The Kawkawlin River Watershed Monitoring Project Report

(A survey of water quality conducted from April - October 1997)

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INTRODUCTION

The Kawkawlin River watershed is located in the central portion of Bay County, Michigan, and extends into northeastern Midland County and portions of Saginaw and Gladwin County. In Bay County, the Kawkawlin River flows through the townships of Bangor, Beaver, Garfield, Kawkawlin, Monitor, and Williams, before discharging into the Saginaw Bay approximately two miles north of the mouth of the Saginaw River in Bangor Township. The North and South branches of the river join to form the Main Branch, approximately one-half mile southeast of the Village of Kawkawlin, Michigan at the intersection of M-13 and Old Kawkawlin Road. The South Branch of the river is the larger of the two branches and flows through Beaver, Williams and Monitor Township. The North Branch flows from its northernmost source located in Bentley Township, Gladwin County, and from its westernmost source located at the outlet of the Kawkawlin Creek Flooding in Midland County. In Bay County, the North Branch flows through Garfield, Beaver, Monitor and Kawkawlin Township, before joining the South Branch, southeast of the Village of Kawkawlin.

The Main Branch of the Kawkawlin River, from the Village of Kawkawlin to the mouth, is primarily a suburban residential area with some riparian woodlands intermixed. As the Main Branch approaches the Saginaw Bay, it becomes more intensely utilized for residential housing. The South Branch of the Kawkawlin River flows primarily through agricultural areas with some woodlands and marshlands located along the river. In 1990, the Bay County Soil Conservation District and the Natural Resources Conservation Service conducted an extensive study of the South Branch of the Kawkawlin River. In that study, the South Branch watershed was noted to cover approximately 66,590 acres, including 66% cropland, 24% woodland, and 10% a combination of roads, ditches, and rural development.[1] The watershed of the North Branch is similar in area, but appears to extend a longer distance than the South Branch and is much narrower and shallower. During the summer months, the North Branch often becomes a series of ponds separated by dry river bed. The North Branch of the Kawkawlin River flows through agricultural land use areas also, but more extensive woodlands and wetlands are located along the northern course.

Residential development occurs periodically upstream of the Village of Kawkawlin along the north and south branches, but tends to be widely dispersed and of low density. Wetlands and seasonal flooding create problems for home construction near the river in many areas along the upper portion of the river. Agricultural land use primarily involves row crops such as sugar beets, dry beans, and corn. To a limited degree, some livestock are raised in the watershed area.

The Kawkawlin River serves as a recreational resource and also as a wildlife and fish habitat. The primary recreational uses of the river are boating and fishing, with larger motor boats utilizing the lower portion of the Main Branch for access to the Saginaw Bay. Motor boats are able to travel upstream from the Saginaw Bay to the North Euclid Avenue Bridge

before shallow water and low clearance restrict access. Upstream of the North Euclid Avenue Bridge, small motor boats, canoes, and kayaks use the river. Walleye and yellow perch fishing are popular in the spring, with perch runs occurring again in the fall. Pike and large mouth bass are also found in the river. A September 1995 biological survey conducted by the Michigan Department of Environmental Quality/Surface Water Quality Division on the South Branch of the Kawkawlin River reported finding twenty (20) varieties of fish, including nine (9) varieties of game fish.[2] Reported results for the North Branch of the river were significantly lower.

Boat launching facilities are available at Monitor Township's Herbert W. Steih Memorial Park, located at the southern end of the Village of Kawkawlin on the Main Branch of the Kawkawlin River, and also at a Michigan Department of Natural Resources Public Access Site, located at Wheeler and Mackinaw Roads near the I-75 overpass on the South Branch of the Kawkawlin River. Shore fishing is popular at both locations. Recent improvements to the Herbert W. Steih Memorial Park include a paved parking area and a small boat/canoe launch, and have contributed to the popularity of the site and resulted in an overall increase in the number of canoes and kayaks on the river.

ORIGIN OF THE STUDY

Initially, property owners living along the Kawkawlin River expressed concerns about excessive aquatic plant growth, including mats of floating duckweed and rooted plants that were becoming entangled in boat motor propellers. Suspecting that excessive plant growth could be an indicator of deteriorating water quality conditions, the Kawkawlin River Watershed Property Owners Association (the "Association") sought assistance with the evaluation of the water quality of the Kawkawlin River watershed. Working in conjunction with Bay County, a coalition consisting of members of the Association, the Bay County Health Department Environmental Health Division, Michigan Department of Environmental Quality Surface Water Quality Division (MDEQ), and the Natural Resources Conservation Service (NRCS) was established to conduct a study of the watershed. This study was conducted from April 16 through October 27, 1997.

PURPOSE

The primary purpose of this study was to obtain data that could be used to evaluate water quality conditions along the Kawkawlin River watershed. Several various water quality parameters including: phosphates, nitrogen, suspended solids, pH, and bacteriological levels were selected. It was further determined that: 1.) water quality should be evaluated at regular intervals under varying weather and seasonal conditions; and 2.) that water samples should be collected at several locations throughout the watershed.

