PRELIMINARY PRE-POST OPERATIONAL STUDY OF BLACK CREEK RELATED TO CITY OF SEYMOUR AND VILLAGE OF BLACK CREEK PUBLICLY OWNED TREATMENT WORKS

Performed as part of the 1979 and 1981
Lake Michigan District Basin Assessment Survey Program

Publication Date: February 1982

GENERAL INFORMATION

Drainage Basin	:	Wolf -112
Location	:	R18E, T24N, Sections 29, 30 and 31 in Seymour Township; R17E, T24N, Sections 24, 25, 26, 34, 35, 36, Cicero Township; T23N, R17E, Sections 3, 4, 7, 8, 9, 10, in Black Creek Township; Outagamie County, Wisconsin.
Chemical Investigation Dates:		July 11, 1978; September 1, 1981, and December 15, 1981.
Survey Personnel	:	Michael Reif, Dennis Weisensel, Tim Rasman, Laura Herman, Tim Doelger and Mark Corbett.
Periphyton Collection and Identification	:	Tim Rasman
Periphyton Evaluation	:	Tim Rasman and Michael Reif
Macroinvertebrate Identification	:	Nancy McNauton (1979) and Laura Herman (1981)
Macroinvertebrate Collection	:	Linda Vogen (1979) and Michael Reif (1981)

Author: Michael D. Reif

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY AND CONCLUSIONS

1. A chemical, physical, and biological evaluation of Black Creek was conducted in 1978 and 1979 to document stream conditions prior to the upgrading of the City of Seymour and Village of Black Creek POTW's.

2. A chemical, physical, and biological evaluation of Black Creek above and below the Village of Black Creek was conducted in 1981 to evaluate stream conditions after the upgrading of this POTW prior to the startup of the new City of Seymour POTW scheduled for July 1982.

3. The 1978 and 1979 chemical and biological surveys found Black Creek to be severely polluted below the City of Seymour POTW downstream, approximately 8 stream miles to the Village of Black Creek POTW and below the Village of Black Creek POTW. Heavy slime growths and sludge deposits were documented at the outfalls and at least 1/4 mile below both POTW's. All macroinvertebrate communities below the POTW's indicated very poor water quality with the upstream (above the City of Seymour POTW) control indicating very good to excellent water quality. Periphyton communities changed significantly from a control (located above the City of Seymour POTW) with an entirely diatom community to communities (below both POTW's) dominated by filamentous bacteria and algae that indicate organic enrichment. Dissolved oxygen levels were found to be near 0 below both POTW's.

4. The 1981 chemical, physical, and biological surveys conducted at the Village of Black Creek POTW documented continued severe pollution of Black Creek since the old City of Seymour POTW located above the Village of Black Creek impacts Black Creek downstream beyond the Village of Black Creek POTW. All macroinvertebrate communities above and below the Village of Black Creek POTW still indicated very poor water quality. However, the heavy slime growths and sludge deposits at the Village of Black Creek POTW and 1/4 mile downstream were gone as a result of the upgrading of the facility which is a dramatic improvement. However, at 1/4 mile below the POTW, Black Creek was found to be severely polluted by a creamery, Outagamie Producers Cooperative, to the point where slime growths covered nearly 100% of the creek bottom and large sludge beds reached 6" in depth. The polluted creamery effluent has since been eliminated.

5. A nutrient and total phosphorus load evaluation of Black Creek conducted on December 15, 1981, found total phosphorus loads at State Road 1 mile below the Village of Black Creek POTW to be 57.4 lbs/day of which 94.6% was due to the City of Seymour POTW. Also, a majority of the total nitrogen at State Road was determined to be due to the City of Seymour POTW.

6. A masters thesis was conducted on the water chemistry and diatoms of Black Creek in 1970-71. Yearly average total phosphorus levels above the City of Seymour POTW were found to be 1.00 mg/l, 3.00

mg/l in the stretch between the City of Seymour POTW and Village of Black Creek POTW, and 3.65 mg/l below the Village of Black Creek POTW. Diatom communities above the City of Seymour POTW indicated clean water quality, while below the City of Seymour and Village of Black Creek POTW's the diatom community was characteristic of eutrophic slow-moving streams.

7. It is mandatory that both the City of Seymour and Village of Black Creek POTW's be upgraded because of the overlap of degradation zones described above. This upgrading should lower the biotic index values of Black Creek below these plants from over 4.0 (indicating very poor water quality) down to near 2.0 (indicating very good water quality) as in the control site above the City of Seymour POTW. This upgrading should significantly decrease nutrient loads though they may remain high because of creamery inputs that affect both POTW's.

OBJECTIVES

The objectives of this study were: (1) to document water quality conditions (biological, chemical, and physical) in Black Creek as they related to the effluents of the City of Seymour and Village of Black Creek Publicly Owned Treatment Works (POTW) prior to modifications and upgrading of these facilities designed to improve stream water quality conditions; and (2) to document water quality conditions (biological, chemical, and physical) in Black Creek related to the effluent of the Village of Black Creek POTW after upgrading of this facility.

INTRODUCTION

Black Creek in Outagamie County received effluent from the City of Seymour (1980 population 2,530) POTW and the Village of Black Creek (1980 population of 1,097) POTW. The City of Seymour is building a new activated sludge plant that will have secondary effluent limits and phosphorus limits (Table 1). The old City of Seymour POTW (which was discharging throughout this study) is an activated sludge plant that is severely hydraulically and organically overloaded. Construction completion of the new POTW is scheduled for July, 1982. Final effluent limits for this plant are in Table 2. The old Village of Black Creek POTW was an activated sludge plant that was severely hydraulically and organically overloaded. The effluent limits for this plant are in Table 3. A new activated sludge plant was constructed on the same site and began discharging in the spring of 1979. Final effluent limits for this plant are in Table 4.

PHYSICAL SETTING OF THE STUDY AREA

Black Creek is a small hard water creek that flows 19.7 miles through the northern half of Outagamie County. It empties into the Shioc River approximately 4 miles downstream from the Village of Black Creek. The study reach extends from Hwy C above the City of Seymour downstream to State Road below the Village of Black Creek (Figure 1).

Within the study reach, Black Creek was extensively polluted by effluents from the City of Seymour POTW and Village of Black Creek POTW and Outagamie Producers Cooperative of Black Creek, during and before this study.

Land use along Black Creek, within the study reach, was approximately 50% agricultural, 40% marsh, and 10% wooded. The upper part (near the City of Seymour POTW) of the study reach had a significantly greater slope, and as a result more riffles, than the lower part (Figure 2). The approximately 4 miles of the lower end of the study reach of Black Creek was marsh where the creek was very slow moving (with a few short riffles) and the bottom was almost entirely silt. This area is typified by heavy mats of the duckweed Lemna minor, and large growths of emergent and submergent macrophytes including Sagitaria latefolia, Vallisneria americans, Sparganium eurycarpum and Potomogeton pectinatus (Garfinkle, 1974). The heavy growth of duckweed can be seen in the photographs located in the Appendix.

Table 1. WPDES permit effluent limits of the City of Seymour POTW through December 31, 1981 (in effect throughout the study).

Parameter	Monthly Average	Weekly Average	Minimum	Maximum
BOD_5 (mg/l)	50	75	-	-
SS (mg/l)	50	75	-	-
pH (s.u.)	-	-	6.0	9.0

Table 2. Final WPDES permit effluent limits for the new City of Seymour POTW (January 1, 1981 - December 31, 1986).

Parameter	Monthly Average	Weekly Average	Minimum	Maximum
BOD_5 (mg/l)	15	-	-	-
SS (mg/l)	20	-	-	-
NH_3-N (mg/l; May-Oct.)	-	3.0	-	-
NH_3-N (mg/l; Nov.-April)	-	6.0	-	-
D.O. (mg/l)	-	-	4.0	-
pH (s.u.)	-	-	6.0	9.0

Table 3. WPDES permit effluent limits of the Village of Black Creek POTW (until June 30, 1979).

Parameter	Monthly Average	Weekly Average	Minimum	Maximum
BOD_5 (mg/1)	75	100	-	-
SS (mg/1)	75	100	-	-
pH (s.u.(	-	-	6.0	9.0

Table 4. Final WPDES permit effluent limits of the Village of Black Creek POTW (July 1, 1979 - June 30, 1984).

