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CHILTON MILLPOND
LAKE MANAGEMENT PLANNING GRANT
1993
REPORT

BY
CHILTON LAKE DISTRICT
AND
AQUATIC RESOURCES

WRITTEN BY
RAND ATKINSON
AQUATIC RESOURCES
BOX 2221
WAUSAU, WI 54402

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INTRODUCTION

BACKGROUND

Lake Chilton or the Chilton Millpond is an irregularly shaped impoundment of the South Branch of the Manitowoc River located in the City of Chilton, Calumet County. The pond currently has a maximum depth of eight feet and has a maximum width of 420 feet near the center of its 1850 foot length. The millpond tapers at both the upstream and down stream ends.
In the past Chilton Millpond was a focal point for leisure and recreational activities such as boating, swimming, and fishing. By the late 70's the millpond had filled with nutrient rich sediment from watershed runnoff which produced a heavy growth of aquatic plants and an accumulation of duckweed (Lemna sp.). At this time the Chilton Lake District was formed so the millpond could be dredged to 1.) reduce the plant growth by removing the rooting medium, 2.) reduce light penetration to the bottom by increasing it's depth, and 3.) to reduce the nutrient levels in the lake. By eliminating the aquatic plants with this dredging project the problems of duckweed accumulation and stagnant mosquito habitat would also be illiminated. It was believed a deeper millpond would also improve oxygen levels therefore increase the pond's ability to sustain fish life and reduce shallow areas in the winter that in the past froze solid. In 1977 a permit was issued and approximately 28,000 cubic yards of sediment was removed from the bed of the millpond before the project was abandoned due to weather conditons. In 1978 financial assistance was sought for hydraulic dredging of another 35,000 cubic yards of sediment in 1979. In 1980 the Calumet County Soil and Water Conservation District assisted in a hydrographic survey of water depths to document before and after depths of sediment.

Spring and fall stocking of northern pike, largemouth bass, and bluegill occurred from 1972 to 1974. After dredging an intense effort was made to establish a warm water fishery in the millpond. From 1979 to 1988 10,400 northern pike, 4500 largemouth bass, 3500 yellow perch, 4325 bluegill, and 500 general panfish were stocked in the millpond as fry and fingerlings. All attempts at establishing a fishery in the Chilton Millpond to date have failed.

GOALS AND OBJECTIVES

The main objective of this study was to collect limnological data on Chilton Millpond. Our goal with gathering this baseline information to help us make decisions on whether to continue the effort to establish a warm water fishery in Chilton Millpond at this time or defer this attempt to a later time. A secondary goal of this study was to look for relationships between the land uses in the watershed and the water resources of the South Branch of the Manitowoc(and it's tributaries) and the problems of that face the resources of the Chilton Millpond.

PHYSICAL CHARACTERISTICS

Methods

Physical limnological assessments of Chilton Millpond consisting of oxygen and temperature profiles and light penetration (water clarity) measurements were collected monthly in 1993 from February to December (Table 1). The location of the profile and secchi disc readings during open water periods was at center of Cross Section A-A (See Figure 3) and off the dam when ice covered any part of the millpond. When possible these assessments corresponded to scheduled water chemistry sampling. The oxygen and temperature profiles were taken at 1 foot intervals from surface to bottom in 8 feet of water. Standard secchi disc methods were used to determine light penetration.

Further oxygen and temperature sampling was conducted in the South Branch of the Manitowoc River and it's tributaries above and below the Chilton Millpond (Figures 1 & 2, Table 1). Though not originally planned, these measurements were necessary to evaluate the suitability of sustaining a fishery in adjacent waters. Sampling occurred from May to September to assess the conditions of the stream habitat during the growing season and corresponded to Chilton Millpond sampling dates. May and September sampling dates corresponded to macroinvertebrate sampling.

A hydrographic survey and soft sediment profile was completed on June 7, 1993 to assess the sediment accumulation in the millpond since the last dredging. The original cross section sampling methods and transects used in the pre amd post-dredging evaluations of the late of 1976 and 1980 were used in this evaluation. Water and sediment level elevations were adjusted to correspond to new bench mark elevations that were changed with dam reconstruction. The survey and profiles were conducted from an anchored boat at the location described in Figure 4 A-A thru G-G.

Results

The results of the oxygen/temperature profile and corresponding water clarity is described in Table 1. Low oxygen conditions were found in Chilton Millpond during the summer months paralleling warm water temperatures and weather from June through August. As expected dissolved oxygen levels were higher during cool water periods but did not approach saturation.

Water clarity or light penetration during open water periods was limited to 30 to 36 inches from the surface of the Chilton Millpond (Table 1). When the pond was covered with ice secchi disc reading increased to 62-72 inches. Light penetration during the growing season only reached the bottom in the shallow areas. These areas are located at the edges of the widest cross section of the millpond and in the shallows at the head of the millpond.

Oxygen and temperature sampling data above and below the Chilton Millpond are detailed in Tables 2 thru 6. Low oxygen conditions were found in the North Branch of the Manitowoc River above Chilton Millpond in July and August. These low oxygen conditions corresponded to low oxygen conditons in the millpond below. On August 26 only 2.0 mg/l of oxygen was found in the South Branch of the Manitowoc above Stony Brook; and only increased to 4.0 mg/l after the confluence with Stony Brook's cool well-oxygenated water (Table 5). The cascading roller dam at the outfall of Chilton Millpond raised oxygen levels to 8 mg/l during the warmest part of summer creating excellent oxygen levels that continued throughout the stream course through the City of Chilton (Tables 4 & 5).

The hydrographic survey/soft sediment profile indicates little overrall sediment accumulation over the 13 year period since the pond was dredged. Greatest sediment accumulation occurred at X-section C-C which is the widest part of the millpond with the most cross-sectional area. Sediment accumulation also occurred in the deepest areas of the millpond at X-sections A-A, B-B, and C-C. X-sections E-E, F-F, and G-G actually lost sediment depth. Calculation results of the amount of silt accumulation in the pond at the present time can be found in Table 7.

Discussion

The results of oxygen/temperature profiling and sampling in the Chilton Millpond and the surrounding waters of the South Branch of the Manitowoc River indicate that physical conditions to support a fishery in the Millpond from June through August do not exist at this time. Based on monthly sampling profiles, covering rainy and sunny conditions on days prior to sampling, low oxygen levels that cause chronic stress or acute death exposure conditions to most game fish exists in the millpond when water temperatures climbed above the low 60's.

Recruitment of fish from areas upstream and downstream into the Chilton Millpond is also limited. Adequate oxygen levels to support a fishery in the summer exist below the dam as a result of the cascading roller dam; but this same dam is a physical barrier to fish migration upstream. Oxygen sampling on August 26 (Table 5) also indicated that during the warmest part of summer a low oxygen barrier exists upstream several miles on the North Branch of the Manitowoc River.

During most of the open water period suspended matter in the water column limits light penetration below a 3 foot depth. This suspended matter makes fish respiration even more difficult as gill filaments where oxygen exchange occurs become clogged. Game and panfish that depend on sight for food capture cannot exist under these conditions.

Limited light penetration during much of the open water period prevents the growth of aquatic plants. Light does not reach the bottom substrate of the millpond except for the upper shallow areas near the county fairgrounds and a few shallow areas at the widest part of the millpond. A few plant species were observed in late summer at these locations.

An association between Chilton Millpond conditions prior to dredging and at present can also be made. The aquatic plants that were at nuisance levels before dredging were there as a result of silt and nutrient accumulation and the fact that light could penetrate to the shallow depths of this accumulation. Today's conditions of deeper depths due to dredging and limited light penetration during the growing season explains the lack of aquatic plant growth.

A critical review of the history of pre and post-dredging periods indicates that plant growth was important in maintaining the fishery. Assuming water quality conditions of the North Branch of the Manitowoc River today are similar to 1976 conditions, plant growth provided oxygen to the millpond during the periods that now lack enough oxygen to support fish. Aquatic plant growth also acted as a silt curtain to clarify the suspended matter and allow deeper light penetration than exists at present. Aquatic plants also provided food and cover for fish and their prey species.