Secondary goals for the study included: 1.) Encouragement of local citizen participation in the collection of samples and site information; 2.) Establishment of a prioritized list of resource concerns based upon the study; 3.) Utilization of citizen input in short and long-term solution planning; and 4.) Commitment to the implementation of the identified short and long-term solutions.

OPERATIONAL STRUCTURE

Funding for the Project Coordinator position and bacteriological testing was provided through the Bay County Board of Commissioners. The Bay County Health Department Environmental Health Division was designated as the lead agency responsible for the implementation of the County's role in the project, including: the development of a plan of operation; coordination of activities of the various participants; collection of bacteriological water samples; analysis of bacteriological water samples utilizing the facilities located at the Bay County Health Department Laboratory; and preparation of a final report. In addition, the Project Coordinator worked with the volunteer groups and involved agencies; arranged for the transportation of water samples; completed the necessary forms; distributed supplies; and collected and organized data.

The Michigan Department of Environmental Quality Surface Water Quality Division, Saginaw Bay District Office contributed funding for the program; participated with the organization of the project and the development of the plan of operation; provided bottles and materials for the collection and preparation of water samples for transportation; transported samples; conducted sample analysis; and provided technical interpretation of the data for the final report.

Members of the Kawkawlin River Watershed Property Owners Association participated with the organization of the project and the development of the plan of operation; assisted with the collection of data and water samples; transported water samples to the designated central drop-off location; and provided equipment for the collection of data.

A representative of the Natural Resources Conservation Service (NRCS) participated with the organization of the project and the development of the plan of operation; served as a liaison with the agricultural community; and also served as a Team Leader for the monitoring and collection of water samples at sampling stations located along the South Branch of the Kawkawlin River.

Additional equipment for the study was provided by the Northeast Michigan Regional Planning Commission and the Partnership for the Saginaw Bay Watershed.

PLAN OF OPERATION

Staff of the MDEQ Surface Water Quality Division identified seven (7) sampling stations along the Kawkawlin River watershed that data had been collected at during previous studies. In addition to these sites, the Planning Committee identified three (3) additional sampling stations located at suburban area drain discharges flowing into the lower portion of the river. Each station was marked and numbered with spray paint to facilitate consistent data collection.

A sampling frequency of once per month was established for all ten (10) sampling sites. In addition, one (1) site on the Main, South, and North Branch (a total of three (3) sites) were designated for bi-weekly sampling. Samples and specific site observations were collected by the Project Coordinator and the volunteer teams. To determine the influence of storm water run-off on the watershed, samples were also collected at all ten (10) sampling stations following heavy rains.

The MDEQ staff identified the physical and chemical data required to evaluate the water quality. Site and weather specific data were organized into a questionnaire that was completed on site, by the volunteer teams and/or the Project Coordinator, at the time that the water samples were collected.

The responsibility for specific site sampling was assigned to four (4) volunteer teams at an Organizational/Training Meeting held with members of the Kawkawlin River Watershed Property Owners Association. "Team Leaders" were designated and members of the association volunteered to serve on a "Team". Each team was responsible for the collection of site data and water samples at two (2) or three (3) sampling stations. Equipment use was also demonstrated and distributed at the meeting.

After collection, water samples were stored on ice and transported to the designated drop-off location. At the drop-off location, the Project Coordinator gathered the samples and the data questionnaires and water samples were prepared for transportation. Shipping forms, labels and data questionnaires were checked for completeness, and all samples were then transported on ice by the Project Coordinator to the MDEQ Saginaw Bay District Office. The MDEQ staff then transported the water samples to the laboratory for analysis.

Bacteriological water samples were collected at the designated sampling stations by the Project Coordinator at the same frequency as the other water samples. Samples were submitted to the Bay County Health Department Laboratory for testing for fecal coliform bacteria.

PARAMETERS

Specific onsite data was collected and recorded on a questionnaire at the same time that the water samples were collected. The questionnaire included physical characteristics such as air and water temperature, water clarity, water color, direction of flow of the river, weather conditions, wind direction and a description of wind velocity, and the presence or lack of any type of aquatic vegetation.

Water quality chemical data analysis included: Nitrite (NO_2), Nitrate (NO_3), Ammonia (NH_3), Kjeidahl Nitrogen, Ortho-Phosphate (PO_4), Total Phosphorus, and Suspended Solids. Microbiological data was obtained using two testing methods: 1.) the Membrane Filter Technique to determine the actual number of fecal coliform organisms present per 100 ml. of water; and 2.) the Biochemical Oxygen Demand (BOD) test as an overall indicator of biological activity. Due to the cost, BOD testing was limited to three (3) sites, one site located on the Main, North, and South Branch.

DATA COLLECTION

The data from the questionnaires and the chemical analyses were transferred to tables and spreadsheets developed and maintained by the Project Coordinator at the Bay County Health Department/Environmental Health Division office. This data was used as the basis for the evaluation of the water quality of the Kawkawlin River watershed.