Parameter	Monthly Average	Weekly Average	Minimum	Maximum
BOD_5(mg/1)	15	30	-	-
SS (mg/1)	20	30	-	-
NH_3-N (mg/1; May-Oct.)	-	3.0	-	-
NH_3-N (mg/1; Nov.-April)	-	6.0	-	-
D.O. (mg/1)	-	-	6.0	9.0
pH (s.u.)	-	-	4.0	-

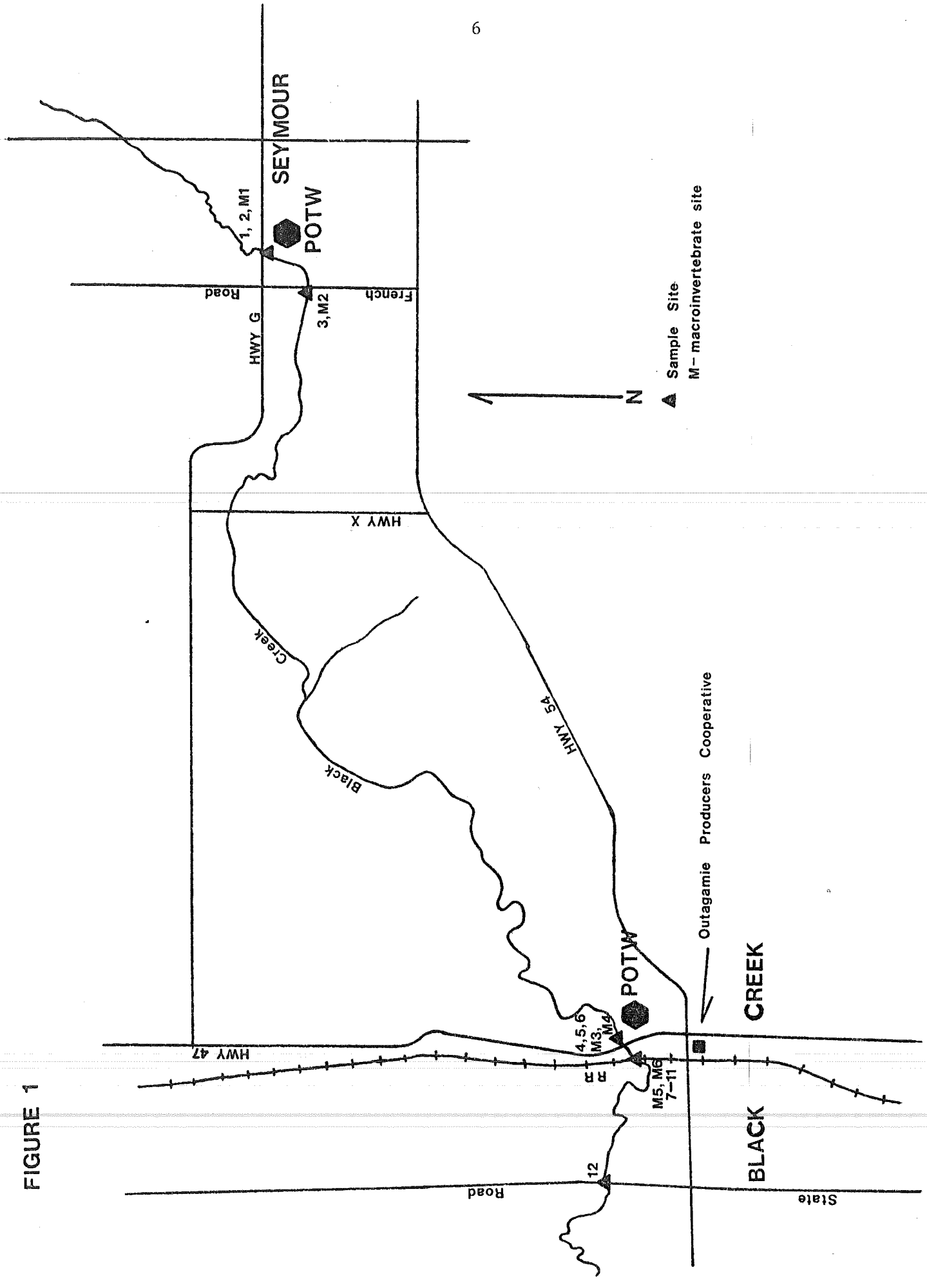

SEYMOUR
POTW
1, 2, M1
3, M2
HWY G
French
Road
HWY X
Black
Creek
HWY 54
N
Sample Site
M – macroinvertebrate site
Outagamie Producers Cooperative
POTW
4,5,6
M3,
M4
M5, M6
7–11
BLACK
CREEK
HWY 47
12
Road
State

FIGURE 1

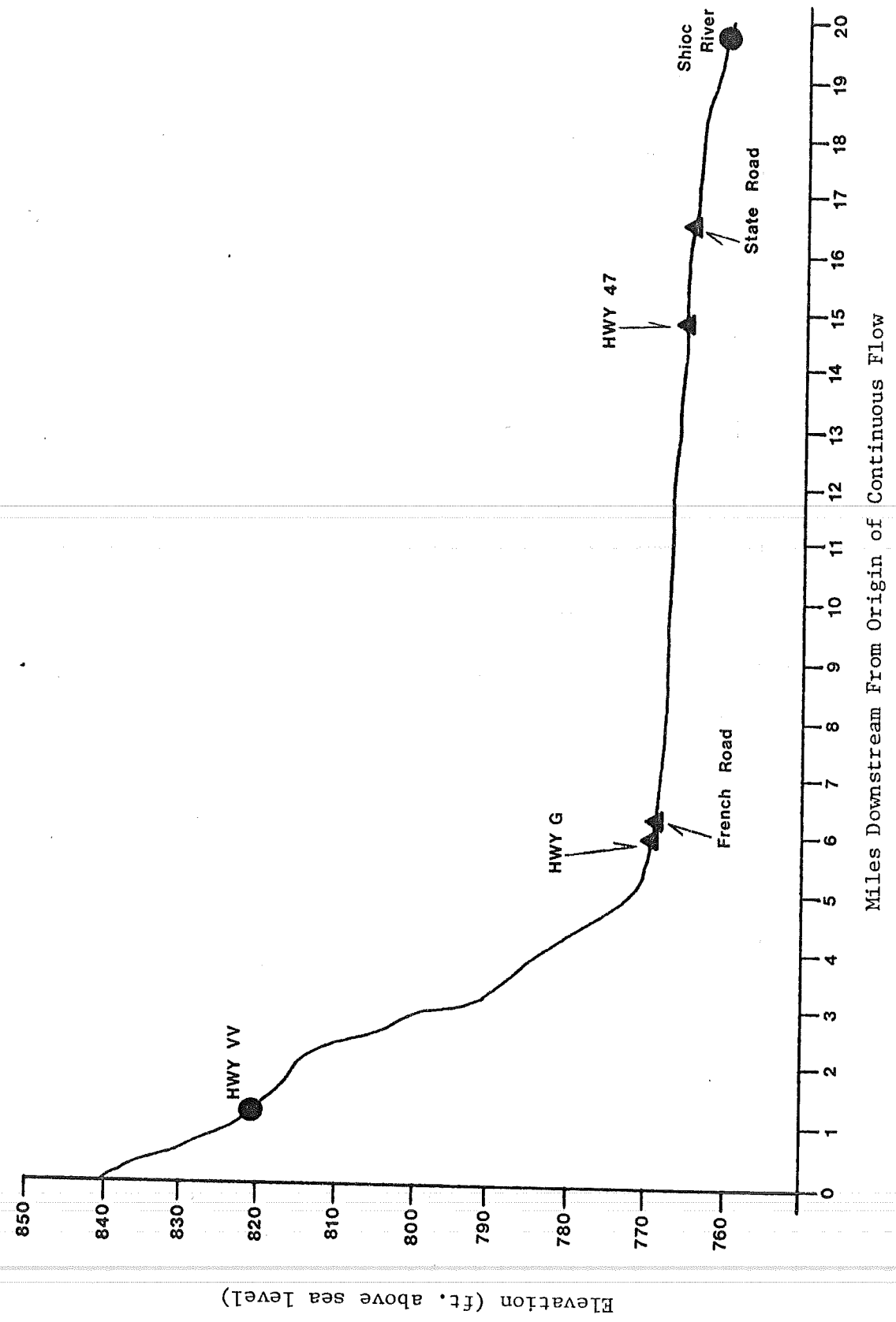


Figure 2. Elevation profile of the continuous flowing portion of Black Creek (modified from Garfunkle, 1974).