Sediment in the Chilton Millpond is being deposited at the present time in the deeper water areas of X-sections A'-A',B'-B', and C'-C'. Areas of the central channel in the upper reaches of the millpond have actually scoured out and now have less depth. Silt is accumulating in the shallow areas of the upper end of the Chilton Millpond.

The general physical conditions that exist in Chilton Millpond can be attributed to water quality problems that exist in the watershed and the upstream reaches of the North Branch of the Manitowoc River. Long term solutions to the problems of Chilton Millpond are tied to improvements in the watershed.

Reevaluate for priority watershed eligibility

CHEMICAL CHARACTERISTICS

Methods

Water chemistry sampling was completed in Chilton Millpond from March through September 1993. Samples were taken at X-section A-A 200 feet upstream from Millpond dam at a point midway between tbe banks of the millpond. Oxygen/temperature profiles, water level recording, and secchi disc transparency readings corresponded to the water chemistry sampling. All sampling was completed at midday.

Spring and fall macroinvertebrate studies and upstream and downstream oxygen and temperature profiles accompanied water chemistry sampling dates to give a complete picture of water condition above and below the millpond. This procedure was a modification of the original parameters of the study after early sampling indicated macroinvertebrates and a supporting environment were lacking in the millpond itself.

The timing of water chemistry sampling by the City of Chilton tried to capture various weather conditions such as periods of high temperatures,drought, and heavy rains. Bacteria, nutrient, and particulate sampling were included in the sampling.

Results

Water chemistry sampling results for Chilton Millpond are found in Tables 8 and 9. Water chemistry values indicate high levels of dissolved organic and inorganic compounds. Levels varied with oxygen, temperature, rainfall, and water clarity but remained high throughout variations in each.

High levels of both total and dissolved phosphorus were found throughout the study period. Total phosphorus ranged from 105 to 460 micrograms/liter. Dissolved phosphorus ranged from 63 to 149 micrograms/liter. Total phosphorus levels were highest on July 22 corresponding to high water temperatures, low dissolved oxygen, little water runnoff, and little or no plant growth-either as plankton or macrophytes.

Nitrogen levels in the millpond were also elevated indicating high levels of organic matter in the watershed above. Levels of total nitrogen were from 2.03 to 3.21 mg/l with the lower levels corresponding to summer growing periods and the higher to fall and spring dormant periods. Ammonia-nitrogen levels ranged from .055 to .352 milligrams/liter. The highest level of ammonia corresponded to the high water temperatures, low oxygen levels, and a low rainfall period.

Sulfate levels ranged from 9 to 21 milligrams/liter during the study period. The lowest reading corresponded to low oxygen levels - the highest with lower water temperatures and high water levels.

Suspended solids ranged from 4 to 14 milligrams/liter with little range during the growing season even when comparing periods of drought with periods of heavy rains. There is a direct correlation between secchi disk reading and suspended solid readings (Table 9).

The high levels of dissolved inorganic chemicals were evident with conductivity readings ranging from 327 to 733 umhos/l. Levels in summer nearly doubled May readings and spiraled in late September. Alkalinity level changes correlated to increases and decreases in conductivity ranging from 290 to 322 milligrams/liter. The pH ranged from 7.93 to 8.21 and showed direct correlation to alkalinity and dissolved oxygen changes.

Five-day Biochemical Oxygen Demand was 2.6 in spring, 2.1 in summer and 1.5 in the fall. Summer BOD sampling exceeded the dissolved oxygen found in the Chilton Millpond at the time of sampling. Fecal Streptococcus and E. Coli sampling results indicated low levels of these organisms.

Discussion

Water chemistry analysis of Chilton Millpond indicates that North Branch of the Manitowoc River has severe nutrient loading problems that consume large amounts of oxygen that is necessary for biological and chemical processes. The high dissolved nutrient loads combined with suspended organic detritus and inorgannic colloidal clay which limits light penetration has restricted the growth and reproduction of aquatic plants, fish, and supporting organisms in the Chilton Millpond.

The extremely high levels of dissolved phosphorus that was found in the water passing through the Chilton Millpond normally would produce massive algae blooms; But limiting light penetration and nitrogen availibilty - in a form suitable for algae growth - is limited.

Phosphorus precipitation is limited by low oxygen and the high pH of the water. Water velocities, suspended colloidal clay particles, and lack of plants to absorb phosphorus all contribute to the high phosphorus levels found in the Chilton Millpond.

High total ammonia levels through out the growing season in the millpond indicated that oxygen levels in the millpond and in the stream above are not adequate to allow decomposition of organic matter or the nitrification process to proceed. Total ammonia levels found during the growing season exceeded levels recommended for chronic exposure limits for fish.

The nutrient series water chemistry helped to explain the gas exchanges occurring below the millpond. The roller dam at the millpond exit and a series of low head dams below quickly added oxygen and drove off nitrogen gas compounds. Under the lowest oxygen conditions some nitrogen entrainment occurred beneath the dams immediately below the millpond.

Sulfate concentrations were within the range of distribution gradients found in surface waters of the area. Lack of oxygen in the South Branch of the Manitowoc system can free sulfide ions which in return bond to most metals and precipitate out as metal sufides. In 1976 high concentrations of various metals were found in the spoil material that was removed Chilton Millpond during the former dredging project (Table 10).

BIOLOGICAL CHARACTERISTICS

Methods

Biological data collection as part of this study was to include a single sampling of the Millpond for algae, diatoms, micro/macroinvertebrates and aquatic plants. The original plan was revised to include vertical and horizontal plankton tows on each monthly visit through the 1993 growing season and spring and fall macroinvertebrate sampling in spring and fall. Poor water clarity conditions limited light penetration. Aquatic plant growth was limited to a shallow water areas in the widest area of the millpond and in the riverine areas at the head of the millpond.

Results

Vertical and horizontal plankton net tows of the Chilton Millpond during the growing season indicated sparse and seasonal growth of both phyto and zooplanktors. A few plankton were found during May when adequate oxygen levels and water clarity supported them. During the rest of the growing season when water clarity and oxygen levels dropped they completely disappeared. Suspended detritus dominmated the tows throughout the sampling period. Results of the plankton tows are found below.

Date	Algae	Zooplankton
5-20-93 *	Closterium sp.(Desmid) Microspora sp.(Green) Oedogonium sp.(Green) Zygnema sp. (Green) Aphanizomenon(Blue-Green)	Rotaria sp.(Rotifer)
7-22-93 *	None	None
8-26-93 *	None	None
9-28-93 *	None	None

* Fine Detritus & Plant & animal parts- Less gelatinous detritus was found on September 28 sampling date.

Macroinvertebrate sampling was conducted at several sites above and below the Chilton Millpond corresponding to many oxygen/temperature sampling sites. D-frame kick net sampling techniques were used in gathering and collecting the organisms. The organisms found directly above and below the Chilton Millpond and on Stony Brook are include in Table 11. A Stoney Brook macroinvertebrate sampling is included to show the diversity and abundance of organisms that can be found when oxygen and other favorable physical and chemical conditions exist. No aquatic macroinvertebrates were in the bottom sediments of the millpond were sampled.

Aquatic plants were abundant in the South branch of the Manitowoc River above the Chilton Millpond. A wide variety of floating, submergent, and emergent plants are found in the shallow water areas of the river. Only a few lily pads were found in the millpond in the shallow mudflat areas at the widest transect. Coontail, a submergent aquatic plant, was found at the head of the millpond where the pond is more stream-like and light penetration allowed some growth. Coontail is a plant that does well in water where their is a high nutrient load. Few aquatic plants were found below the Millpond in the South Branch of the Manitowoc River as water velocities and turbulence prevent their growth. A few were found in slower portions and pool areas of the stream. Duckweed was found floating through the pond from above during the summer through fall sampling periods.

Discussion

The summertime physical and chemical environment in the Chilton Millpond at the present time will not support aquatic organisms. Lack of light penetration limits the growth of aquatic plants. Low oxygen and poor water quality excludes and isolates aquatic organisms from fish to zooplankton from living and growing in the pond during most of the growing season.

