runoff.

Filtrable phosphate (range 0.11 - 6.0 mg/L) and total phosphate (range 0.33 - 9.1 mg/L) values were typical of runoff conditions and paralleled closely the turbidity values. The filtrable to total phosphate ratio did not exhibit any consistent pattern.

Dissolved oxygen values were overall quite low, ranging from 1.7 mg/L (station 5) to 8.1 mg/L (station 2). Dissolved oxygen values below 5 mg/L were observed at station 5 (1.7 mg/L), station 6 (3.0 mg/L) and the Des Moines River stations: station 10 (3.9 mg/L), station 11 (4.0 mg/L) and station 12 (4.5 mg/L).

Values for BOD (range 6 - 50 mg/L), TOC (range 18.2 - 179 mg/L) and COD (range 44 - 500 mg/L) were elevated but not unexpected during a runoff condition. As with many of the other parameters, BOD, TOC and COD values paralleled the rise and fall in turbidity values.

Two sampling stations (station 4 and station 12) are worthy of special note in regard to the Muchakinock survey. Station 4 located just downstream of a large mining area had a very low pH (3.6), a result of the acid mine drainage.

TABLE 3

ARSENIC AND SELECTED HEAVY METALS DATA FOR MUCHAKINOCK CREEK

16 July 1977

(all values in mg/L)

Station	Arsenic	Barium	Chromium	Copper	Lead	Nickel	Zinc	Turbidity**
1	<0.01	0.4	<0.01	0.02	0.01	<0.1	0.05	260
2	0.01	0.8	0.08	0.09	0.06	0.1	0.28	1200
3	0.01	0.8	0.08	0.07	0.06	0.1	0.25	1100
4	0.02	0.6	0.02	0.03	<0.01	0.4	0.84	170
5	<0.01	0.6	0.02	0.02	0.01	0.1	0.13	190
6	0.01	0.5	0.03	0.02	0.04	0.2	0.25	500
7	0.02	0.9	0.12	0.10	0.08	0.2	0.33	650
8	0.02	0.8	0.46	0.11	0.08	0.2	0.36	1800
9	0.04	1.2	0.41	0.22	0.20	0.4	0.69	1800
10*	<0.01	0.5	0.02	0.02	0.02	<0.1	0.08	240
11*	0.01	0.6	0.09	0.05	0.04	0.1	0.22	600
12*	0.01	0.6	0.09	0.05	0.04	0.1	0.22	600

*Des Moines River Stations

**NTUs

The low pH has many effects on water quality. Fecal coliforms were non-existent, not being able to live at that low a pH. The low pH also has an effect on water chemistry by dissolving many substances which is reflected in the total dissolved solids value of 2060 mg/L. Station 12, located on the Des Moines River downstream of Muchakinock Creek, when compared to station 11 above, demonstrates the tributaries' effect on water quality. Water quality in general declines from station 11 to station 12 as a result of Muchakinock Creek.

To determine if phenolic compounds were associated with runoff from the coal mine areas, samples for phenol analysis were collected at all stations. Results indicate phenol values ranged from 2 to 18 µg/L with no indications that the levels were related to the mine wastes. The highest values found, 18 µg/L, is not unusual and phenol values of this magnitude occur frequently in Iowa.

Sampels for metals analysis were collected at all stations and reportable values may be found on table 3. Arsenic was found at eight stations with the highest value being 0.04 mg/L (station 9). Barium and zinc, metals that are regularly found in Iowa surface water, were detected at all stations, ranging from 0.4 mg/L to 1.2 mg/L for barium and 0.05 mg/L to 0.84 mg/L for zinc. Ranges for the remaining metals were: chromium <0.01 to 0.46 mg/L; copper 0.01 to 0.22 mg/L; lead <0.01 to 0.20 mg/L; and nickel <0.1 to 0.4 mg/L. The highest metals values also coincide with the highest turbidity values indicating the metals are attached to the soil particle. Similar results have been found in previous rainfall runoff surveys.

SUMMARY AND CONCLUSIONS

Results of a water quality survey on Muchakinock Creek demonstrates the effects rainfall runoff from coal mine areas have on stream water quality. Rainfall runoff from broadland agricultural areas generally reflect stream increases in turbidity, fecal coliforms, phosphates and BODs with an overall decline in dissolved oxygen. This also occurred in the Muchakinock Creek survey.

In addition, the exposed high sulfate soils caused a decline in pH and a significant increase in dissolved solids. The decline in pH was so drastic at one station that it virtually sterilized the water of fecal coliform organisms. Until stabilization and vegetation is established on the debris piles, these conditions are expected to occur during rainfall runoff periods.