MATERIALS AND METHODS

Since the impact zone in Black Creek below the City of Seymour POTW overlaps that of the Village of Black Creek POTW, both were sampled together in 1978 prior to upgrading of the Village of Black Creek POTW. Chemical samples were collected on July 11, 1978, from above the City of Seymour POTW downstream to State Road below the Village of Black Creek POTW (Figure 1). Samples were iced and sent to the State Laboratory of Hygiene for biochemical oxygen demand, 5-day (BOD_5), suspended solids (SS), dissolved ammonia-nitrogen (NH_3-N), and lab pH. Temperature and dissolved oxygen (D.O.) were analyzed on-site.

A post operational chemical survey was conducted on Black Creek on September 1, 1981, related to the new Village of Black Creek POTW. Samples were collected from site 5 above the POTW to site 11 at State Road (Figure 1). Samples were iced and sent to the State Laboratory of Hygiene for BOD_6, SS, total phosphorus (T-P),dissolved ortho phosphorus (O-P), total kjeldahl nitrogen (TKN), NH_3-N, dissolved nitrite plus nitrate-nitrogen (NO_2+NO_3-N), chlorides (Cl), conductivity, fecal coliform (FC), fecal streptococcus (FS), and lab pH. As a result of a heavy amount of duckweed in samples 5 and 7, these samples were sieved with a No. 40 sieve prior to all analyses.

During a non-point source survey on the Shioc River, conducted on December 15, 1981, samples were collected from sites 1, 2, 6, 7 and 11 to determine how much of the phosphorus load from Black Creek to the Shioc River was due to the City of Seymour POTW and the Village of Black Creek POTW. Samples were treated and analyzed for as in the September 1, 1981, chemical survey except no duckweed was present (so samples didn't have to be seived).

Macroinvertebrates were collected on June 5 and November 7, 1979, and on November 11, 1981, in connection with the studies of those years. All macroinvertebrate sites were sampled in 1979 except M_4-M_6 (Figure 1). During the 1981 survey, M_3-M_7 were sampled.

Macroinvertebrate sites were selected that were similar in physical characteristics whenever possible so the only variable between sites would be water quality.

A D-frame net was used to collect bottom material (12-inch opening with $1mm^2$ mesh openings). Macroinvertebrates were collected by placing the net downstream and disturbing the bottom with one's feet, while the current carried the dislodged material into the net. Macroinvertebrates were also collected manually from sticks, rocks and leaves collected from the stream. An attempt was made to collect sufficient material to obtain at least 100 organisms. However, as a result of the extensive pollution of many sites, few organisms were collected despite very intensive collecting. All material was placed into pint Mason jars half full of 95% ethyl alcohol.

In the laboratory macroinvertebrates were initially separated into easily discernable taxa. They were picked from a white enamel pan and put into vials containing 95 percent alcohol. Picking of each sample continued until at least 100 organisms were picked. Macroinvertebrates were then identified to the lowest possible taxonomic level.

A taxonomic list was prepared for each site with numbers of each taxa. Biotic index values were assigned for each appropriate taxa and a biotic index calculated for each site according to Wisconsin Department of Natural Resources Technical Bulletin 100 (1981 updated edition) by William Hilsenhoff. Biotic index values ranged from 0-5 with 0 being indicative of streams with no organic pollution and 5 of streams that have severe pollution. Water quality determinations from biotic index values by Hilsenhoff are below (Table 5).

Table 5. Water quality determinations from biotic index values.

Biotic Index	Water Quality	State of Stream
1.75	Excellent	No organic pollution
1.75 - 2.25	Very Good	Possible slight pollution
2.26 - 2.75	Good	Some pollution
2.76 - 3.50	Fair	Significant pollution
3.51 - 4.25	Poor	Very significant pollution
4.26 - 5.00	Very Poor	Severe pollution

Periphyton samplers were placed on July 11, 1978, at chemical sites 1, 4, 5 and 8. Periphyton were allowed to colonize for 23 days (until August 3, 1978). Periphyton were sampled by attaching 3 glass slides to pieces of two by fours (approximately 12 inches long) which were suspended in the stream just below the surface.

After retreival, the top side of 1 or 2 slides were scraped in the field with a clean slide into a known volume of preservative (2 drops lugols per 100 ml distilled water) to be used for identification. Another slide was wrapped in aluminum foil, iced, and sent to the State Laboratory of Hygiene for chlorophyll analyses.

RESULTS AND DISCUSSION

Summary of the 1978 and 1981 Discharge Monitoring Reports for the City of Seymour and Village of Black Creek POTW's.

Summaries of the City of Seymour POTW discharge monitoring reports are in Tables 6 and 7 for 1978 and 1981 respectively. A bar graph of the effluent BOD_5 concentration data is in Figure 3 for 1978 and 1981. A very large increase in BOD_5 and SS concentrations occurred from 1978 to 1981 (64% and 45% for BOD_5 and SS respectively on a yearly average). The same holds true for BOD_5 and SS loads which increased 79% and 37% for BOD_5 and SS respectively on a yearly basis. Much of the increases are apparently due to increased organic loads from North Osborn Cheese Co. disrupting an already overloaded POTW.

Summaries of the Village of Black Creek POTW discharge monitoring reports are in Tables 8 and 9 for 1978 and 1981 respectively. A bar graph of the BOD_5 concentration data is in Figure 4 for 1978 and 1981. A bar graph of the total phosphorus concentrations and loads for 1981 is in Figure 5. A very large decrease in BOD_5 and SS concentrations and loads

occurred from 1978 to 1981 (95% reductions in concentration and 98% reductions in load). This decrease can be attributed to the new POTW which began operation in spring of 1979. However, 1981 data are variable with BOD_5 concentrations varying between 1 and 326 mg/l and SS concentrations varying between 1 and 99 mg/l through the year. The same holds true for total phosphorus which varied from a minimum daily average of 0.30 mg/l to a maximum daily average of 11 mg/l. According to comments on the discharge monitoring reports, these variations are due to periodic disruptions of the POTW by effluent from Outagamie Producers Cooperative.

Chemical Survey Results

The chemical survey conducted on Black Creek on July 11, 1978, prior to upgrading of the Village of Black Creek POTW documented heavily impacted water quality. Dissolved oxygen levels dropped from 6.1 mg/l above the City of Seymour POTW to 0.8 mg/l at French Road and decreased again from 3.1 mg/l above the Village of Black Creek POTW to 0.2 mg/l at mixed point and rose slightly to 0.5 mg/l at site 8 (Table 10). Sharp rises in BOD_5 and SS can also be attributed to these POTW's. There was little change in NH_3-N concentrations from above to below the City of Seymour POTW. An increase in NH_3-N was documented at 0.38 mg/l above the Village of Black Creek presumably due to marsh effects.

Heavy slime growths and large sludge beds were noticed at French Road below the City of Seymour POTW during the July 11, 1978, chemical survey. Distressed fish were also noticed including bullheads and suckers. Heavy slime growths and sludge beds were also noticed at the Village of Black Creek POTW outfall and downstream to the railroad tressel. No sampling was conducted at State Road on July 11, 1978, so it is unknown how far these slimes and sludge extended.

On September 1, 1981, a chemical survey was conducted on Black Creek above and below the Village of Black Creek POTW after upgrading of the POTW in 1979. A very heavy duckweed growth was observed above and below the POTW outfall covering nearly 100% of the creek surface (see photographs). This resulted in difficult sampling (i.e. it was difficult to obtain duckweed-free samples) above the POTW and at the mixed point. Suspended solids analyses were not conducted at these sites because most of the solids would have been due to duckweed. It is assumed that sieving these samples resulted in fairly representative BOD_5, nutrient, Cl and conductivity data.

Dissolved oxygen levels were low at all Black Creek stations sampled indicating severe water quality problems above and below the Village of Black Creek POTW (Table 4). BOD_6 levels were high at all sites in Black Creek. According to the D.O. and BOD_6 data the POTW effluent was of better quality than Black Creek. Nutrient levels were very high at all sites in Black Creek. Much of the high nutrient levels above the POTW are probably due to the continued (or increased) poor quality effluent from the City of Seymour POTW. I assume the heavy duckweed growth as well as high nutrient levels will decrease with the startup of the new City of Seymour POTW in the summer of 1982.

Very high T-P and O-P levels were documented by Garfinkel (1974) in 1970-71 on the stretch of Black Creek between the City of Seymour POTW and Village of Seymour POTW averaging 3.00 mg/l for T-P and 2.95 mg/l for O-P and even higher levels in the stretch between the Village of Black Creek POTW and State Road averaging 3.65 mg/l for T-P and 3.50 mg/l for O-P. Total - P in Black Creek above the City of Seymour POTW averaged less than 1.00 mg/l.