Plants and tolerant aquatic organisms exist above and below the Millpond during the growing season. Plants above the pond provide cover and some oxygen but a low oxygen barrier extends for several miles above the millpond for most of the summer. The roller dam at the exit of the millpond is excellent in restoring oxygen to the river during the critical hot weather periods of summer but is a phyical barrier to fish and aquatic animals that could repopulate the pond during more favorable seasons.

The macroinvertebrate species found above and below the millpond have a wide variety of tolerances to water quality. Those species that required excellent water quality were absent or represented by only a few individuals. Those able to tolerate significant organic loadings dominated the samples.

There was a substantial decrease in the number and species of organisms found just above the millpond from spring to fall. This corresponds to the poor water quality that existed between those times - low oxygen and high nitrogenous and suspended matter loading. Below the millpond there was a dramatic increase in the number of riffle beetles that feed on waterlogged wood and old plant vegetation that dominated the detritus that was suspended in the millpond above.

WATERSHED CHARACTERISTICS

Chilton Millpond is an impoundment of the South Branch of the Manitowoc River whose headwaters begin in Fond du Lac County. Several tributaries enter the South Branch in both Fond du Lac and Calumet counties. The watershed that enters the river and it's tributary is extensively used for agriculture - mainly dairy and cash cropping. The soils of the watershed vary from loam formed by glacial till to muck from the accumulation of organic materials in low areas. A small area of the watershed located southwest of the City of Chilton contain soil with a dolomite substratum that is quarried for it's stone. The topography varies from moderately steep well drained areas to poorly drained nearly level areas.

It is the combination of soil types and land uses that contribute to the water quality problems of Chilton Millpond. Both inorganic and organic substances contained in the runnoff from the three soil association landscapes found in the watershed influence the water characteristics of Chilton Millpond. Below is a description of each soil association landscape and how it effects the water quality of the South Branch of the Manitowoc River and especially the Chilton Millpond.

HOCHHEIM-LAMARTINE-MAYVILLE

Loam soils dominate the moderately steep, well drained to somewhat poorly drained southwest and west areas of Calumet County. The surface layer of each of these soils is a very organically rich loam or silt loam. The subsurface layer contains clay that is very friable (easily crushed or crumbled into powder). The substratum layer also contain friable loams.

These soils are used extensively for cultivated crops. The main problems in management of these soils for crops are controlling water erosion, improving drainage, and maintaining tilth and fertility.

Water erosion from these clay loam soils create a colloidal clay and coarse suspensions of soil particles in the water during runnoff and open water periods. Colloids are gelatinous substances made of very small, insoluble, non diffusible particles larger than molecules but small enough so they remain in suspension without settling to the bottom. Their suspension reduces light penetration in the Chilton Millpond during the open water periods.

Wet areas where this group of soils exist have been ditched in many areas to improve drainage. Ditching provides faster drainage during runnoff periods but also increases the organic load to the South Branch of the Manitowoc River and the Chilton Millpond.

HOUGHTON-PALM-WILLETTE

This group of organic soils in found in very poorly drained low and level areas adjacent to the South Branch of the Manitowoc River and it's tributaries. They consist of brown to black muck soils and have wetland vegetation or bottomland trees growing on them.

Runnoff water from exposed cultivated land soils during spring runnoff and heavy rain periods in the watershed flood or cut channels through these areas adding more organic nutrients to the water. High levels of nitrogen and phosphorus compounds dissolved in the water is the result. Many of the large particles settle out on curves and bends in the river but their dark colors absorb light and heat and increase the temperature of the water running over them. They also create an oxygen demand in the river during the heat of the summer causing levels of oxygen to drop to levels so low they will no longer support fish and other aquatic organisms. This seasonal drop in oxygen and increase in temperature extends upstream from the Chilton Millpond for several miles.

CHANNAHON-WHALEN-KOLBERG

These soils are found above the Chilton Millpond in the watershed just east of Charlesburg. They are found on gently sloping to sloping, well drained loamy soils that have dolomite substratum.

Clay loam soils are the main soil types in this area and are heavily cultivated. The soils are friable and subject to erosion during exposed soil periods and dry seasons.

Dolomite rock is within 10 to 40 inches of the surface. Depending on the soil type the underlying dolomite could be white, gray, or white fractured. This substratum is a source of stone for construction and agricultural lime. Open stone pits dot the landscape of tilled soils in the area.

Water running off these soils and the dolomite beneath or from stone quarries can increase the bicarbonate ion content of the water. Dolomite normally has low solubility, but in solution with high carbon dioxide levels (low oxygen) it's solubility increases. With this increase is an increase in conductivity and turbidity. Lime from the dolomite that does not dissolve at once and stays suspended can react with phosphate that can be lost from solution (precipitation) during periods of high oxygen and low carbon dioxide levels. This precipitate was observed in the Chilton Millpond bottom muds. Precipatation occurs in the river and millpond during the winter when little water runnoff occurs and oxygen levels are high. The carbon dioxide concentrations fluctuate with seasons of aquatic plant growth and from day to night time during the growing season. Therefore, the presence of dolomite runnoff from the watershed combined with high levels of carbon dioxide during the growing season contribute to the problems of Chilton Millpond.

CONCLUSIONS

Soil types and human activities on the land in the watershed of the South Branch of the Manitowoc River above Chilton are having tremendous impacts on the water quality. It is the accumulative impact of inorganic and organic substances entering the water system that are causing adverse chemical, physical, and biological conditions in the Chilton Millpond. The characteristics of the soils, topography, and climate combined with land use practices have created this situation.

Dredging of the Chilton Millpond in the late 70's removed the accumulated sediment and changed the characteristics of the pond that supported fish. There was no way of knowing that water clarity problems would be a result of the dredging.

Agricultural activities from the early sedimentation of the pond to today also have changed that contribute to the problem. Surface and subsurface soil with clay characteristics in the watershed are more likely to cause water quality problems when eroded- especially during spring thaws and heavy rains when moisture absorption is limited by frozen ground. Land management practices that limit exposed soil nead to be used.

RECOMMENDATIONS

The watershed of the South Branch of the Manitowoc River should be considered immediately for the Priority Watershed Nonpoint Pollution Program. This program adds financial incentives for the use of management practices to stop the problems but is not effective without good stewardship of the land. The aquatic ecosystem of this watershed has the ability to heal itself if water leaving the watershed can be slowed. Oxygen is the key to healing the system.

Restoration of the Millpond is limited by light penetration limits set by the suspended matter in the growing season. Plant restoration would be limited to shallow water areas and would provide shelter for the fish and collect suspended matter. But the oxygen depletion and barriers still exist that limit the fish from entering the areas in the summer months. Restoration of the Chilton Millpond needs improvements in the watershed above first.

Restoration and stocking efforts should be considered by the City in the South Branch of the Manitowoc below the Millpond. Excellent oxygen and water temperatures exist that will support a wide variety of warm water fish. Removal of many of the small dams will allow fish recruitment from one areas to the next. A restoration plan of restoring the pool - riffle and meandering hydraulics of a stream should be considered. The recreational fishing opportunity would be asset to the community and particulate plant matter could be settled out of the river improving water quality.