Jack O. Kennedy

Jack O Kennedy
Limnologist

APPENDIX

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
E 7th & Court, Rm 405, Des Moines, Iowa 50309

Town Source Specific Location	Muchakinock Creek Co. Rd. Bridge T76N R17W Sec. 17	Muchakinock Creek Co. Rd. Bridge T75N R17W. Sec. 1	Muchakinock Creek Co. Rd. Bridge T75N R16W Sec. 7
Date Collected Date Received Lab Number	16 July 1977 18 July 1977 246	16 July 1977 18 July 1977 247	16 July 1977 18 July 1977 248
	FIELD DATA		
Collection Time pH Temperature Dissolved Oxygen	11:45 21°C	12:15 21.5°C	12:30 22°C
	BACTERIOLOGICAL EXAMINATION		
Fecal Coliform/100 ml	960,000 >30 hrs	5,500,000 >30 hrs	3,200,000 >30 hrs
	CHEMICAL ANALYSIS (as mg/l unless designated otherwise)		
~~Conductance (micromhos)~~ MBAS (as LAS)	~~130~~	~~530~~	~~350~~
pH (units)	6.25	6.85	6.15
Alkalinity: P	none	none	none
T	27.0	116	29.0
NITROGEN: Organic N	3.3	2.0	10
Ammonia N	0.77	5.2	1.7
Nitrite N			
Nitrate N	1.7	1.1	2.2
Nitrate as NO_3			
RESIDUE: Total	458	2560	2250
Fixed	342	2040	1920
Volatile	116	520	330
Filtrable Residue T	164	412	400
F	108	308	320
V	56	104	80
Nonfiltrable Residue T	320	2130	1920
F	268	1780	1670
V	52	350	250
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	1.0	6.0	1.7
Total P	1.5	9.1	3.9
Dissolved Oxygen	6.7	8.1	5.3
BOD	12	50	25
COD	73	410	230
Grease or Oil			
Turbidity (JTU)	260	1200	1100
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	5.0	60	10
Sulfate (SO_4^{--})			
Phenol	12 µg/L	18 µg/L	8 µg/L
Total Organic Carbon	38.2	170	95.9

REMARKS:

COLLECTOR REPORT TO

Miller
Limnology Division
State Hygienic Lab
Des Moines Branch

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
E 7th & Court, Rm 405, Des Moines, Iowa 50309

wn			
urce	Muchakinock Creek	Little Muchakinock Creek	Muchakinock Creek
ecific Location	Hwy 92 Bridge T75N R16W Sec. 22	Co. Rd. Bridge T75N R16 W Sec. 26	Co. Rd. Bridge T75N, R16W Sec. 35
ate Collected	16 July 1977	16 July 1977	16 July 1977
ate Received	18 July 1977	18 July 1977	18 July 1977
ab Number	249	250	251
	FIELD DATA		
ollection Time	12:50	2:00	2:20
H			
emperature	24°C	24.5	24°C
issolved Oxygen			
	BACTERIOLOGICAL EXAMINATION		
ecal Coliform/100 ml	100 >30 hrs	150,000 >30 hrs	96,000 >30 hrs
	CHEMICAL ANALYSIS (as mg/l unless designated otherwise)		
onductance (micromhos)	2100	600	1200
MBAS (as LAS)			
pH (units)	3.6	6.7	6,6
Alkalinity: P	none	none	none
T	none	51.0	39.0
NITROGEN: Organic N	1.2	1.8	3.5
Ammonia N	1.9	0.91	1.0
Nitrite N			
Nitrate N	0.9	1.8	1.3
Nitrate as NO_3			
RESIDUE: Total	2420	876	2230
Fixed	2100	544	1970
Volatile	320	332	260
Filtrable Residue T	2060	460	980
F	1860	376	890
V	200	84	90
Nonfiltrable Residue T	316	436	1230
F	280	388	1100
V	36	48	130
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	0.11	0.64	0.73
Total P	0.33	0.97	1.5
Dissolved Oxygen	5.5	1.7	3.0
BOD	6	8	11
COD	49	44	100
Grease or Oil			
Turbidity (JTU)	170	190	500
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	10	10	10
Sulfate (SO_4^{--})			
Phenol	10 µg/L	5 µg/L	2 µg/L
Total organic carbon	18.2	22.5	37.8

REMARKS:

COLLECTOR REPORT TO: Miller
Limnology Division
State Hygienic Lab

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
E 7th & Court, Rm 405, Des Moines, Iowa 50309