DATA ANALYSIS

Analysis and interpretation of the physical and chemical data was provided by the staff of the MDEQ Surface Water Quality Division, Saginaw Bay District Office. The data collected reflects the unusual weather conditions observed during the study period and the low amount of rainfall. The low rainfall resulted in low water flow conditions which are atypical when compared to previous studies conducted during the same time period. Attempts to measure the flow of the river and calculate nutrient loading were unsuccessful due to the low water flow and strong easterly winds which often caused the water to flow away from the Saginaw Bay.

The influence of the wind on the direction of flow on the river system was far greater than anticipated, especially on the South Branch. In fact, water movement away from the Saginaw Bay was noted on the South Branch as far west as the Fraser Road sampling station (Site 6) and the Wheeler and Nine Mile Road sampling station (Site 7). During much of the 1997 study period, the Kawkawlin River system could be characterized as an extension of the Saginaw Bay, both in terms of the direction and volume of water flow. Future studies will determine how typical this occurrence actually is.

Upon review of the data, four (4) parameters of interest were selected. Several of the parameters examined in the study of the watershed were within levels considered acceptable for flowing streams emptying into stationary bodies of water, per EPA Guidelines. However, at times, suspended solids, ortho-phosphates, total phosphates, and fecal coliform bacteria were found in excess of established acceptable levels in certain portions of the Kawkawlin River watershed.

Fecal coliform bacteria are associated with fecal material from warm blooded animals and mammals. As a result of this association, the presence of fecal coliform in significant numbers is used as an indicator of water contamination, either from human or animal sources. It appears that the most probable sources of fecal coliform bacteria contamination in the watershed is either the result of run-off from cattle ranches or discharges from failing residential onsite sewage disposal systems. There are not any known municipal wastewater discharges. Run-off from farmland on which manure or septage has been applied is another possible source of fecal coliform contamination, but this is not a general practice in the area of study.

The level of fecal coliform contamination is based upon the number of fecal coliform colonies present in 100 milliliters of water. The Michigan Water Quality Standard establishes a limit of 400 colonies per 100 milliliters of water. On the South Branch of the Kawkawlin River, fecal coliform levels in excess of 1,000 colonies per 100 milliliters of water were noted at the Fraser Road sampling station (Site 6), on three (3) occasions, and at the Wheeler and Nine Mile Road sampling station (Site 7), on four (4) occasions. Visual observation determined that cattle have direct access to the South Branch, a short distance upstream of Site 7. In addition, immediately downstream from Site 7, cattle are being raised on land adjacent to the river that inclines toward the riverbank. At this location, the cattle are kept from the river by a fence, but it appears that surface water run-off is directly into the river. It is suspected that the elevated fecal coliform bacteria levels in the area might be the result of cattle in the stream itself, and/or run-off from the pasture and yarding areas. Site 6 is located downstream of Site 7 and could be influenced by the conditions at Site 7.

Suspended Solids (SS) is a measure of the amount of soil particles and organic matter floating or suspended in water. Suspended solids are linked to sedimentation and siltation, which increase when suspended solids levels are high. High concentrations of suspended solids can be damaging to aquatic organisms by interfering with their ability to obtain oxygen from the water, or by damaging the habitat that they need to survive and reproduce. Suspended solids are generally the result of soil erosion, or in some cases, discharges from commercial facilities and industrial processes. There are no known industrial or commercial facility discharges in the Kawkawlin River watershed.

Suspended solids are measured in milligrams per liter (mg/l) of water. An average suspended solids concentration of greater than 50 mg/l, or a maximum concentration of greater than 400 mg/l, is considered to be elevated for this area.[3] One concern on the

Kawkawlin River watershed is the need for walleyes, a game fish, to have gravel-covered river bottom for spawning. Elevated levels of suspended solids result in sedimentation that covers the gravel beds and eliminates spawning areas. High levels of suspended solids also adversely effect the recreational value of the waterway by making the water appear "muddy" and the bottom appear "mucky" and unattractive for swimming. In addition, siltation reduces water depth and can impede boat navigation.

Suspended solids concentrations in excess of 50 mg/l were noted twice on the South Branch following storm events. The lack of rain during the 1997 study period resulted in insufficient data to accurately assess the impact of suspended solids on the Kawkawlin River watershed. Future monitoring of suspended solids after rain events along the South Branch of the watershed is recommended.

Suspended solid concentrations in excess of 50 mg/l, following storm events, were also noted twice on the North Branch. At the same time, the suspended solids were less than 50 mg/l at the sampling station located immediately downstream. This reflects a pattern which was evident on a number of occasions. A wetland area located between these two sampling stations may receive and retain suspended solids from upstream sources and thus reduce the level of suspended solids found downstream. Future monitoring of suspended solids after rain events along the North Branch of the watershed is also recommended.