FIGURE 1. Map of Locations of Temperature/ Dissolved Oxygen Sampling of the South Branch of the Manitowoc River- 1993

SAMPLING LOCATIONS

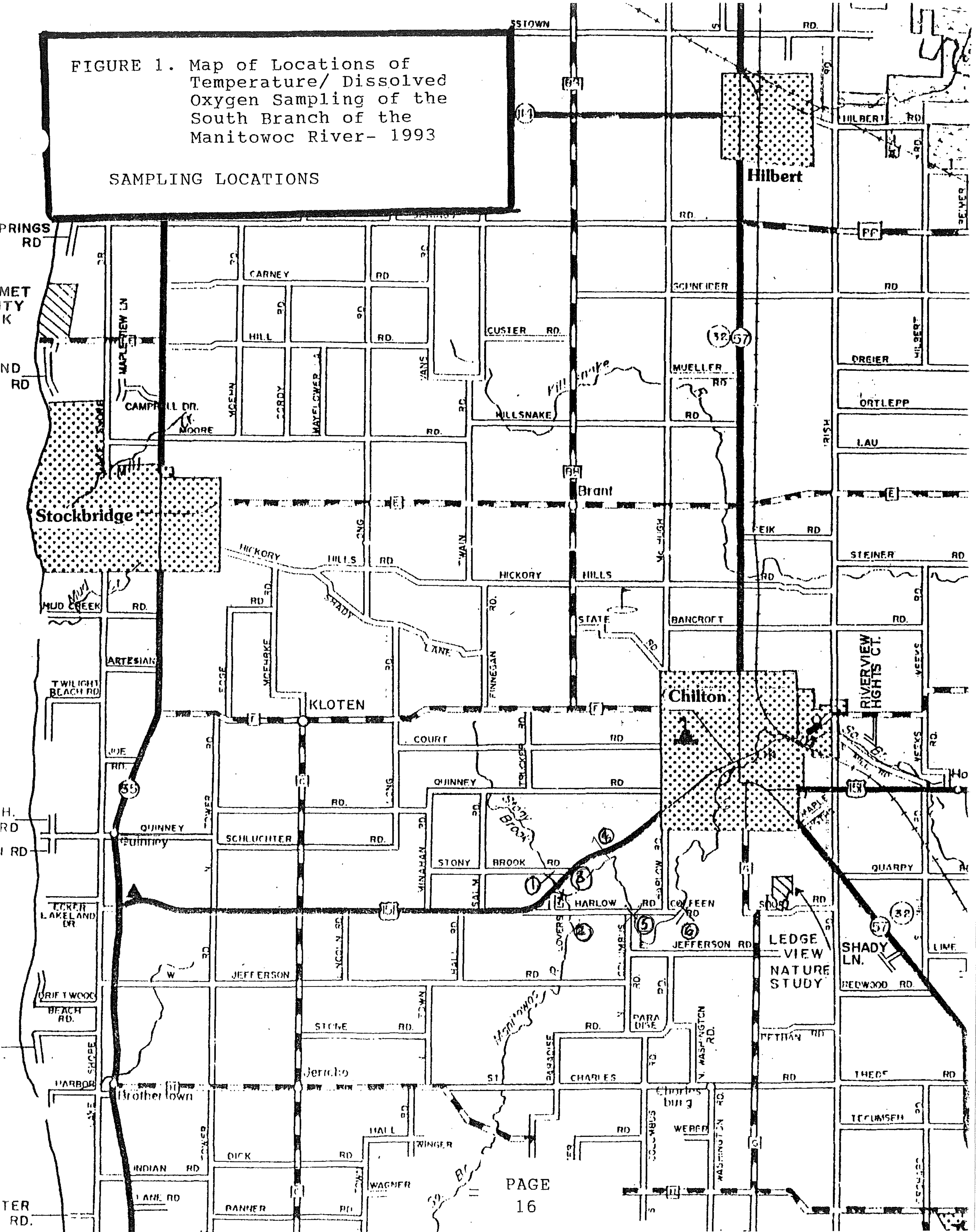
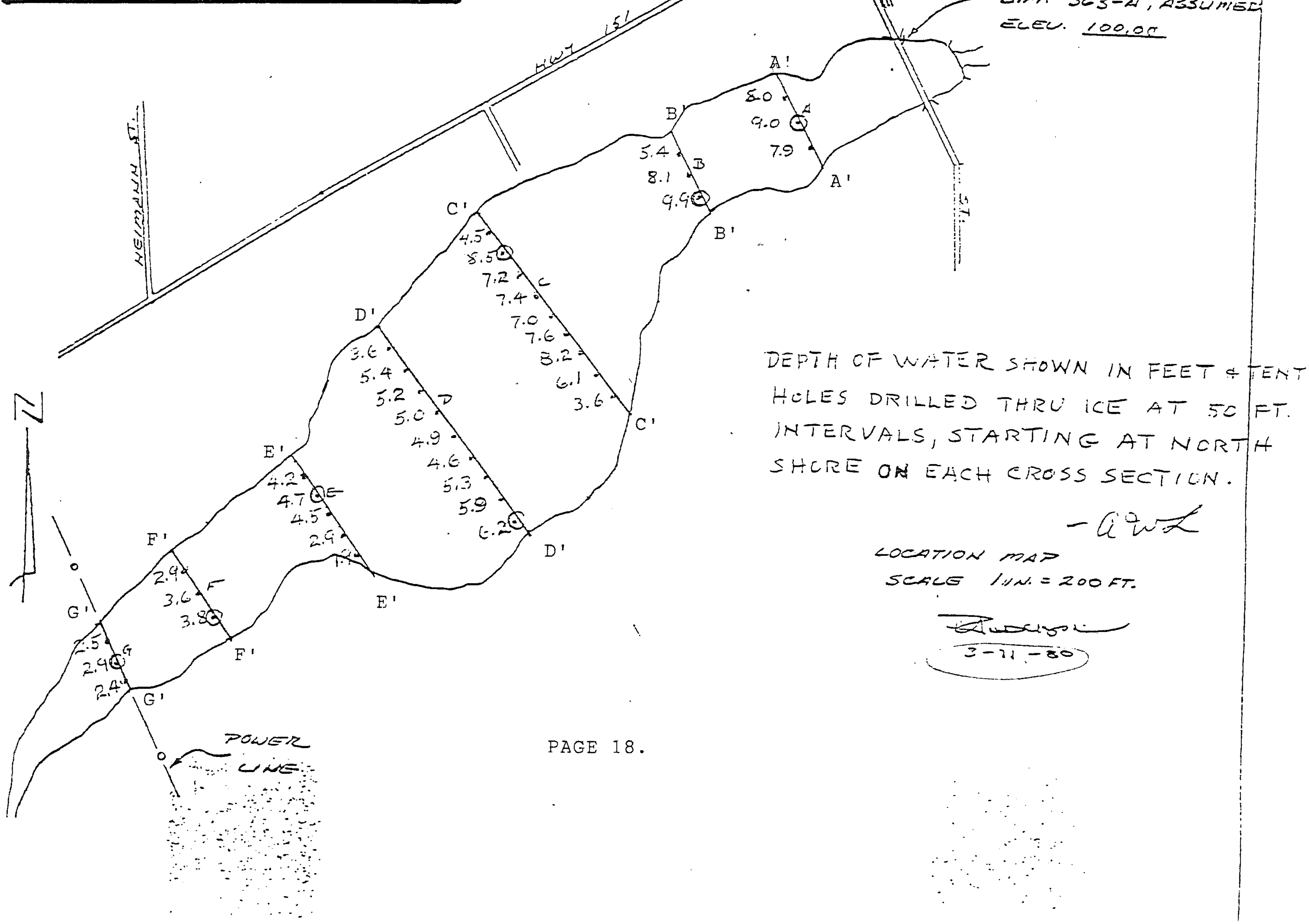


FIGURE 3. Locations of Sediment Profile Sampling Transects and Points on June 7, 1993 & March 11,1980