No slimes or sludge deposits were evident near the Village of Black Creek POTW during the 1981 chemical survey as was the case in 1978. This partial cleanup of Black Creek (partial because of continued heavy impact from the City of Seymour POTW) can be attributed to the much improved quality of effluent from the Village of Black Creek POTW. However, very heavy white to grey slime growths and heavy grey to black sludge deposits were very evident in the Outagamie Producers Cooperative Tributary and downstream from there through State Road. Black sludge beds as thick as 6" were observed at State Rpad along with a very heavy slime growth covering most of the creek bottom. The Frank Pure Foods Tributary (Figure 1) was clean with good water quality.

During the September 1, 1981, survey, I evaluated the Outagamie Producers Cooperative outfall to determine if this problem originated there. This facility's outfall 001 was clean and analyses showed no problems (BOD_6-1.8 mg/l and SS - 2 mg/l). I informed the maintenance supervisor at Outagamie Producers of the problem in the creek and asked him if they had any other outfalls. He said they didn't (see WPDES file for contact information).

During the macroinvertebrate survey on November 11, 1981, (described in the Macroinvertebrate Survey Results and Discussion) I observed a similar slime growth in this tributary and in Black Creek below this tributary down through State Road though it appeared even more extensive. The tributary smelled highly of creamery waste at this point where it met Black Creek. I then made a thorough evaluation of the storm sewer around Outagamie Producers with the POTW operator and Outagamie Producers' maintenance chief and documented that the polluted effluent was coming from this facility at a point in the storm sewer above 001 (see WPDES file for correspondence). This problem has apparently been resolved. Outagamie Producers Cooperative has been given, and has paid, a Chapter 29:29 citation for this discharge which was effluent from a reverse osmosis system.

The December 15, 1981, chemical survey documented high BOD_5, SS, and nutrient concentrations and loads coming from the City of Seymour POTW (Tables 13 and 14). Of the T-P load at State Road, 94.6% can be attributed to the City of Seymour POTW. Also, a major percent of the BOD_5 and total nitrogen at State Road can be attributed to the City of Seymour POTW. A majority of the rest of the T-P, T-N and BOD_5 at State Road can be attributed to the Village of Black Creek POTW.

Macroinvertebrate Survey Results and Discussion

The physical characteristics of all macroinvertebrate sites are in Table 21.

The June 5 and November 7, 1979, macroinvertebrate surveys of Black Creek documented a heavy degredation of the macroinvertebrate community below the City of Seymour POTW. Above the POTW the community was dominated by stoneflies and mayflies while below the POTW at French Road (site M_2) it was dominated by bloodworms and other highly pollution tolerant chironomids (Table 15). The resultant increase in biotic index from above to below the POTW was 1.68 to 3.63 in the spring (clean undisturbed to poor water quality) and 2.70 to 4.94 in the fall (fair to very poor water quality) (Table 16).

There was essentially little difference in the 1979 spring and fall macroinvertebrate communities between site M_3 above the Village of Black Creek and site M_7 at State Road except that a large number of black flies were found at State Road but not at site M_3 in the spring as a result of the increased current at State Road (Table 15). The biotic index values were all similar between sites and seasons, indicating very poor water quality (Table 16).

No change (from 1978) can be measured from the November 11, 1981, macroinvertebrate sampling to describe the increase in effluent quality coming from the Village of Black Creek POTW because of continued (or increased) heavy pollution of Black Creek by the City of Seymour POTW and the extensive degredation of Black Creek caused by the effluent from Outagamie Producers Cooperative (a taxonomic list of macroinvertebrates for 1981 is in Table 18). Biotic index values are greater than 4.0 at all sites (Table 18). However, though near 100 organisms were obtained at M_3-5 (above Outagamie Producers Tributary) extensive collecting acquired few organisms at M_6 and M_7 below Outagamie Producers Tributary. This indicates an extensive amount of pollution beyond that of the reach between M_3 and 5. This extensive pollution was caused by Outagamie Producers Cooperative. The stretch of Black Creek from M_3-5 had a clean substrate (i.e. free of sludge and slimes) as was true on September 1, 1981, illustrating the partial cleanup of Black Creek due to the POTW upgrading since this stretch was characterized by heavy slime growth and sludge deposits prior to upgrading. The upgrading of the City of Seymour POTW in 1982 and the elimination of the heavy pollution from Outagamie Producers Cooperative should be reflected in significantly cleaner macroinvertebrate communities and lower biotic index values at all sites (probably indicating at least very good water quality because the control above the City of Seymour POTW in 1978 indicated very good to excellent water quality).

Periphyton Results and Discussion

The 1978 periphyton sampling and analyses showed a periphyton community above the City of Seymour POTW to be composed entirely of diatoms with Cocconeis spp comprising 76% of the total number (Table 19). A dramatic change in algae community structure was documented from above the POTW to French Road where community dominance shifted to the red algae Audouinella spp comprising 76% of the total number), though diatoms still made up 68.9% of the total number. Community diversity also increased significantly at French Road. Dominance of the diatom flora shifted from Cocconeis to Nitzchia which was also documented by Garfinkel (1974). Patrick (1967) noted a community dominated by Nitzchia palea

and Navicula luzonensis is characteristic of eutrophic slow-moving streams which was the case at French Road.

A decrease in numbers per unit area and chlorophyll a (Table 20) from above to below the POTW can be assumed to have resulted from an abundance of dead organic matter and filamentous bacteria growing on the slide taking space and using nutrients that could be used by the algae.

A periphyton sample from above the Village of Black Creek POTW is not available. The periphyton community at the railroad tressel site below the Village of Black Creek POTW was dominated by the blue green algae Oscillatoria sp and the diatom Nitzchia spp. This, as well as an abundant growth of filamentous bacteria, indicates heavy organic and nutrient enrichment. The dominance of Nitzchia is confirmed by Garfinkel (1974) for this section of creek.

Using Palmer's (1968) list of 60 genera as indicators of organic enrichment (with number 1 being most tolerant and 60 being least tolerant of pollution of the 60) affirms the above conclusions. According to Palmer Cocconeis is number 52 on the list, while Nitzchia is 6, Navicula is 7, and Oscillatoria is 2. Therefore, the periphyton community above the City of Seymour POTW indicates a much cleaner water quality than at French Road because it is dominated heavily by Cocconeis, while at French Road the periphyton community was dominated by Nitzchia though the dominance was not nearly as heavy as with Cocconeis in the above site. Palmer's list would indicate even more degradation at the railroad tressel below the Village of Black Creek POTW since 92 percent of the algae periphyton community was comprised of Oscillatoria, Nitzschia, and Navicula.

The upgrading of the City of Seymour and Village of Black Creek POTW's should increase the diatom dominance of the periphyton community at French Road and at least result in a greater growth of diatoms at the railroad tressel below the Black Creek POTW. The elimination of high BOD should eliminate all filamentous bacteria growth. However, high nutrient levels (though they will probably decrease) partially resulting from creamery inputs to the POTW's along with elimination of filamentous bacteria growth may significantly increase total algae production and chlorophyll a below the POTW's.

Table 6. Summary of the City of Seymour POTW discharge monitoring reports for 1978.

Month	Monthly Average Flow MGD	BOD_5 Monthly Average mg/l	BOD_5 Mimimum Daily Average mg/l	BOD_5 Maximum Daily Average mg/l	BOD_5 Monthly Average lbs/day	SS Monthly Average mg/l	SS Minimum Daily Average mg/l	SS Maximum Daily Average mg/l	SS Monthly Average lbs/day
January	0.247	80	4	350	165	106	6	458	218
February	0.247	52	30	100	107	43	16	86	89
March	0.412	84	22	200	289	57	23	130	196
April	0.666	52	26	148	289	76	36	105	422
May	0.523	52	24	225	227	60	22	244	262
June	0.381	170	36	258	541	329	39	688	1046
July	0.530	112	24	385	495	189	69	624	836
August	0.454	41	28	60	155	55	42	72	208
September	0.538	149	31	497	669	290	34	1048	1302
October	0.559	70	15	165	327	97	24	271	452
November	0.447	175	57	268	653	255	70	770	951
December	0.303	186	18	577	470	324	80	700	819
Yearly	0.442	102	4	577	366	157	6	1048	567

Table 7. Summary of the City of Seymour POTW discharge monitoring reports for 1981.