Total phosphorus and ortho-phosphates are important nutrients for aquatic plants. The amounts of these nutrients available is a determining factor for how much and what variety of aquatic plants, including algae, a particular body of water can support. The amount of total phosphorus is an important consideration when nuisance aquatic plant growth is an issue. Available phosphorus is regarded as a primary chemical factor, often referred to as a limiting factor. Other factors also influencing the growth of nuisance plants include: water temperature, depth, and clarity.

Total phosphorus refers to free phosphorus and phosphorus combined with other elements from all sources available in the water. Ortho-phosphate (PO_4) is phosphorus in combination with oxygen and is formed or associated with living organisms. Ortho-phosphates are more readily usable by plants than elemental phosphorus and other phosphorus combinations.

The recommended standard for total phosphorus in flowing water entering a stationary body of water is 0.05 mg/l of Phosphorus (P), the recommended standard for total phosphorous for stationary bodies of water is 0.025 mg/l, and the standard for total phosphorous for flowing water that does not enter a stationary body of water is 0.1 mg/l.[4]

As previously discussed, excessive aquatic plant growth was one of the issues that resulted in this study. For much of the 1997 study period, the total phosphorus results for the State Park Road sampling station (Site 1) were within the recommended level of 0.05 mg/l of P

for flowing water entering a lake. One question is whether the recommended phosphorous level for flowing water is applicable to the Kawkawlin River watershed, in view of the low water flow volume observed this year. If these conditions are typical of the watershed, then portions of the system could be considered stationary bodies of water and the recommended level of 0.025 mg/l of P for stationary bodies of water would be more applicable at these locations.

Overall, the total phosphorus levels within the Kawkawlin River watershed are a concern. Review of the data reveals that the phosphorus levels within the watershed exceed the recommended level for flowing waters entering a stationary body of water and, in many cases, even exceed the recommended level for flowing waters that do not enter into a stationary body of water. At sampling stations located along the river, phosphorous levels were as high as 0.33 mg/l. Furthermore, phosphorous levels at sampling stations located on the urban drains were as high as 0.77 mg/l.

The sample results also indicate peaks in phosphorous levels on the North Branch of the Kawkawlin River at the Beaver Road sampling station (Site 2), and downstream of the Seven Mile Road sampling station (Site 4), indicating that there may be a source of phosphates located somewhere between these two stations. There are also peaks in phosphate levels on the same sampling dates at the Garfield Road sampling station (Site 5), but the phosphate levels drop before reaching Site 4. This decrease could be the result of dilution from waters with lower phosphate concentrations entering the system between Site 5 and Site 4. It is also possible that the wetlands located between Site 5 and Site 4 are collecting and retaining sediments, including phosphates. Once removed from the water through sedimentation, the phosphates become available to terrestrial wetland and aquatic plants and can actually be removed from the watershed for extended periods of time.

The source of phosphates between the Beaver Road sampling station (Site 2) downstream of the Seven Mile Road sampling station (Site 4) is not known at this time. The elevated phosphate level may be the result of surface water run-off from land high in phosphates, such as recently fertilized agricultural land or suburban residential property, leakage from storage facilities, or from natural processes that release phosphates, or a combination of sources. A possible source of the phosphates in this location could be from the wetlands located between Site 4 and Site 2. Under certain conditions, such as extended dry periods, low oxygen levels, high water temperatures, or a combination of these conditions, phosphates may be released from the sediments into the water. During rain events, water with elevated concentrations of phosphorus are flushed downstream and detected. Due to the low water flow conditions in the watershed this spring and summer, elevated phosphorous concentrations would not be detected until after a rain event. Future studies in this area are needed to identify the source or sources of phosphates.

Elevated concentrations of phosphorus were also detected at the urban drain sampling stations, including: Mill Pond Drain (Site 8), Corbin Drain Storm Water Pump Station (Site

9), and Frank Jean Drain Storm Water Pump Station (Site 10). Samples collected from the Mill Pond Drain sampling station (Site 8) and the Frank Jean Drain Storm Water Pump Station (Site 10) contained phosphate concentrations as high as 0.43 mg/l and 0.77 mg/l. The probable source of phosphates in this area is surface water run-off containing suburban lawn fertilizers. A study of land use in these drainage areas was previously conducted by Mr. Charles Curtiss of the Kawkawlin River Watershed Property Owner's Association.

CONCLUSIONS

The isolated locations of elevated levels of fecal coliform bacteria are a concern as they represent sources of pathogenic micro-organisms that may be hazardous to public health. Fortunately, this appears to be a problem that can be resolved in the short term by identifying and remediating the source(s) of contamination.

The elevated phosphate levels in the Kawkawlin River watershed system are also a concern. At several sampling stations, phosphate concentrations often exceed the recommended level for flowing water entering a stationary body of water. If the low water flow volume and flow direction observed during this study are typical, the stationary water standard may be more appropriate and the phosphate concentrations would be above the recommended level throughout the watershed.