CHILTON MILLPOND

SEDIMENT PROFILE & X - SECTIONS

A - A

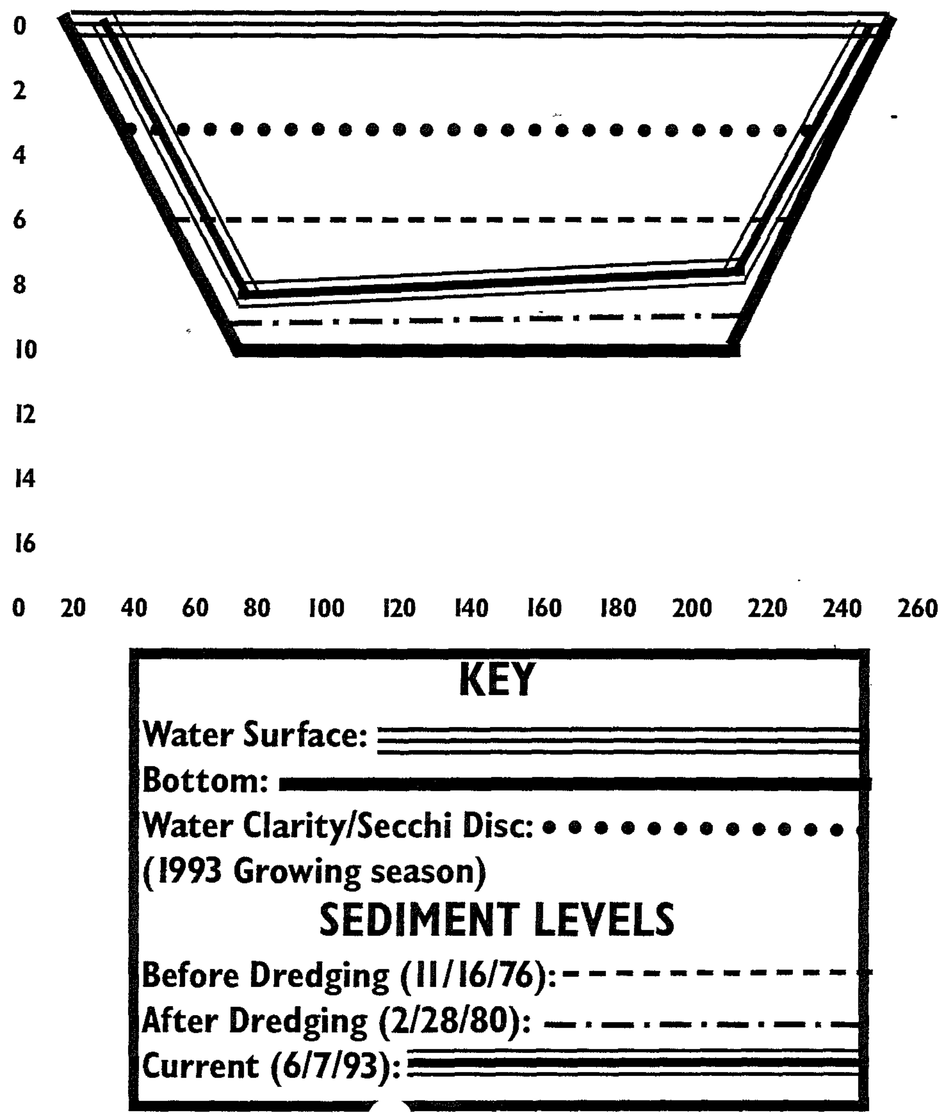


FIGURE 4 A-A

CHILTON MILLPOND

SEDIMENT PROFILE & X - SECTIONS

B - B

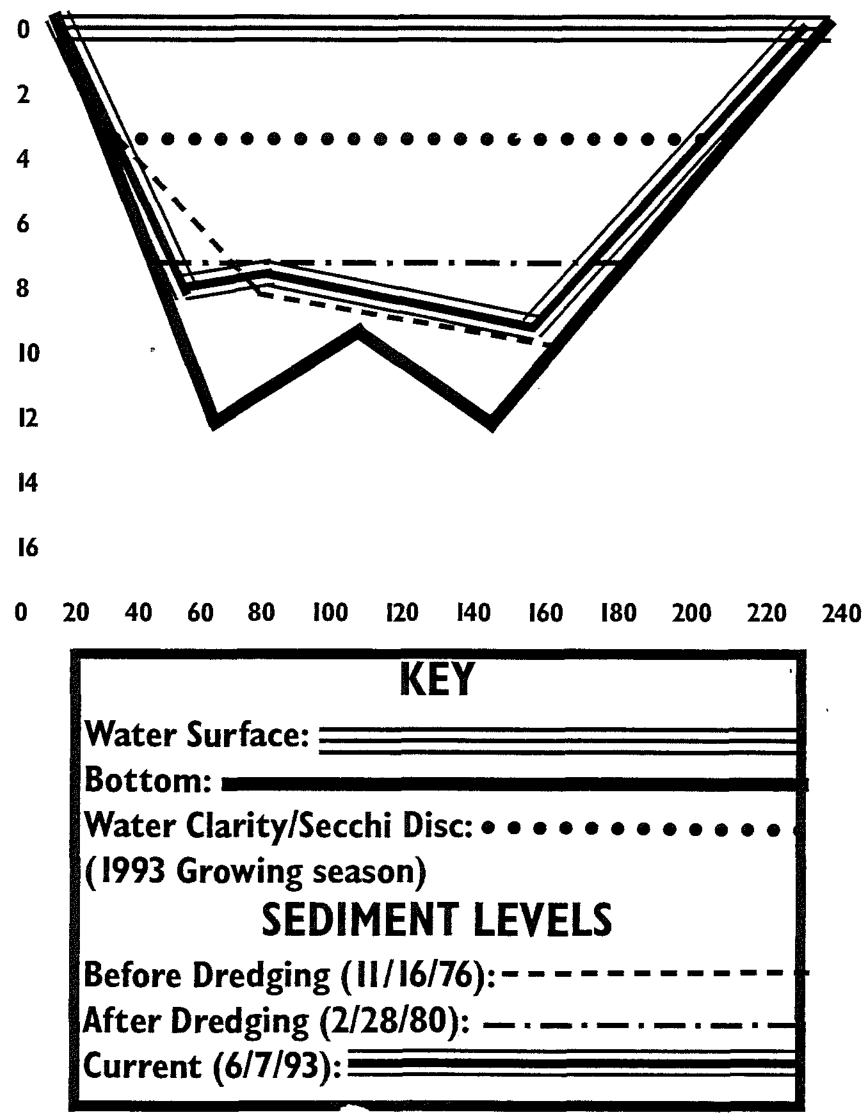
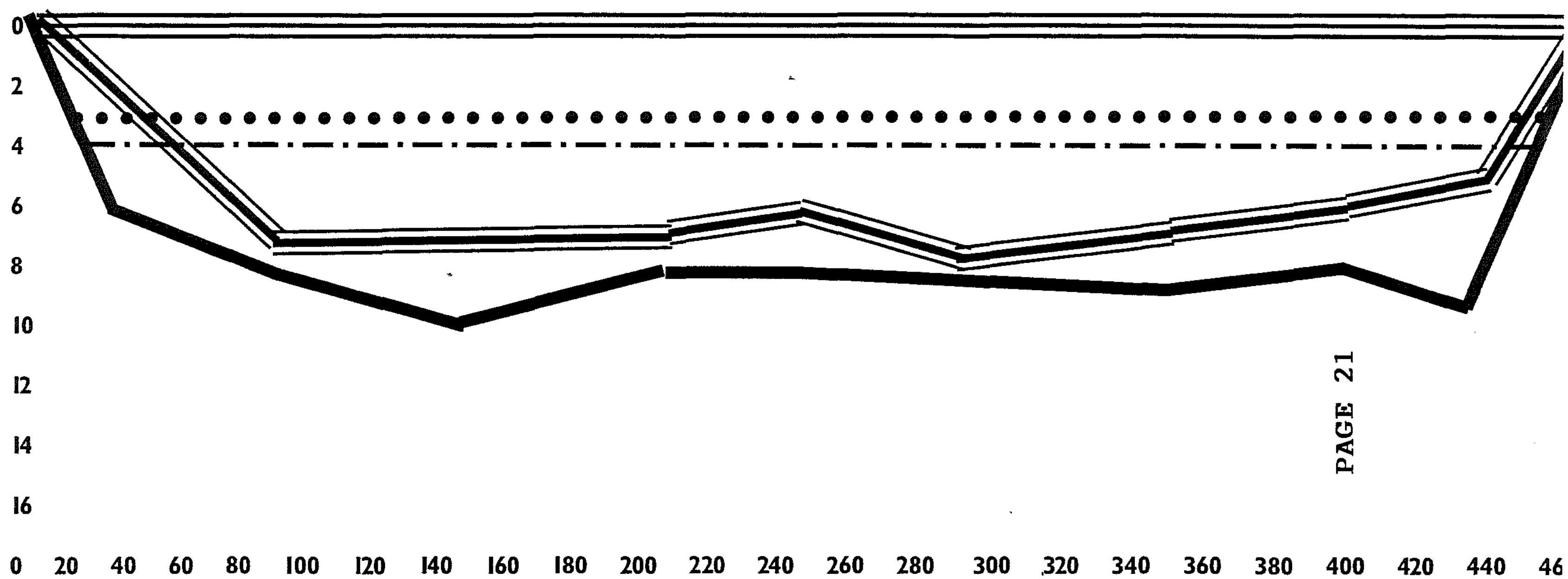