Month	Monthly Average Flow MGD	BOD_5 Monthly Average mg/l	BOD_5 Minimum Daily Average mg/l	BOD_5 Maximum Daily Average mg/l	BOD_5 Monthly Average lbs/day	SS Monthly Average mg/l	SS Minimum Daily Average mg/l	SS Maximum Daily Average mg/l	SS Monthly Average lbs/day
January	0.271	127	60	247	135	130	28	452	138
February	0.439	172	70	442	630	175	64	370	641
March	0.460	168	44	483	645	258	65	940	990
April	0.678	193	44	500	1092	119	53	331	673
May	0.507	353	91	770	1494	173	37	320	732
June	0.510	529	253	1022	2251	178	52	610	758
July	0.448	693	334	1050	2591	241	44	576	901
August	0.427	608	350	860	2166	334	160	676	1190
September	0.435	581	137	1610	2109	323	75	544	1173
October	0.559	734	150	1485	3424	350	40	776	1633
November	0.431	789	470	1040	2838	339	232	496	1219
December	0.376	535	268	880	1679	265	36	1089	831
Yearly	0.462	457	44	1610	1755	240	28	1089	907

Figure 3. Bar graph of the 1978 and 1981 City of Seymour POTW average monthly BOD_5 concentrations.

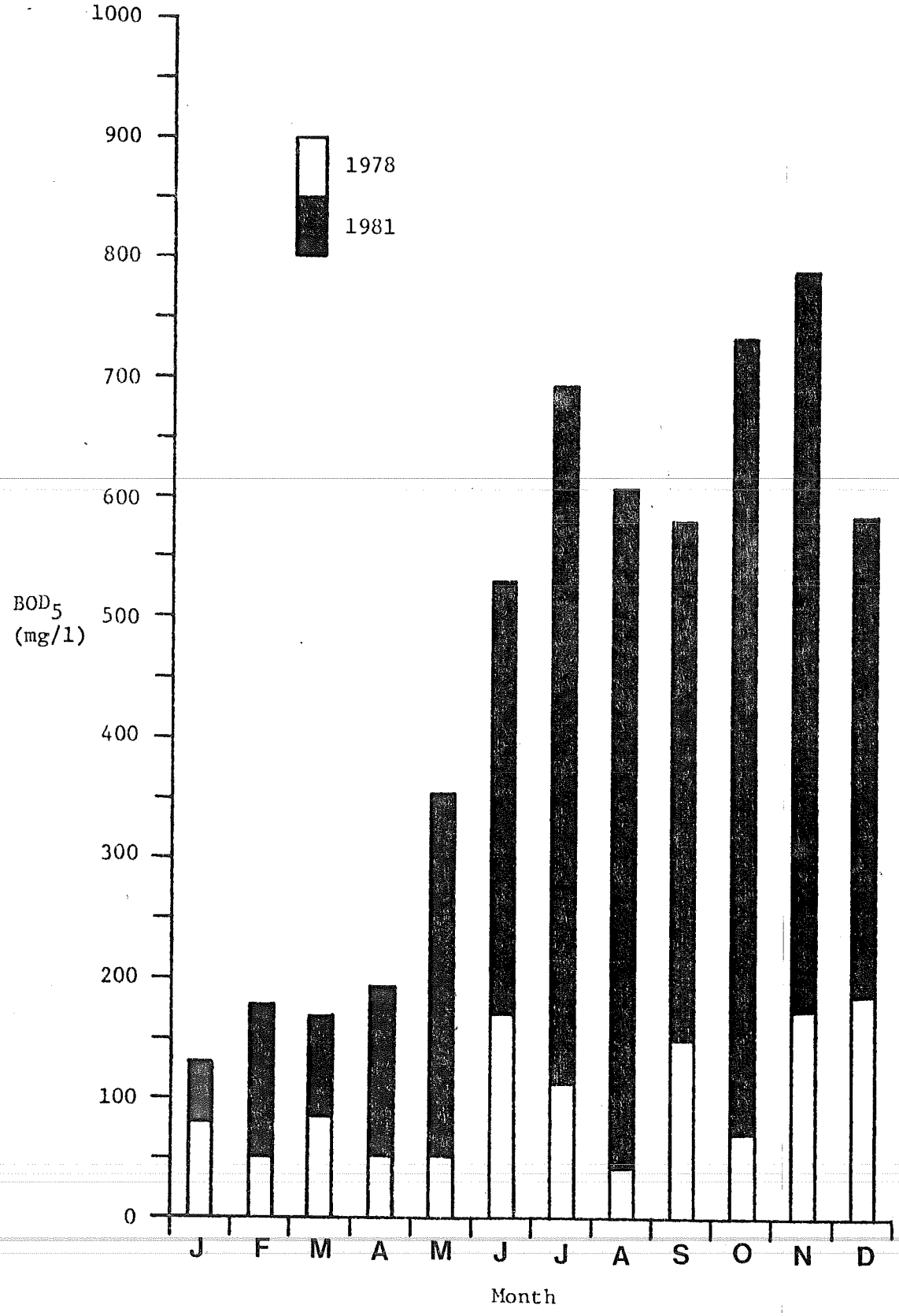


Table 8. Summary of the Village of Black Creek POTW discharge monitoring reports for 1978.

Month	Monthly Average Flow MGD	BOD_5 Monthly Average mg/l	BOD_5 Minimum Daily Average mg/l	BOD_5 Maximum Daily Average mg/l	BOD_5 Monthly Average lbs/day	SS Monthly Average mg/l	SS Minimum Daily Average mg/l	SS Maximum Daily Average mg/l	SS Monthly Average lbs/day
January	0.1708	441	289	608	629	442	40	1378	630
February	0.1781	482	248	603	716	687	312	1120	1021
March	0.2016	764	566	1030	1285	615	168	1056	1035
April	0.3703	572	372	785	1768	322	24	792	995
May	0.3154	921	435	1330	2424	502	80	824	1321
June	0.2759	444	243	785	1022	370	40	768	852
July	0.2619	706	416	1120	1543	513	128	960	1121
August	0.2176	689	470	915	1251	800	432	1480	1453
September	0.2770	468	107	1100	1082	751	200	1984	1736
October	0.2942	283	47	409	695	355	16	672	872
November	0.2717	228	86	381	517	340	112	552	771
December	0.2186	199	89	475	270	403	80	896	914
Yearly	0.2544	516	47	1330	1100	508	16	1984	1060

Table 9. Summary of the Village of Black Creek POTW discharge monitoring reports for 1981.

Month	Monthly Average Flow MGD	BOD_5 Monthly Average mg/l	BOD_5 Minimum Daily Average mg/l	BOD_5 Maximum Daily Average mg/l	BOD_5 Monthly Average lbs/day	SS Monthly Average mg/l	SS Minimum Daily Average mg/l	SS Maximum Daily Average mg/l	SS Monthly Average lbs/day	T-P Monthly Average mg/l	T-P Minimum Daily Average mg/l	T-P Maximum Daily Average mg/l	T-P Monthly Average lbs/day
January	0.139	3	1	6	3	10	5	20	12	4.61	2.70	8.60	5.35
February	0.160	20	2	246	27	16	4	78	104	4.72	2.20	7.82	6.30
March	0.185	7	2	20	11	10	2	22	15	2.50	1.49	6.54	3.86
April	0.258	7	2	24	15	7	2	14	15	1.04	0.64	1.63	2.24
May	0.145	5	2	7	6	7	2	15	8	1.20	0.53	2.91	1.45
June	0.131	25	3	324	27	7	2	20	8	1.37	0.40	4.12	1.50
July	0.072	8	2	82	5	8	2	54	5	3.35	0.67	10.15	2.01
August	0.082	7	1	34	5	7	2	13	5	2.17	0.51	6.00	1.48
September	0.136	6	1	24	7	7	2	15	8	0.94	0.31	4.29	1.07
October	0.213	19	11	54	34	22	2	54	39	0.90	0.30	2.09	1.60
November	0.186	34	3	150	53	32	4	99	50	4.5	1.7	9.1	7.0
December	0.181	31	1	326	47	20	1	86	30	2.9	1	11	4.4
Yearly	0.157	14	1	326	20	13	1	99	25	2.52	0.30	11	3.19

Figure 4. Bar graph of the Village of Black Creek POTW effluent BOD_5 average monthly concentrations for 1978 and 1981.