The peaks in phosphate concentrations on the North Branch warrant further monitoring to identify the source(s) of the phosphates and to determine what remedial action may be possible. If the water flow direction and volume are consistent, the concentration of phosphates is a likely factor in the excessive aquatic plant growth observed on the lower Kawkawlin River. It should also be noted that the concentration of suspended solids and the concentration of phosphates in the water are positively related and indicate similar problems. By reducing the suspended solids level, phosphate concentrations may also be reduced.

The source(s) of suspended solids and total phosphorus are often varied and complex. A watershed-wide approach may be necessary to reduce the amount of sedimentation and phosphate associated problems.

RECOMMENDATIONS

Further monitoring of the Kawkawlin River watershed system is needed to establish a broader data base and to minimize the possibility of unusual weather conditions resulting in inaccurate conclusions.

On the South Branch of the Kawkawlin River at the Fraser Road sampling station (Site 6) and at the Wheeler and Nine Mile Road sampling station (Site 7), there appears to be a problem as demonstrated by the elevated levels of fecal coliform bacteria. The source(s) of contamination should be identified through additional testing and the access of cattle to the river should be restricted. Minimizing surface water run-off and preventing drainage to the river from pasture land will be more difficult and complicated issues to address.

Further study of the watershed is needed to identify the source(s) and remediate the elevated levels of total phosphorus and ortho-phosphates. As discussed, reductions in the level of suspended solids in the watershed may also result in reductions in the levels of total phosphorus and ortho-phosphates. Additional sampling is needed to determine whether the wetlands may be releasing phosphates through a natural process.

At certain times, suspended solids are elevated in the watershed. Suspended solids are often the result of soil erosion, possibly from agricultural land use in the area. The Natural Resource Conservation Service (NRCS) and the Bay County Soil Conservation District are valuable resources in this regard, with many years of experience and expertise in addressing soil erosion issues. A joint plan of action with the active support of local groups, such as the Kawkawlin River Watershed Property Owners Association, should address this issue.

The location of the sampling station Site 2 should also be re-considered. The Beaver Road sampling station (Site 2) is problematic in that the bridge is narrow and traffic is traveling fast at that point. A site on Chip Road, approximately one mile downstream, appears to be a safer alternative.

The number of chemical parameters being evaluated can be reduced without compromising the quality of the watershed study. Biochemical Oxygen Demand (BOD) is a testing parameter that is relatively costly and the data collected during this study was inconclusive. In addition, portable test kits can be used to collect some of the sampling data either at the sampling stations or a central location.

Dissolved Oxygen (DO) testing should be added to the study. Dissolved Oxygen is an established water quality standard in the State of Michigan and provides an immediate indication if there is a problem. Documented decreases in dissolved oxygen levels have resulted in fish kills in the watershed in the past.

Finally, the study of the water quality of the Kawkawlin River watershed should be continued. The data collected through this study and future studies will provide valuable information for the future management and enjoyment of the Kawkawlin River watershed.

LOCATION OF SAMPLING STATIONS

1.) **State Park Drive Bridge**, located in Bangor Township on State Park Drive. South of Boy Scout Road on East side of the bridge.

2.) **Beaver Road Bridge**, located in Kawkawlin Township on Beaver Road between Old Beaver and Four Mile Roads on North side of the bridge.

3.) **Wheeler Road Bridge**, located in Monitor Township on Wheeler Road West of Four Mile Road and the I-75 overpass adjacent to the DNR Kawkawlin River Public Access Site on North side of the bridge.

4.) **Seven Mile Road Bridge**, located in Kawkawlin Township on Seven Mile Road between River and Wetter Roads on East side of the bridge.

5.) **Garfield Road Bridge**, located in Beaver Township on Garfield Road North of Cottage Grove Road on East side of the bridge.