FIGURE 4 B-B

CHILTON MILLPOND

SEDIMENT PROFILE & X - SECTIONS

C - C



KEY

Water Surface:

Bottom:

Water Clarity/Secchi Disc:
(1993 Growing season)

SEDIMENT LEVELS

Before Dredging (11/16/76):

After Dredging (2/28/80):

Current (6/7/93):

FIGURE 4 C-C

CHILTON MILLPOND

SEDIMENT PROFILE & X - SECTIONS
D - D

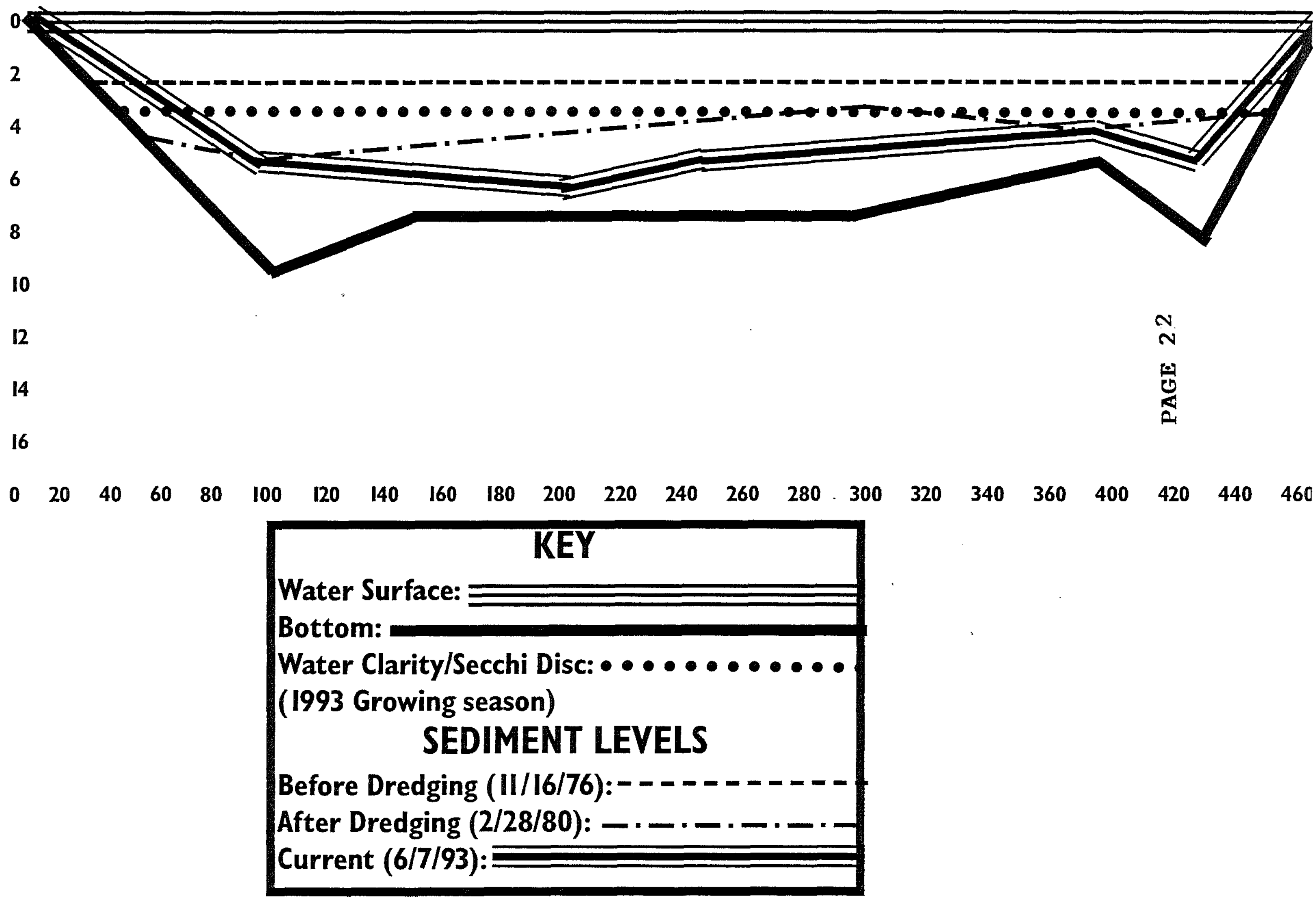


FIGURE 4 D-D

CHILTON MILLPOND

SEDIMENT PROFILE & X - SECTIONS

E - E

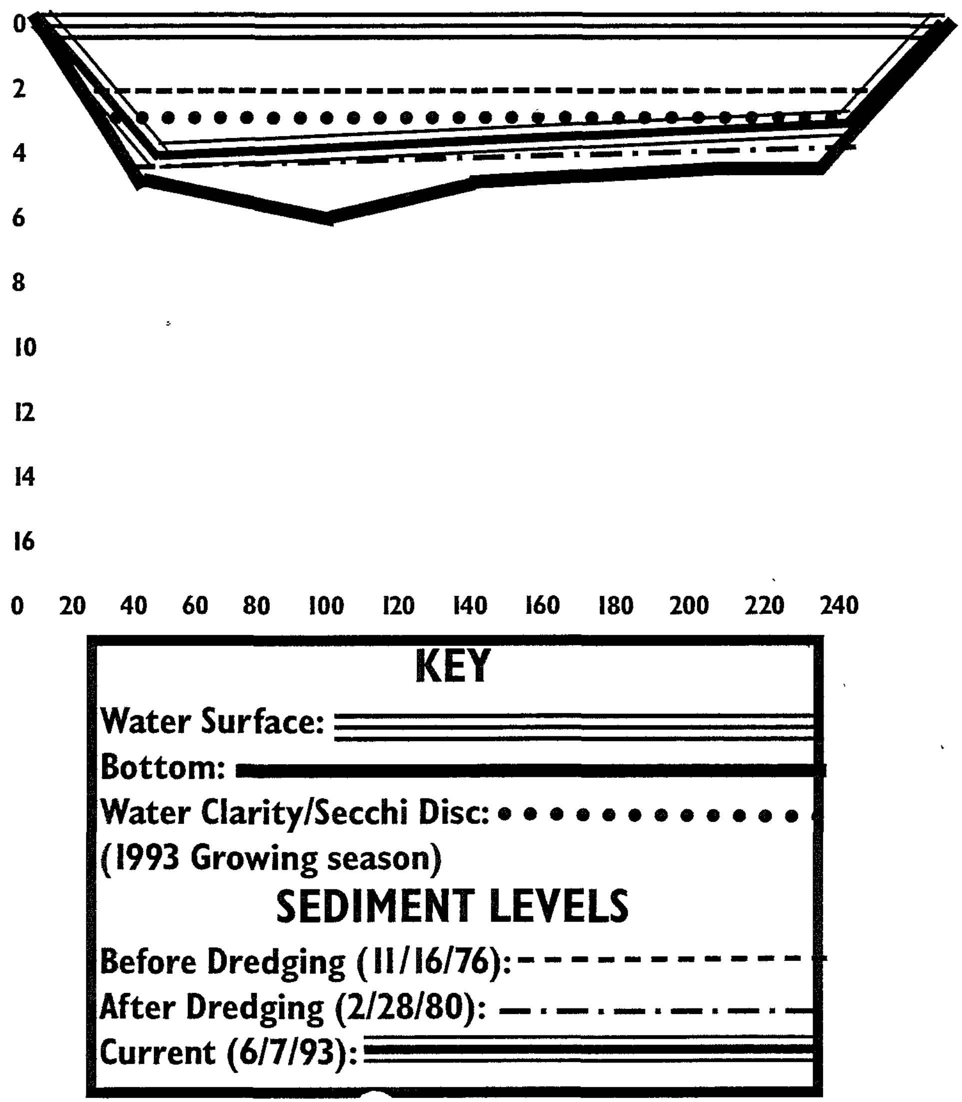
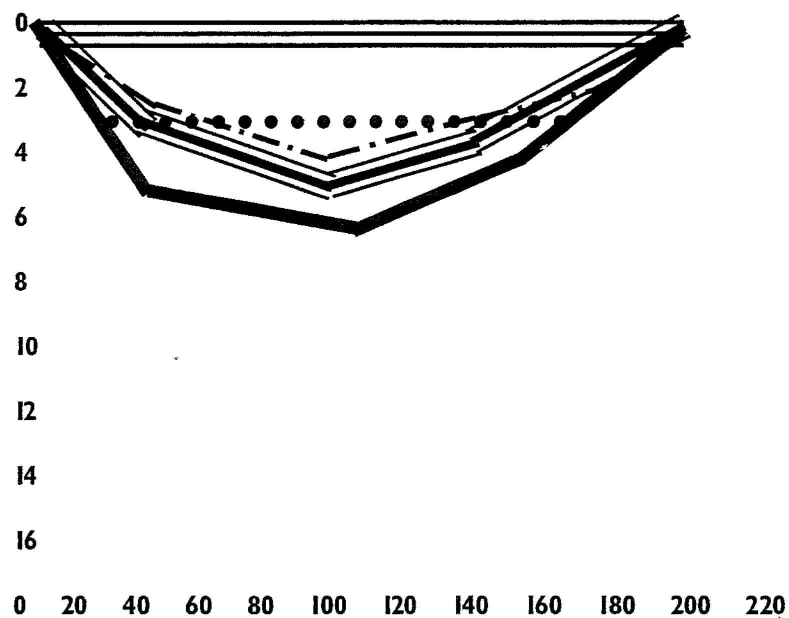