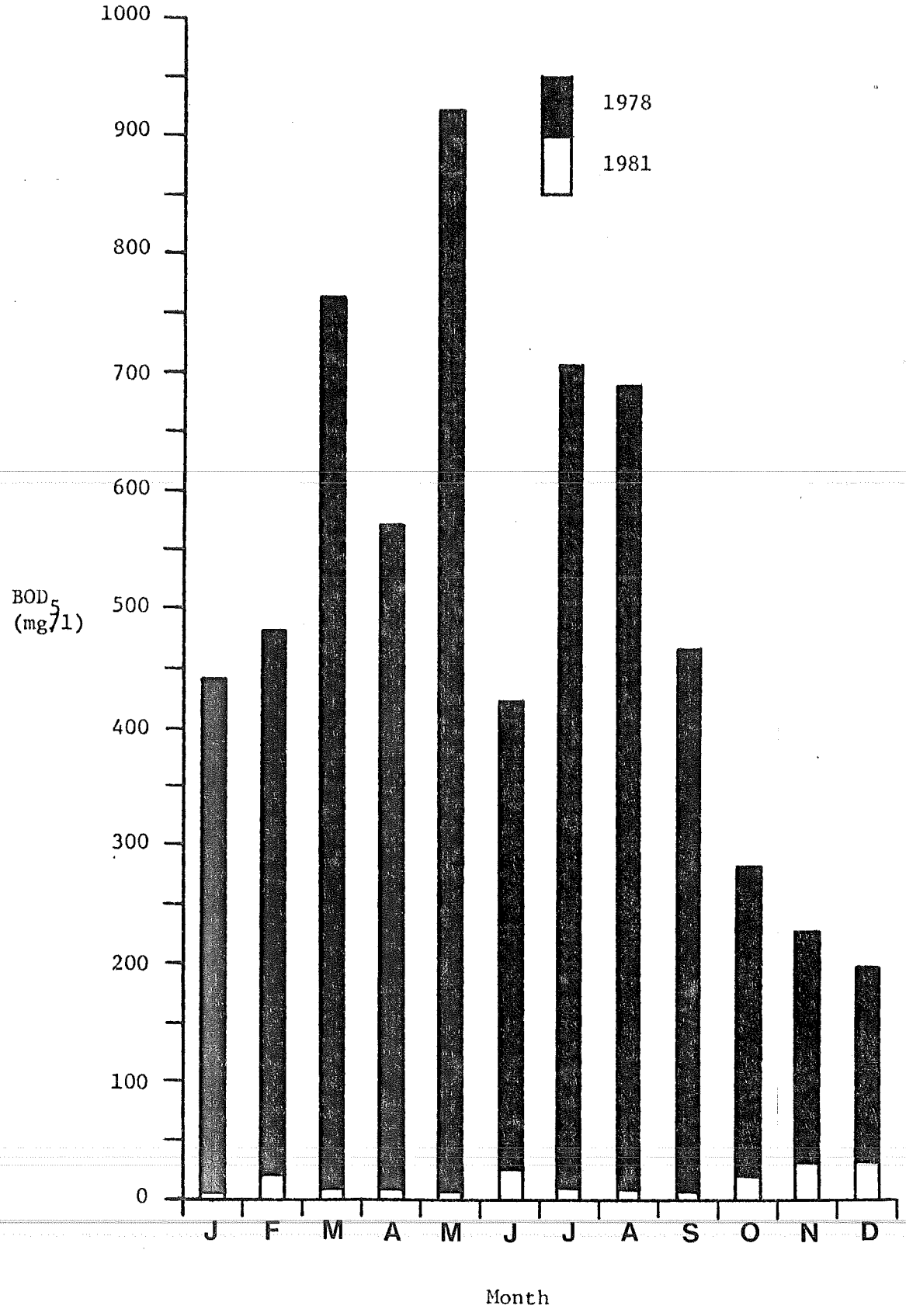


Figure 5. Bar graph of the 1981 Village of Black Creek POTW effluent average monthly T-P concentrations.

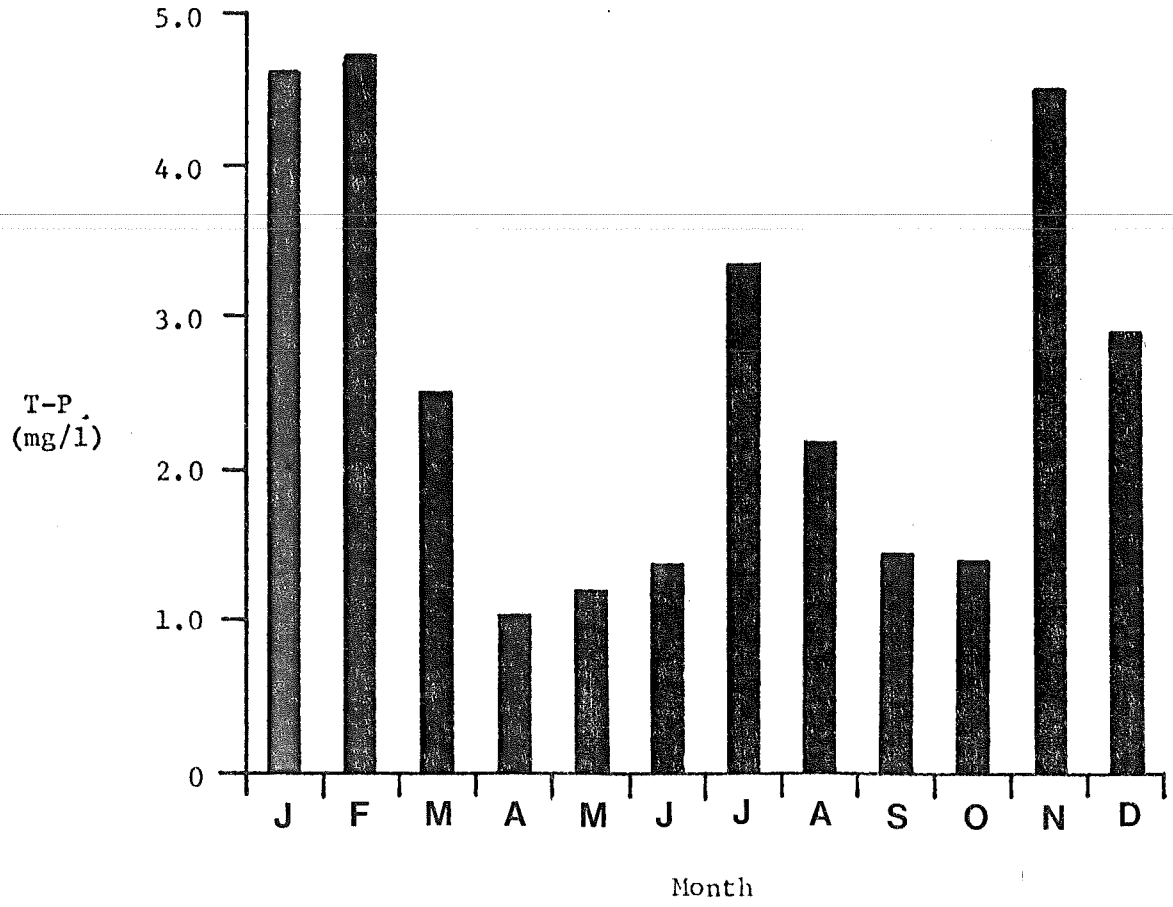


Table 10. Chemical results from the July 11, 1978 survey.

	Site					
Parameter	1	3	4	5	7	8
Time	10:30	10:40	11:30	13:00	13:30	14:00
Water Temp °C	18	18	18	19	22	22
D.O. (mg/l)	6.1	4.7	0.8	3.1	0.2	0.5
BOD_5 (mg/l)	2.9	95	30	3.7	8	44
Lab pH (e.u.)	7.9	7.0	7.4	7.3	7.4	7.2
SS (mg/l)	6	88	23	7	8	32
NH_3-N (mg/l)	0.07	0.08	0.04	0.38	0.29	0.21
Ft^3/sec	2.88	5.34	3.04	-	17.38	25.77

Table 11. Chemical results from the September 1, 1981 survey.

	Site							
Parameter	5	6	7	8	9	10	11	12
Time	09:20	09:15	09:35	10:05	09:50	10:00	10:20	10:35
Water Temp. (°C)	19	23	20	20	22	21	-	20
D.O. (mg/1)	0.6	7.5	1.0	0.3	0.9	1.0	-	0.4
BOD_6 (mg/1)	32	3.1	26	7.8	270	500	3.7	11
Lab pH (s.u.)	7.3	5.0	7.4	7.4	6.0	4.7	7.7	7.2
SS (mg/1)		2		29	28	66	27	16
T-P (mg/1)	5.2	5.3	4.6	4.2	5.0	12	0.35	3.2
O-P (mg/1)	4.7	5.3	4.4	4.0	4.5	11	0.24	3.0
TKN (mg/1)	9.0	11	7.5	7.0	7.5	16	1.0	6.0
NH_3-N (mg/1)	4.6	9.0	4.3	4.9	0.02	1.2	0.06	3.8
NO_2+NO_3-N (mg/1)	0.02	31	0.02	5.0	0.02	0.34	0.81	0.33
Cl (mg/1)	56	675	77	190	60	160	57	120
Cond. (umhos/cm)	700	260	740	1200	670	1200	590	810
FC M-FCAGAR/100 ml	2000	-	2200	400	2,000,000	760,000	4400	120,000
FS MF M-ent/100 ml	-	-	-	700	26,000	3500	8600	5400

Table 12. Loading data from the September 1, 1981 survey.