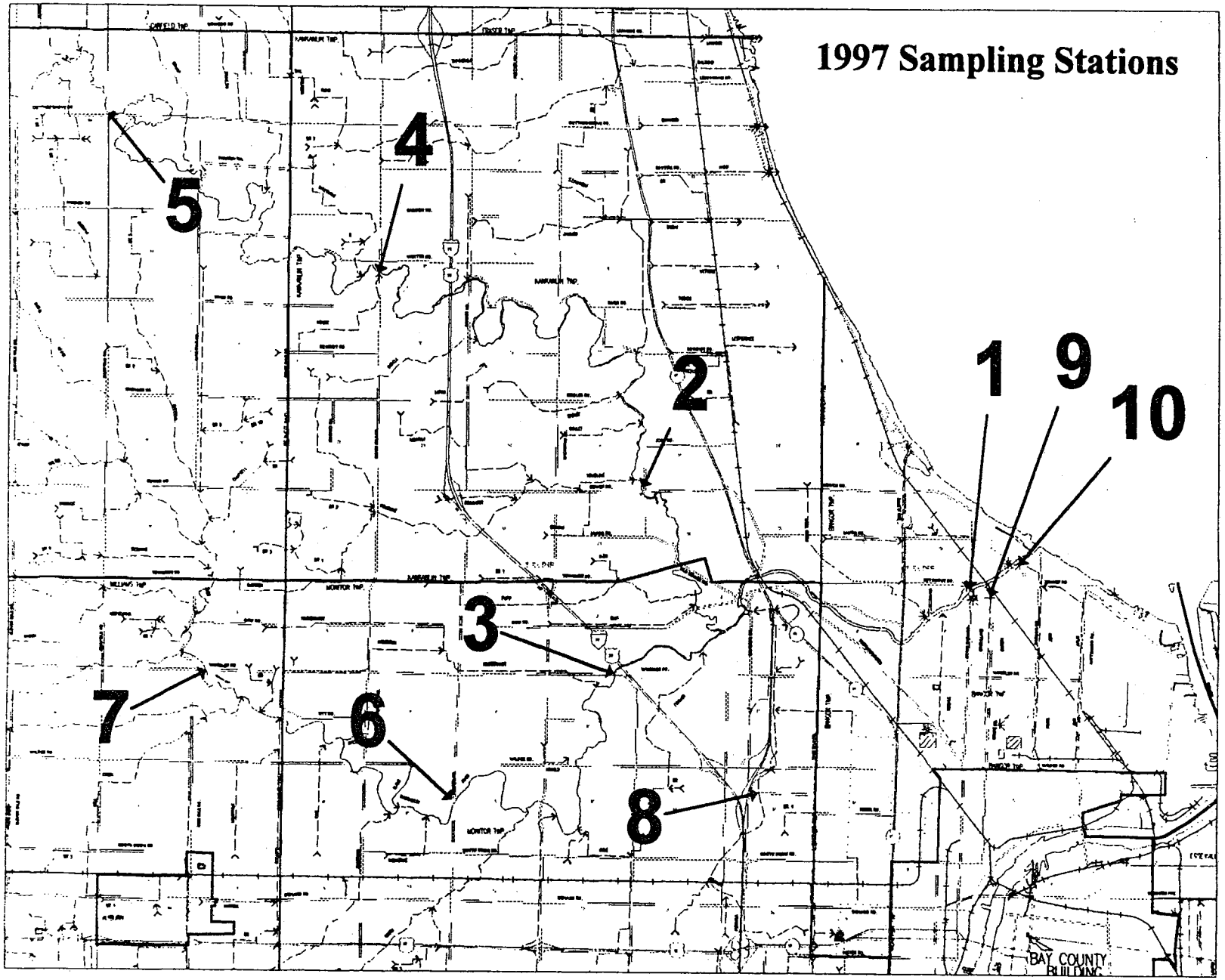
6.) **Fraser Road Bridge**, located in Monitor Township on Fraser Road between North Union and Wilder Roads on East side of the bridge.

7.) **Wheeler Road Bridge**, located in Williams Township on Wheeler East of Nine Mile Road on South side of the bridge.

8.) **Mill Pond Drain**, located in Monitor Township on the Bay-Arenac Intermediate School District Office service road between Two Mile and Monitor Road at the North end of the culvert.

9.) **Corbin Drain Storm Water Pump Station**, located in Bangor Township at the North end of State Road at the inlet pipe screen.

10.) **Frank Jean Drain Storm Water Pump Station**, located in Bangor Township on a private drive off of Bay Side Park Drive Southwest of Birch Ridge Street at the South end of the inlet pipe screen.


1997 Sampling Stations
1
2
3
4
5
6
7
8
9
10
BAY COUNTY BUILDING

Kawkawlin River Watershed Monitoring Project

(Fecal Coliform Organisms per 100 ml. of Water)

Sampling Station	4/16 C	4/29 PC	5/01 R, C	5/05 R, PC	5/13 C	5/27 S	6/10 S	6/24 PC	7/09 S	7/22 S
1	5	6	41	38	36	21	6	35	226	26
2	63	52	73	87	22	46	79	240	226	60
3	38	26	90	127	49	14	22	63	221	94
4	---	---	---	102	---	---	128	---	600	46
5	---	---	---	56	---	---	52	---	442	68
6	---	---	---	185	---	---	124	---	>1000	30
7	---	---	---	93	---	---	143	---	>1000	141
8	---	---	---	107	---	---	49	---	211	17
9	---	---	---	55	---	---	304	---	>400	58
10	---	---	---	37	---	---	424	---	>400	69