FIGURE 4 E-E

CHILTON MILLPOND

SEDIMENT PROFILE & X - SECTIONS

F - F



KEY

Water Surface:

Bottom:

Water Clarity/Secchi Disc:

(1993 Growing season)

SEDIMENT LEVELS

Before Dredging (11/16/76):

After Dredging (2/28/80):

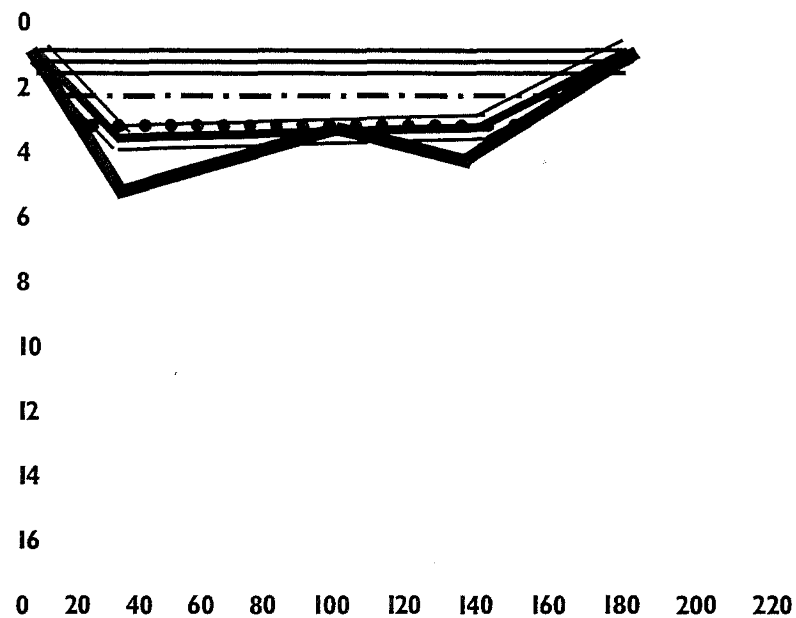
Current (6/7/93):

FIGURE 4 F-F

CHILTON MILLPOND

SEDIMENT PROFILE & X - SECTIONS

G - G



KEY

Water Surface:

Bottom:

Water Clarity/Secchi Disc:

(1993 Growing season)

SEDIMENT LEVELS

Before Dredging (11/16/76):

After Dredging (2/28/80):

Current (6/7/93):

FIGURE G–G

TABLE 1. Oxygen, Temperature, and Water Clarity of Chilton Millpond February 22 thru December 22, 1993.

DATE 1993	OXYGEN* mg/l	TEMP* oF	WATER CLARITY Inches-Secchi	COMMENTS
Feb 22	8.3-11.0	33-35	72"	30" ice
Mar 23	8.3-8.0	33-35	66"	24" ice
Apr 28	9.0-7.8	50-46	48"	Sunny
May 20	8.5-6.9	55-52	42"	Sunny
May 26	7.2-6.4	57-54	36"	Sunny Rain Prior
Jun 8	5.0	60-59	33"	Sunny Rain Prior
June 30	3.4-2.4	68-66	30"	Cloudy Rain Prior
Jul 22	3.0-2.0	70-69	31"	Sunny-80 F 3 Days Prior
Aug 26	6.2-2.2	76-75	35"	Sunny-80 F 3 Days Prior
Sep 28	6.5-6.2	52-51	31"	Sunny-50 F
Oct 26		49		Cloudy
Nov 21			27"	
Dec 27			62"	Ice cover

*Oxygen/Temperature Profiles Ranges are from Surface to Bottom

Table 2. Oxygen/Temperature Sampling Above and Below Chilton Millpond of the S. Br. Manitowoc River on May 20, 1993 (Number of sampling location described corresponds to locations on map in Fiqure 1.).

SAMPLING LOCATION #	DISSSOLVED OXYGEN mg/l	WATER TEMP. F	DESCRIPTION OF SITE
DMAY 8@			
1.*	9.8	54	250' Below Stony Brook Road on Stony Brook
3.*	10.2	57	Below Private Road (E. Stony Br. Rd) Bridge off STH 151
7.*	8.5	56	1st Riffle Above Millpond Adj. to Fair Grounds
9.	8.5	55	In Millpond 100' Above Dam,at A-A X-Section Site
12.*	7.8	58	Below 151 Bridge On S. Br. Manitowoc River

* Macroinvertebrate Sampling Sites for Spring and Fall

TABLE 3. Oxygen/Temperature Sampling of the S. Br. of the Manitowoc River above and below Chilton Millpond on June 8, 1993 (Number of sampling location described corresponds to locations on map in Figure 2.).

SAMPLING LOCATION #	DISSOLVED OXYGEN mg/l	WATER TEMP. C	DESCRIPTION OF SITE
7. *	5.5	59	1st Riffle above Millpond Adj. to Fairgrounds
8.	5.0	59	In Narrows at Head of Millpond,200' below Location 7.
10.	5.8	59	In Millpond off Dam on State St. Bridge.
11.	7.8	60	200' below State St Millpond's Cascade/ Roller Dam
12.*	6.2	60	Below 151 Bridge/ Box Culvert
13.	8.5	60	Above 3rd Dam along Parkway north of High School Grounds
14.	6.7	60	150' below 3rd Dam (All riffle areas above to #13)
15.	7.5	60	Above 4th Dam along Parkway in back of Library
16.	7.0	60	Below 4th Dam

* Macroinvertebrate Sampling Sites

TABLE 4. Oxygen/Temperature Sampling of the S. Br. of the Manitowoc River above and below the Chilton Millpond on July 22, 1993 (Number of sampling location described below corresponds to the locations on map in Figure 2.).