Town Source Specific Location	Muchakinock Creek Co. Rd. Bridge T74N R16 W Sec. 2	Muchakinock Creek Co. Rd. Bridge T74N R16W Sec. 13	Muchakinock Creek Co. Rd. Bridge T74N R16W Sec. 25
Date Collected Date Received Lab Number	16 July 9177 18 July 1977 252	16 July 1977 18 July 1977 253	16 July 1977 18 July 1977 254
	FIELD DATA		
Collection Time pH Temperature Dissolved Oxygen	2:40 23.5°C	4:20 23.5°C	4:00 23.5°C
	BACTERIOLOGICAL EXAMINATION		
Fecal Coliform/100 ml	1,600,000 >30 hrs	290,000 >30 hrs	340,000 >30 hrs
	CHEMICAL ANALYSIS (as mg/l unless designated otherwise)		
Conductance (micromhos) MBAS (as LAS)	330	510	310
pH (units) Alkalinity: P T	6.95 none 60.0	6.65 none 51.0	6.5 none 39.0
NITROGEN: Organic N Ammonia N Nitrite N Nitrate N	9.7 1.0 2.0	7.6 0.73 2.7	16 0.74 1.7
Nitrate as NO_3			
RESIDUE: Total Fixed Volatile	3280 2960 320	3910 3490 420	8620 7810 810
Filtrable Residue T F V	300 190 110	410 310 100	420 330 90
Nonfiltrable Residue T F V	3020 2710 310	3500 3140 360	8270 7540 730
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P Total P	2.3 4.6	1.4 3.5	1.8 6.6
Dissolved Oxygen BOD COD	6.5 21 220	6.9 12 230	6.3 16 500
Grease or Oil Turbidity (JTU)	650	1800	1800
Total Hardness (as $CaCO_3$) Calcium (Ca^{++}) Magnesium (Mg^{++})			
Chloride (Cl^-) Sulfate (SO_4^-) Phenol Total organic carbon	15 7 µg/L 92.7	20 5 µg/L 92.0	5.0 5 µg/L 179

REMARKS:

COLLECTOR REPORT TO

Miller
Limnology Division
State Hygienic Lab
Des Moines Branch

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
E 7th & Court, Rm 405, Des Moines, Iowa 50309

Town Source Specific Location	Des Moines River Hwy 92 Bridge T75N R17W Sec. 19	Des Moines River Co. Rd. T39 Bridge T75N R16W Sec. 5	Des Moines River Hwy 137 Bridge
Date Collected Date Received Lab Number	16 July 1977 18 July 1977 255	16 July 1977 18 July 1977 256	16 July 1977 18 July 1977 257
	FIELD DATA		
Collection Time pH Temperature Dissolved Oxygen	1:15 26°C	3:10 28°C	3:35 26° C
	BACTERIOLOGICAL EXAMINATION		
Fecal Coliform/100 ml	170,000 >30 hrs	340,000 >30 hrs	190,000 >30 hrs
	CHEMICAL ANALYSIS (as mg/l unless designated otherwise)		
Conductance (micromhos)	510	530	470
MBAS (as LAS)			
pH (units)	7.3	7.6	7.15
Alkalinity: P	none	none	none
T	113	124	91.0
NITROGEN: Organic N	1.8	1.9	7.5
Ammonia N	0.33	0.18	0.59
Nitrite N			
Nitrate N	1.3	1.0	1.4
Nitrate as NO_3			
RESIDUE: Total	984	768	3690
Fixed	816	626	3320
Volatile	168	142	370
Filtrable Residue T	376	356	380
F	268	288	320
V	108	68	60
Nonfiltrable Residue T	616	428	3350
F	560	376	3040
V	56	52	310
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	0.28	0.26	1.1
Total P	0.73	0.64	2.0
Dissolved Oxygen	3.9	4.0	4.5
BOD	7	7	15
COD	51	52	190
Grease or Oil			
Turbidity (JTU)	240	240	600
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	30	35	20
Sulfate (SO_4^{--})			
Phenol	6 µg/L	2 µg/L	9 µg/L
tal organic carbon	20.6	19.3	57.8

REMARKS:

COLLECTOR Miller
REPORT TO Limnology Division
State Hygienic Lab
Des Moines Branch