KEY: S--Sunny, R--Rainy, PC--Partly Cloudy, C--Cloudy

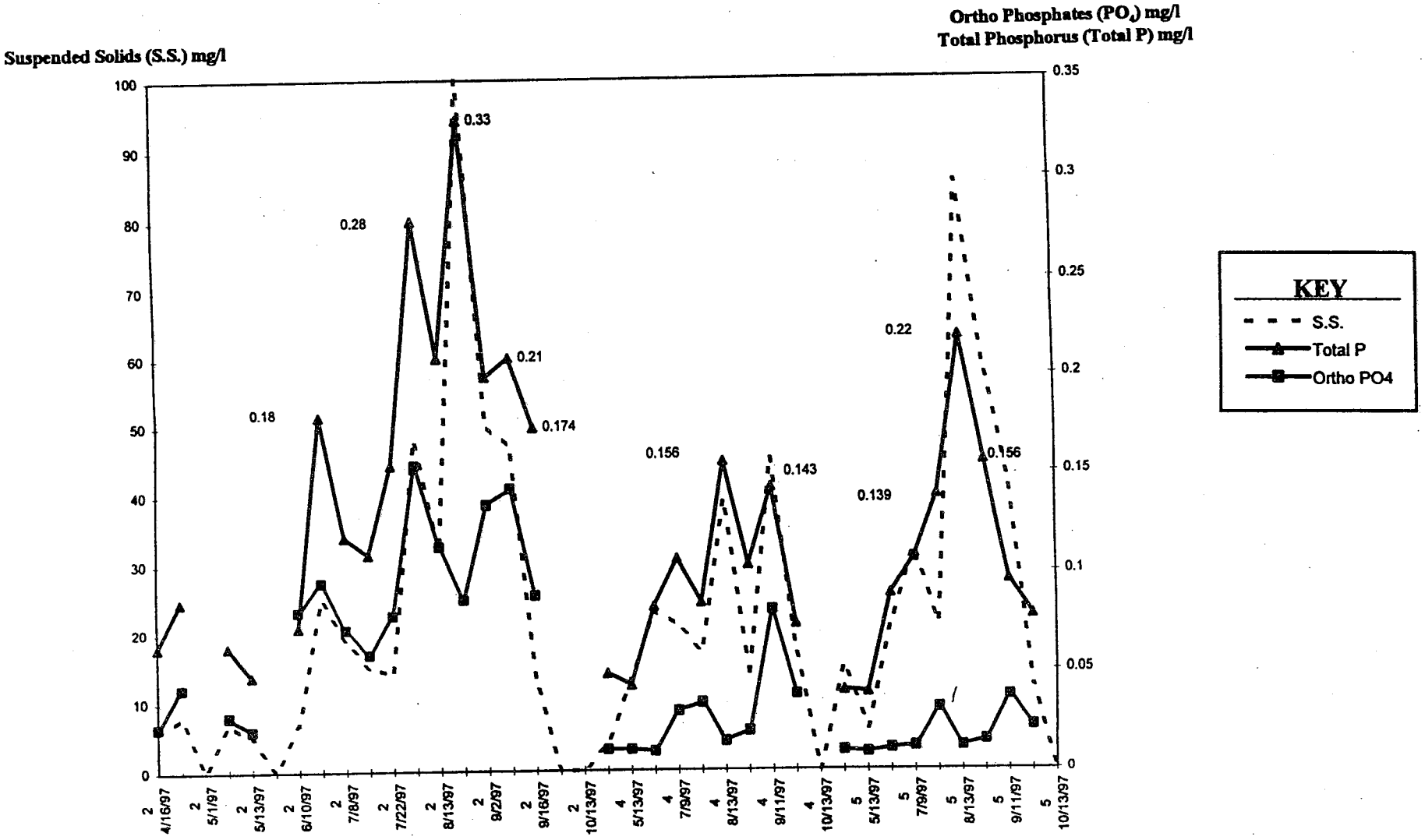
Kawkawlin River Watershed Monitoring Project

(Fecal Coliform Organisms per 100 ml. of Water)