	Site				
Parameter	5	6	7	8	12
BOD_6 (lbs/day)	181	1.8	163	48.8	68.8
T-P (lbs/day)	29.4	3.1	28.8	26.3	20.0
O-P (lbs/day)	26.6	3.1	27.5	25.0	18.8
TKN (lbs/day)	51.0	7	46.9	43.8	37.5
NH_3-N (lbs/day)	26.1	5.3	26.9	30.7	23.8
NO_2+NO_3-N (lbs/day)	0.11	18.4	0.13	31.3	3.92
Ft^3/Sec	1.05+	0.11	1.16	1.16*	2.20

Table 13. Chemical results from the December 15, 1981 survey.

	Site				
Parameter	1	2	6	7	12
Water Temp (°C)	0.0	-	-	3.0	0.0
D.O. (mg/1)	11.0	-	-	11.6	7.0
BOD_5 (mg/1)	2.4	240	4.3	3.3	16
Lab pH (s.u))	8.0	7.5	7.4	7.6	7.4
SS (mg/1)	0	340	0	0	6
T-P (mg/1)	0.16	18	0.88	1.51	1.68
O-P (mg/1)	0.059	9.5	0.74	1.17	1.44
TKN (mg/1)	0.8	47	4.4	4.4	5.1
NH_3-N (mg/1)	0.04	12	3.2	2.6	2.8
NO_2+NO_3-N (mg/1)	4.2	1.6	25	5.6	3.4
CL (mg/1)	70	240	600	150	115
Cond. (unknown)	1200	1700	2500	1400	1300

Table 14. Loading data from the December 15, 1981 survey

	Site			
Parameter	1	2	6	12
BOD_5 (lbs/day)	12.8	725	6.5	547
SS (lbs/day)	0	1027	0	205
T-P (lbs/day)	0.85	54.4	1.33	57.4
O-P (lbs/day)	0.32	28.7	1.12	49.2
TKN (lbs/day)	4.3	142.0	6.6	174.4
NH_3-N (lbs/day)	0.21	36.2	4.8	95.7
NO_2+NO_3-N (lbs/day)	22.4	4.8	38	116.3
Ft^3/Sec	0.99	0.56	0.28	6.34

Table 15. Taxonomic list and numbers of macroinvertebrates for the June 5 and November 7, 1979 survey.

Taxa	Site							
	M1S*	M1F*	M2S	M2F	M3S	M3F	M7S	M7F
Amphipoda								
Hyallela azteca	-	22	-	3	3	43	-	5
Coleoptera								
Dubiraphia spp (larvae)	-	5	3	-	-	-	1	-
Optioservus spp (larvae)	-	1	-	-	-	-	-	-
Diptera								
Ablabesmyia spp	-	-	1	-	-	-	-	-
Acricotopus spp	-	-	11	-	3	-	2	-
Chaetocladius spp	-	1	-	-	-	-	-	-
Chironomus spp	-	-	49	109	-	4	5	70
Chrysops spp	3	12	-	-	-	-	-	-
Conchapelopia spp	2	-	1	-	-	-	-	-
Crictopus spp	-	-	2	-	2	-	14	-
Cryptochironomus spp	1	1	-	-	-	-	-	31
Dicrotendipes spp	-	-	-	1	-	-	-	-
Hydrobaenus spp	-	11	-	-	-	-	-	-
Limnophyes spp	-	1	-	-	-	-	-	-
Micropsectra spp	-	9	-	-	1	-	-	-
Parachironomus spp	-	-	-	-	-	-	2	-
Paratanytarsus spp	-	1	35	-	-	-	-	-
Polypedilium spp	-	-	1	-	-	-	-	-
Psectrotanypus spp	-	-	4	-	-	-	-	-
Rheotanytarsus spp	-	1	-	-	-	-	-	-
Simulium vittatum	1	1	-	-	-	-	58	-
Tanypus spp	-	-	-	-	-	-	-	1
Zavrelimyia spp	-	-	-	1	-	-	-	-
Ephemeroptera								
Baetis brunneicolor	53	-	-	-	-	-	-	-
Baetis intercalaris	17	-	-	-	-	-	-	-
Caenis spp	1	7	-	-	-	-	-	-
Heptagenia hebe	16	-	-	-	-	-	-	-
Leptophlebia spp	-	-	2	-	-	-	-	-
Stenacron interpuntatum	-	1	-	-	-	-	-	-
Isopoda								
Asellus intermedius	-	1	-	5	85	32	20	2
Odonata								
Aeshna allumbrosa	-	-	-	-	1	-	-	-
Coenagrion resolution	-	-	-	-	-	1	-	-
Enallagma ebrium	-	-	-	-	-	4	-	-
Ischnura verticalis	-	-	-	1	-	3	-	-
Lestes spp	-	-	-	-	1	-	-	-
Sympetrum spp	-	-	-	-	1	-	-	-
Plecoptera								
Ksoperla nana	13	-	-	-	-	-	-	-
Tricoptera								
Cheumatopsyche spp	1	15	-	-	-	-	-	-
Total	106	56	99	120	97	87	102	109

* S indicates June 5 and F indicates November 7

Table 16. Biotic Index Values from the June 5 and November 7, 1979 macroinvertebrate surveys.

	Site							
	M1S	M1F	M2S	M2F	M3S	M3F	M7S	M7F
Biotic Index	1.68	2.70	3.63	4.95	4.84	4.22	4.24	4.94

Table 17. Taxonomic list and numbers of the macroinvertebrates from the November 11, 1981, survey.

Taxa	Site				
	M3	M4	M5	M6	M7
Amphipoda					
Hyallela azteca	62	62	88	2	2
Diptera					
Ablabesmyia spp	2	-	-	-	-
Bezzia spp	3	-	3	-	-
Chironomus spp	1	25	6	20	2
Orthocladius spp	-	4	-	-	-
Tabanus spp	-	-	-	1	-
Chironomidae	-	-	2	-	-
Isopoda					
Asellus intermedius	7	4	11	-	-
Total	75	95	110	23	4

Table 18. Biotic index values from the November 11, 1981, macroinvertebrate survey.

	Site				
	M3	M4	M5	M6	M7
Biotic Index	4.04	4.24	4.11	4.87	4.00

Table 19. Taxonomic list and numbers from the 1978 periphyton sampling.

Taxa	Site 1		Site 3		Site 7	
	#/mm^2	% of Total	#/mm^2	% of Total	#/mm^2	% of Total
Bacillariophyceae		100				41.7
Cocconeis-52*	58.4		4.3		2.4	
Fragillaria-29	2.2		-		1.0	
Gomphonema-14	6.1		0.9		-	
Melosira-13	-		0.6		-	
Navecula-7	6.7		1.7		2.9	
Neidium	-		0.2		-	
Nitzschia-6	2.8		8.9		16.8	
Stephanodiscus-32	0.6		0.6		-	
Chlorophyta		0		0.8		0.9
Ankistrodesmus-10	-		0.2		-	
Scenedesmus-4	-		-		0.5	
Cyanophyta		0		3.5		57.4
Chroococcus	-		0.2		-	
Merismopedia	-		0.2		-	
Microcystis	-		0.4		-	
Oscillatoria-2	-		-		31.7	
Rhodophyta		0		26.7		0.9
Audouinella	-		6.7		0.5	
Total	76.8		24.9		55.8	

* Numbers from Palmer's list (Palmer, 1968)

Table 20. Chlorophyll a data from the 1978 periphyton survey.

	Site 1	Site 3	Site 7
Chlorophyll a Ca*/m^2	7.56	0.435	1.63

* Ca is in mg/l

Table 21. Physical characteristics of the macroinvertebrate sites.