WATER QUALITY REPORT
METALS

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
515:281-5371

Town			
Source	Muchakinock Creek	Muchakinock Creek	Muchaninock Creek
Specific Location	Co.Rd. bridge, T76N, R17W, Sec. 17	Co.Rd. bridge T75N, R17W, Sec. 1	Co.Rd. bridge T75N, R16W, Sec. 7
Date Collected	16 July 1977	16 July 1977	16 July 1977
Date Received	18 July 1977	18 July 1977	18 July 1977
Lab Number	246	247	248
METALS ANALYSIS (as mg/l unless designated otherwise)			
Arsenic	<0.01	0.01	0.01
Barium	0.4	0.8	0.8
Cadmium	<0.01	<0.01	<0.01
Chromium, Total	<0.01	0.08	0.08
Chromium, Hexavalent			
Copper	0.02	0.09	0.07
Lead	0.01	0.06	0.06
Mercury	<0.001	<0.001	<0.001
Nickel	<0.1	0.1	0.1
Selenium	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01
Zinc	0.05	0.28	0.25

REMARKS:

COLLECTOR REPORT TO: Miller
Limnology Division
SHL
Des Moines, Ia.

Date Reported: SEP 0 9 1977

W.J. Hausler Jr., Ph.D.
Director

WATER QUALITY REPORT
METALS

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
515:281-5371

Town			
Source	Muchakinock Creek	Little Muchaninock Cr.	Muchakinock Creek
Specific Location	Hwy 92 bridge, T75N, R16W, Sec. 22	Co.Rd. bridge, T75N, R16W, Sec. 26	Co.Rd. bridge, T75N, R16W, Sec. 35
Date Collected	16 July 1977	16 July 1977	16 July 1977
Date Received	18 July 1977	18 July 1977	18 July 1977
Lab Number	249	250	251
METALS ANALYSIS (as mg/l unless designated otherwise)			
Arsenic	0.02	<0.01	0.01
Barium	0.6	0.6	0.5
Cadmium	0.01	<0.01	<0.01
Chromium, Total	0.02	0.02	0.03
Chromium, Hexavalent			
Copper	0.03	0.02	0.02
Lead	<0.01	0.01	0.04
Mercury	<0.001	<0.001	<0.001
Nickel	0.4	0.1	0.2
Selenium	<0.01	<0.01	0.03
Silver	<0.01	<0.01	<0.01
Zinc	0.84	0.13	0.25

REMARKS:

COLLECTOR REPORT TO: Miller
Limnology Division
SHL
Des Moines, Ia.

Date Reported SEP 0 9 1977

W.J. Hausler Jr., Ph.D.
Director

WATER QUALITY REPORT
METALS

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
515:281-5371

Town			
Source	Muchakinock Creek	Muchakinock Creek	Muchakinock Creek
Specific Location	Co.Rd. bridge, T74N, R16W, Sec. 2	Co.Rd. bridge, T74N, R16W, Sec. 13	Co.Rd. bridge, T74N, R16W, Sec. 25
Date Collected	16 July 1977	16 July 1977	16 July 1977
Date Received	18 July 1977	18 July 1977	18 July 1977
Lab Number	252	253	254
METALS ANALYSIS (as mg/l unless designated otherwise)			
Arsenic	0.02	0.02	0.04
Barium	0.9	0.8	1.2
Cadmium	<0.01	<0.01	0.01
~~Chromium, Total~~	~~0.12~~	~~0.46~~	~~0.41~~
Chromium, Hexavalent			
Copper	0.10	0.11	0.22
Lead	0.08	0.08	0.20
Mercury	<0.001	<0.001	<0.001
Nickel	0.2	0.2	0.4
Selenium	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01
Zinc	0.33	0.36	0.69

REMARKS:

COLLECTOR REPORT TO

Miller
Limnology Division
SHL
Des Moines, Ia.

Date Reported SEP 0 9 1977

W.J. Hausler Jr., Ph.D.
Director

WATER QUALITY REPORT
METALS

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
515:281-5371

Town Source Specific Location	Des Moines River Hwy 92 bridge T75N, R17W, Sec. 19	Des Moines River Co.Rd. T-39 bridge, T75N R16W, Sec. 5	Des Moines River Hwy 137 bridge
Date Collected Date Received Lab Number	16 July 1977 18 July 1977 255	16 July 1977 18 July 1977 256	16 July 1977 18 July 1977 257
METALS ANALYSIS (as mg/l unless designated otherwise)			
Arsenic	<0.01	<0.01	0.01
Barium	0.5	0.4	0.6
Cadmium	<0.01	<0.01	<0.01
Chromium, Total	0.02	<0.01	0.09
Chromium, Hexavalent			
Copper	0.02	0.01	0.05
Lead	0.02	0.01	0.04
Mercury	<0.001	<0.001	<0.001
Nickel	<0.1	<0.1	0.1
Selenium	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01
Zinc	0.08	0.05	0.22

REMARKS:

COLLECTOR
REPORT TO

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W.J. Hausler Jr., Ph.D.
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