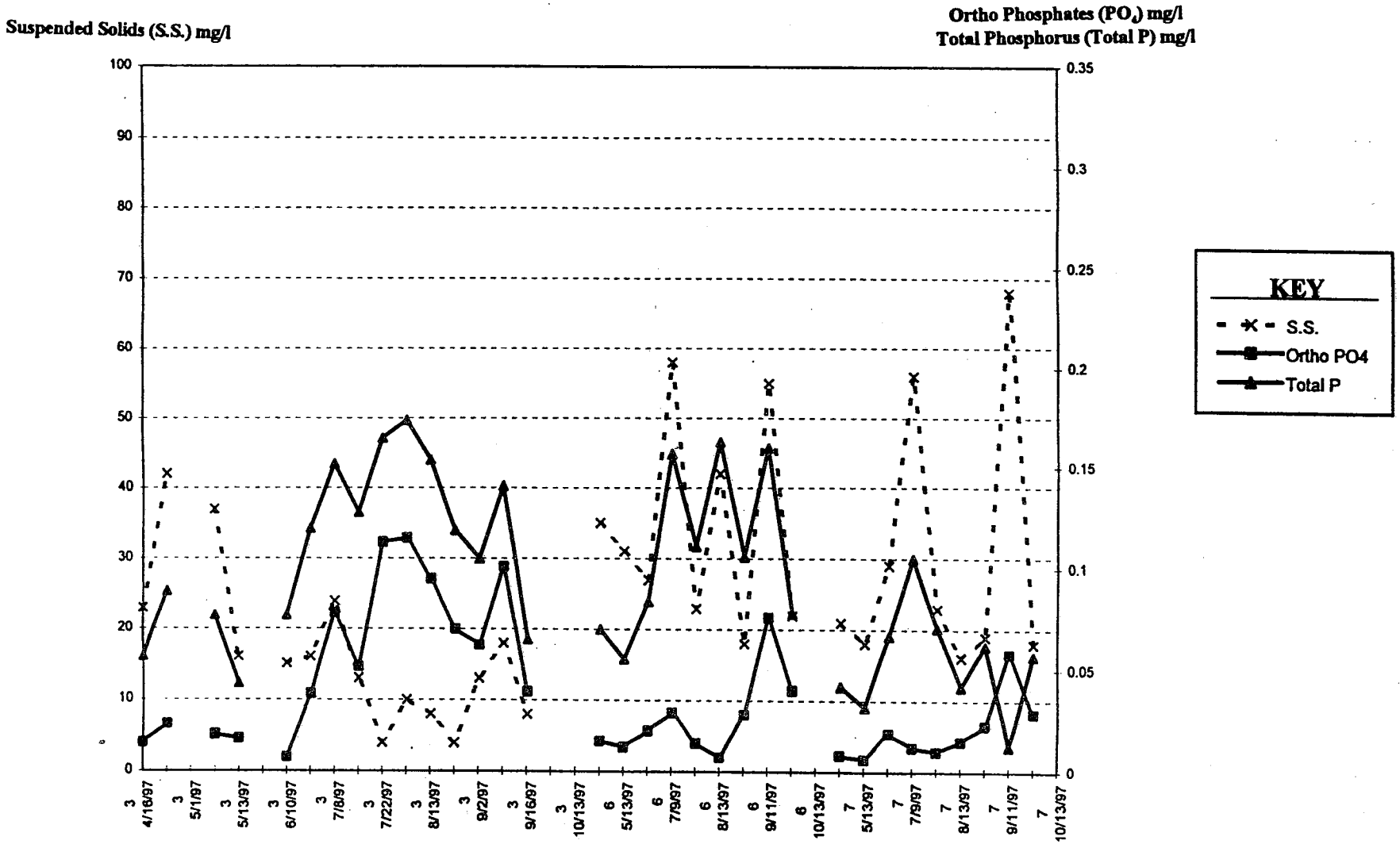
Sampling Station	8/05 S	8/13 PC	8/19 PC	9/02 C	9/11 R	9/16 C	9/30 C	10/13 R,PC	10/27 C
1	215	101	12	6	64	585	116	3	244
2	174	26	23	2	575	970	184	71	132
3	217	263	189	76	610	2130	95	9	442
4	---	54	109	---	2930	770	---	59	---
5	---	68	97	---	190	510	---	19	---
6	---	42	119	---	1590	1000	---	89	---
7	---	1032	158	---	1640	1640	---	197	---
8	---	—	448	---	—	1250	---	122	---
9	---	—	72	---	—	1700	---	48	---
10	---	—	12	---	—	810	---	8	---

KEY: S--Sunny, R--Rainy, PC--Partly Cloudy, C--Cloudy

SUSPENDED SOLIDS, ORTHO-PHOSPHATES, TOTAL PHOSPHATES CHART
NORTH BRANCH OF THE KAWKAWLIN RIVER



SUSPENDED SOLIDS, ORTHO-PHOSPHATES, TOTAL PHOSPHATES CHART
SOUTH BRANCH OF THE KAWKAWLIN RIVER



Kawkawlin River Monitoring Study

Sample Station: _____

Date: _____

Time: _____

Collectors Initials: _____

AT EACH SAMPLE LOCATION

GN	Gen Chm/Neutral	500 ml plastic	No preservative
GA	Gen Chm/Acidic	500 ml plastic	10 drops H2SO4
pH	Litmus Paper		
Fecal	100 ml clear plastic (provided by county)		

Consult collection and preservation instructions for any additional analysis performed at select sample locations.

Monitoring Event: ( ) Monthly ( ) Bi-Weekly ( ) Storm ( ) Low Flow

Environmental Conditions

Weather: ( ) Sunny ( ) Partly Cloudy ( ) Cloudy ( ) Rainy

Wind Velocity: ( ) No Wind ( ) Slight Wind ( ) Strong Wind

Wind Direction _____

Air Temperature: _____ ° (F)

Stream Characteristics

Flow Direction ( ) Toward the Bay ( ) Away from the Bay ( ) Stationary

Depth to Water: _____ Inches from known benchmark

pH Reading: _____

Water Temperature: _____ ° (F)

Water Clarity: _____ Secchi Disk Reading

Water Color: ( ) Clear ( ) Brown ( ) Black ( ) Other _____

Weeds Present ( ) Yes ( ) No Identify type if known _____

Algae Present ( ) Yes ( ) No Identify type if known _____

Notes:

Please note other observations (e.g. significant weed and/or algae growth, detrimental land use practices, presence of dead or dying fish/aquatic organisms, significant sedimentation, water sheens, excess foam or unusual odors).