SAMPLING LOCATION #	DISSOLVED OXYGEN mg/l	WATER TEMP. C	DESCRIPTION OF SITE
7.*	2.0	68	1st Riffle above Millpond, adj.to Fairgrounds
10.	3.0	69	In Millpond on Dam off State St Bridge
11.	6.3	69	200' below State St Millpond's Cascade/ Roller Dam
12.*	7.3	69	Below 151 Bridge/ Box Culvert
13.	7.3	69	Above 3rd Dam along Parkway north of High School Grounds
14.	7.5	68	150' below 3rd Dam (all riffle areas above to #13)
15.	8.0	68	Above 4th dam along Parkway in back of Library
17.	7.9	69	Below E.Grand St. Bridge by Coop.
18.	7.5	69	South of Bridge at WWTP Entrance

* Macroinvertebrate Sampling Site

TABLE 5. Oxygen/Temperature Sampling of the S. Br. of the Manitowoc River above and below Chilton Millpond on August 26, 1993 (Number of sampling location described below corresponds to the locations in Figure 1 & 2).

SAMPLING LOCATION #	DISSOLVED OXYGEN mg/l	WATER TEMP. C	DESCRIPTION OF SITE
1.*	8.0	66	250' below Stony Br Rd on Stony Brook
2.	2.0	75	Off Harlow Rd Brg. S. of Turkey Farm
3.*	4.0	74	Below Private Road (E. Stony Brook Rd) Bridge off STH 151
4.	4.0	70	Trib. to S. Br.,E. of D & D Equipment Flow approx. 60gpm
5.	4.0	74	Off Harlow Rd. Brg. E. of Columbus Rd.
6.	2.8	74	Off Coffeen Rd. Brg
7.*	4.3	74	1st Riffle Above Millpond,Adj. to Fairgrounds
9.	5.0-2.2	76	In Millpond 100' above Dam, at A-A
11.	8.0	75	200' below State St Millpond Cascade/ Roller Dam
12.*	8.0	75	Below 151 Bridge/ Box Culvert
13.	8.0	74	Above 3rd Dam along Parkway N. H.S.Grds
14.	8.0	75	150' Below 3rd Dam
15.	8.0	75	Above 4th Dam(Libr)
17.	8.0	75	Below E. Grand Brdg
18.	8.2	75	S of Brg at WWTP Ent

TABLE 6. Oxygen/Temperature Sampling of the N. Br. of the Manitowoc River above and below the Chilton Millpond on September 28, 1993 (Number of sampling location described below corresponds to locations in Figure 1 & 2).

SAMPLING LOCATION #	DISSOLVED OXYGEN mg/l	WATER TEMP. C	DESCRIPTION OF SITE
1.*	10.0	10.1	250' below Stony Br Rd. on Stony Brook
2.	6.5	10.2	Off Harlow Rd. Brg N. of Turkey Farm
3.*	7.1	11.0	Below Private Rd. (E. Stony Br.Rd.) Bridge off STH 151
4.	6.6	10.0	Tr. to S. Br.,E. of D & D Equipment
5.	6.9	10.2	Off Harlow Rd. Brdg E. of Columbus Rd.
6	7.4	10.3	Off Coffeen Rd. Brg
7.*	6.4	10.3	1st Riffle above Millpond, Adj. to Fairgrounds
9.	6.5-6.2	11.5-11.2	In Millpond 100' above Dam, A-A'
12.*	8.6	10.2	Below 151 Bridge/ Box Culvert
18.	9.6	12.0	S. of Bridge at WWTP Entrance

* Macroinvertebrate Sampling Sites

TABLE 7. Estimated Chilton Millpond Sedimentation from February 28, 1980 to June 7, 1993 in Cubic Yards*

X-SECTION AREA	Cubic Yards
Dam to A'-A'	+62,900
A'-A' to B'-B'	+135,800
B'-B' to C'-C'	+149,850
C'-C' to D'-D'	-64,750
D'-D' to E'-E'	-217,375
Net Sediment Accumulation	+ 65,625 Cubic Yards

* - Sediment profiles in 1993 corresponded to 1980 post dredging profiles as described in report.

- Sediment accumulation was calculated using the Average-End-Area Formula.

TABLE 8. Water Chemistry of Chilton Millpond from February 23, 1993 to October 26, 1993.

DATE	Ttl P mg/l	Dis. P mg/l	SO4 mg/l	BOD 5 mg/l	NH3 NH4 mg/l	NO3 + NO2-N mg/l	TKN mg/l
Feb 23							
Mar 23	.105	.063			.110	2.0	1.2
Apr 28							
May 25		.149	12	2.6			
Jun 8	.177	.104	12		.144	1.14	1.6
Jul 22	0.46		9	2.1	.352	.430	1.6
Aug 26							
Sep 28	0.17		21	1.5	.055	1.55	1.4
Oct 26							

TABLE 9. Water Chemistry of Chilton Millpond Continued from February 23,1993 to October 26,1993.

DATE	DO mg/l	pH su	SS mg/l	Alk. mg/l	Cond umhos/l	Secchi inches	Chor A ug/l	T oF
Feb 23	9.5					72"ice		34
Mar 23	8.2		4			66"ice		34
Apr 28	8.5					48"		48
May 25	7.5	8.13	10		327	42"	9.60	53
Jun 8	5.0	8.09	14	319	651	33"	5.79	67
Jul 22	2.5	7.93	14	290	592	31"	2.86	70
Aug 26	4.0					35"		75
Sep 28	6.3	8.21	12	322	733	31"	3.35	51
Oct 26								49
Nov 21						27"		
Dec 27						62"ice		

TABLE 10. Chemical Analysis Results of Bottom Sediment Samples taken from South branch of the Manitowoc River above, in, and below the Chilton Millpond on October 11, 1976 prior to the 1977 and 1980 dredging of the millpond.*

PARAMETER	ABOVE MILLPOND 1 MILE ANALYSIS	MILLPOND ANALYSIS	BELOW MILLPOND RIVER ABOVE STP ANALYSIS	UNITS
Cadmium (Cd)	2.40	3.00	3.10	mg/kg
Chromium (Cr)	20.00	40.00	42.00	mg/kg
Copper (Cu)	11.00	52.00	36.00	mg/kg
Lead (Pb)	47.00	330.00	150.00	mg/kg
Mercury (Hg)	0.15	0.08	0.06	mg/kg
Nickel (Ni)	4.20	19.50	8.80	mg/kg
Zinc (Zn)	58.00	271.00	304.00	mg/kg
Phosphorus (tH organic)	600	830		mg/kg
Nitrogen (tH organic) (TKN)	1540	4200		mg/kg

* from DNR memorandum dated November 12, 1976

TABLE 11. Macroinvertebrates of the South Branch of the Manitowoc River and Stoney Brook Tributary Above and Below the Chilton Millpond on September 26, 1994.

SAMPLE LOCATION* #	TAXA	ORGANISM COUNT 5-20-93	9-28-93
1.	Malacostraca		
	Cambarus sp.	1	
Stoney	Orconectes sp.	1	
Brook	Gammarus sp.	13	
	Corophium sp.	7	
	Ephemeroptera		
	Baetis pygmaeus	17	
	Baetis brunneicolor	17	
	Leptocerida		
	Astenophylax sp.	3	
	Neophalax sp.	1	
	Pelecypoda		
	Pisidium sp.	5	
4.	Ephemeroptera(mayfly)		
Above	Stenonema sp.	50	43
Chilton	Rhithrogena sp.	13	
Millpond	Ameletus sp.		2
	Malacostraca		
	Corophium sp.	4	
	Asellus sp.		2
	Diptera(two-winged flies)		
	Chironomus sp.	12	
	Hemiptera(water bug)		
	Notonectra sp.	1	
5.	Ephemeroptera(mayfly)		
Below	Stenonema sp.	73	23
Chilton	Hexegenia sp.		1
Millpond	Malacostraca		
	Corophium sp.	3	
	Asellus sp.		2
	Diptera(two-winged flies)		
	Chironomus sp.	3	11
	Coleoptera(larva beetles)		
	Dubiraphia sp.	8	75
	Plecoptera(stonefly)		
	Isopera sp.	1	1