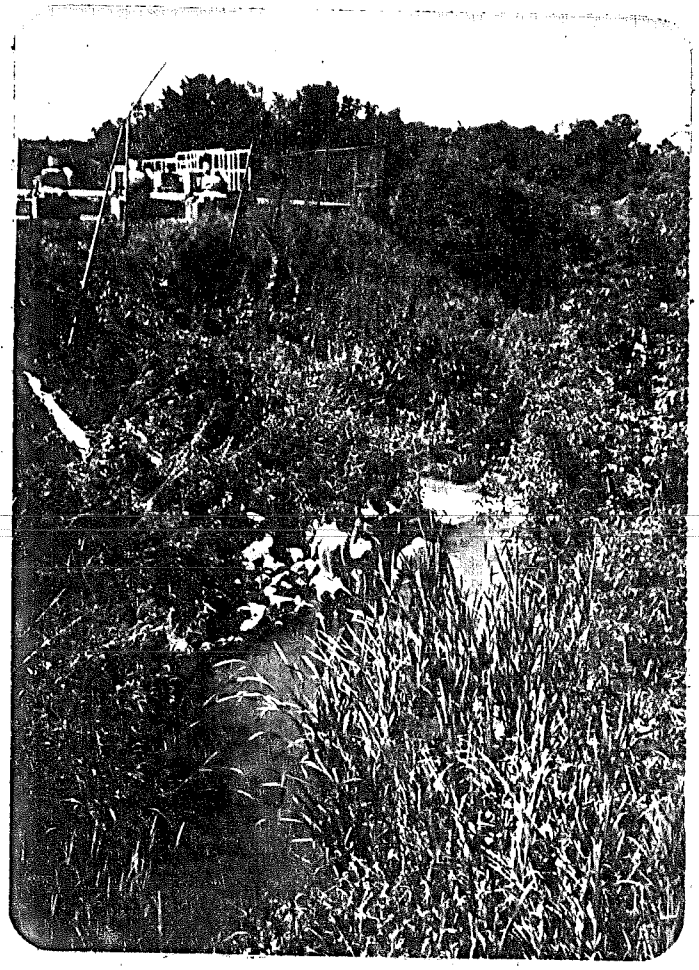
	Site						
	1	2	3	4	5	6	7
Substrate Composition							
% Boulders	0	0	0	0	0	0	0
% Rubble	0	0	0	10	10	40	40
% Gravel	10	10	0	40	40	40	40
% Sand	60	50	0	30	20	10	10
% Silt	20	20	20	0	0	0	0
% Clay	0	0	0	10	10	0	0
% Debris	0	0	30	5	10	10	5
% Muck	0	0	50	5	10	0	5
% Vegetation	0	10	0	0	0	0	0
Current	Mod.	Mod.	Very Slow	Slow	Slow	Mod.	Mod.
Current Characteristics	Riffle	Riffle	pool	run	run	riffle	riffle
Average Width (ft)	4	5	50	10	20	20	15
Average Depth (A)	0.5	1.0	2.0	1.5	1.5	1.0	1.0
Streambank	Wooded	Pasture	Marsh	Marsh	Marsh	Marsh	Pasture

LITERATURE CITED

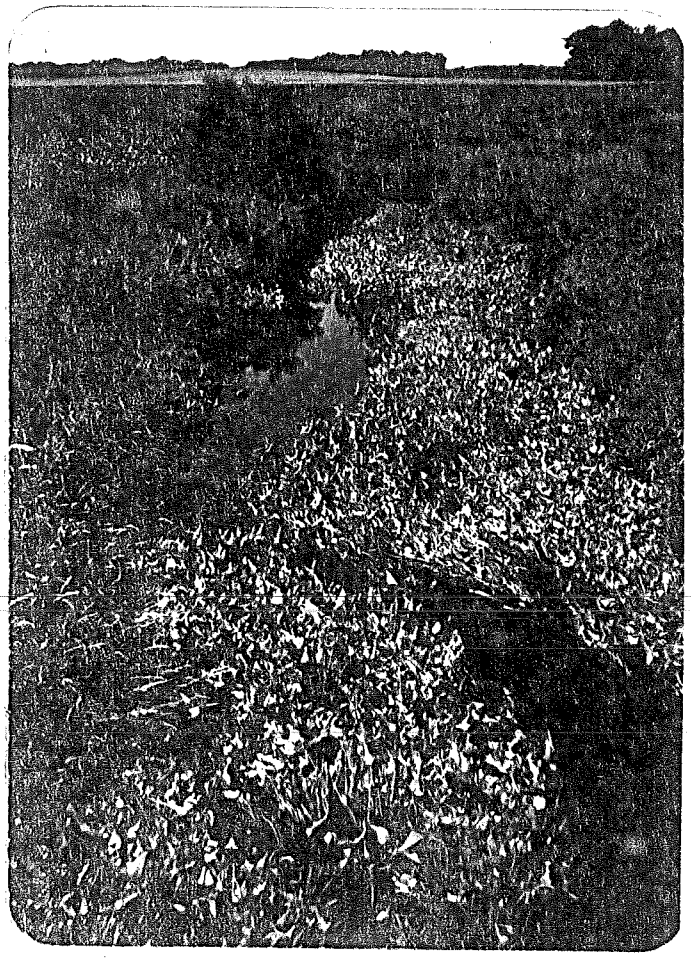
Garfinkle, K. N. 1974. The benthic algae of Black Creek, Outagamie County, Wisconsin. M.S. Thesis. Univ. Wis - Oshkosh. 72 p.

Hilsenhoff, W.L. 1981. Use of arthropods to evaluate water quality of streams. Tech. Bul. No. 100. Wis. Dept. Nat. Res. 17 p.

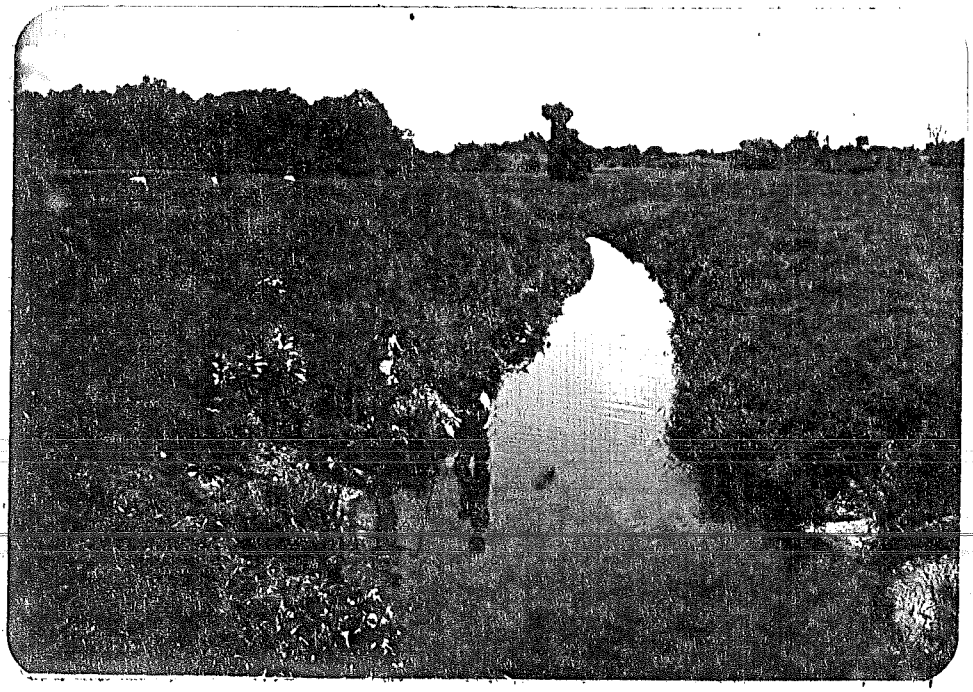
APPENDIX



Black Creek looking downstream
from HWY G beyond the City of Seymour
POTW outfall located in the center
of the photograph (July 11, 1978).



Black Creek looking downstream from French Road. Notice the heavy growth of arrowhead. (July 11, 1978).



Black Creek looking upstream from French Road. (July 11, 1978).

Black Creek looking upstream from Hwy 55. The Village of Black Creek POTW discharges in the lower right corner of the photograph. Note the very heavy duckweed growth. (September 3 1981).

Village of Black Creek POTW looking SE from Hwy 55. The effluent discharged is in the center of the photograph. (September 3, 1981).

Black Creek looking downstream (west) from Hwy 55. The railroad tressel, along who's west side lies the Frank Pure Foods Tributary and along who's east side lies the Outagamie Producers Tributary, is in the upper center of the photograph (September 3, 1981).

Black Creek looking upstream (east) from Town Road 1 (September 3, 1981).

Black Creek looking downstream (west) from Town Road 1 (September 3, 1981).