Branch River Priority Watershed

Surface Water Resource

Appraisal Report

Submitted by

Mary Gansberg

Wisconsin Department of Natural Resources

April 1995

Branch River Priority Watershed

Surface Water Resources Appraisal Workgroup

Mary Gansberg, DNR - Green Bay

Robin McLennan, DNR - Green Bay

Steve Hogler, DNR - Manitowoc

Terry Lychwick, DNR - Green Bay

Mike Mushinski, LCD Brown County

Tony Smith, LCD Manitowoc County

Sue Porter/Len Olson, DATCP

Terry Kafka, DNR - Madison

Acknowledgement

A special thank-you to Greg Cleereman for all his support in monitoring and data analysis for this report.

TABLE OF CONTENTS

List of Tables, Figures, and Appendix

I. INTRODUCTION

The purpose of this surface water resource appraisal report is to summarize the existing and potential condition of water resources, identify causes of surface water use problems, and to provide preliminary surface water resource goals and objectives and pollutant load reductions needed to meet those objectives for each subwatershed in the *Branch River Priority Watershed Project* (Figure 1).

The Branch River watershed ranked high priority for both surface and groundwater under the nonpoint source priority watershed selection process. A separate groundwater appraisal report identifies the activities which were conducted to evaluate existing groundwater conditions and land use practices impacting groundwater.

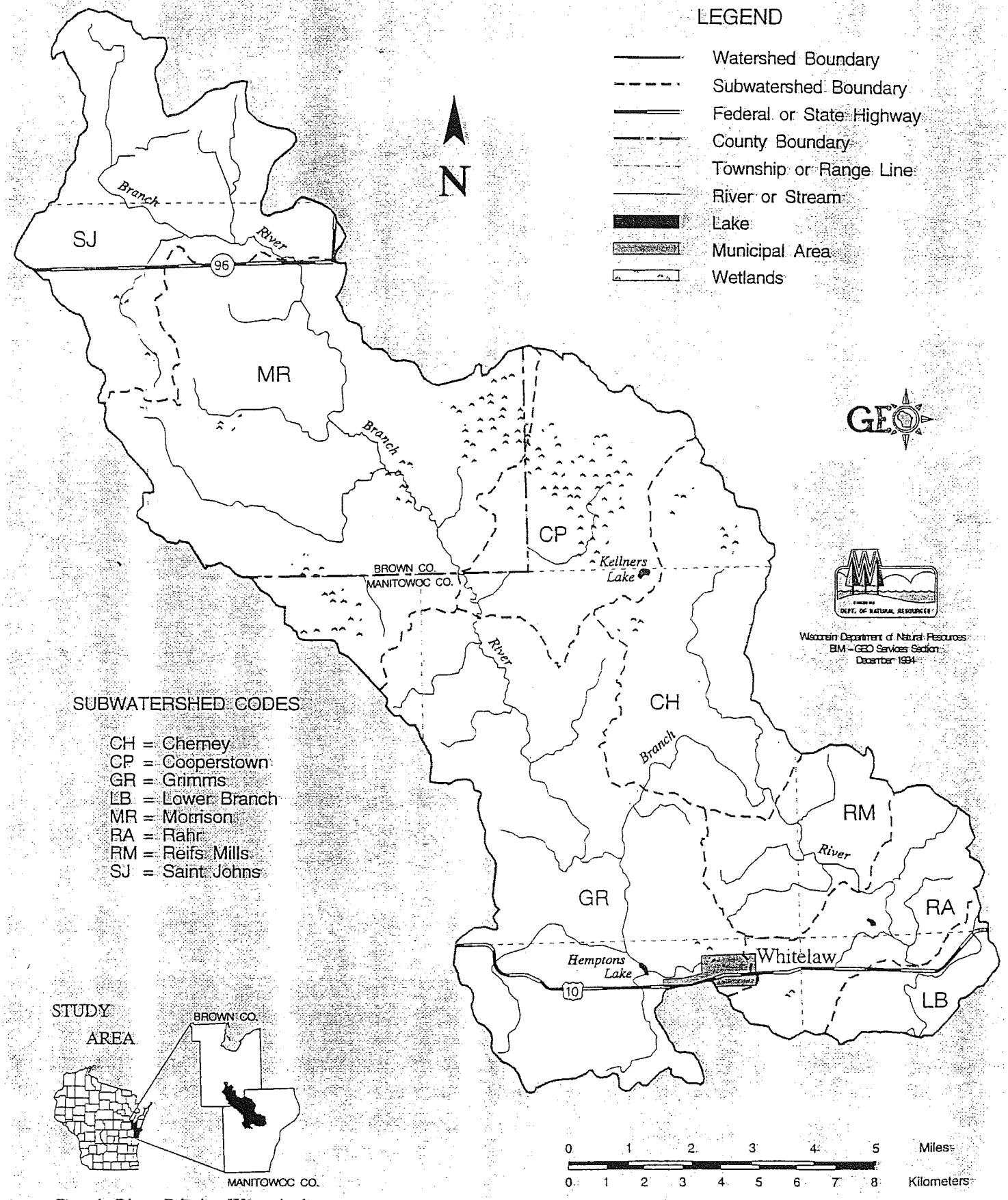
II. SUMMARY OF WATER RESOURCE CONDITIONS

The watershed is 97 square miles in size and located in Brown (37%) and Manitowoc (63%) counties with dairy farming being the primary land use. The Branch River and several unnamed intermittent and perennial tributaries to the Branch River make up the watershed drainage area. The Branch River discharges to the Manitowoc River near the community of Branch. The Branch River is classified as great lakes aquatic communities downstream of the Brown County line and warm water forage fish communities above the Brown County line. The Branch River also supports the Greater Redhorse (Moxostrama carinatun), a threatened species that is sensitive to chemical pollutants, turbidity and siltation (WDNR, 1991). The Branch River is designated as exceptional resource waters. Exceptional classification means the water resource has excellent water quality and valued fisheries, but receives wastewater discharge. Two large wetlands, Cooperstown Swamp and Morrison Swamp, two small lakes, Hemptons and Kellners Lake, are components of the water resources in this watershed.

The many intermittent tributaries make up the headwater of the Branch River system. Continuous flow starts at about Hwy 96 crossing. The river is generally slow, wide and deep in these upper reaches until about CTH J where the gradient increases significantly which changes the character of the river. Habitat is degraded in these upper reaches from sedimentation from bank erosion and field runoff. Most of the bank erosion is caused by flooding, however, livestock access does contribute. It is likely that high water extremes could be reduced to some extent by changing land management practices that would increase infiltration and reduce peak runoff rates. Nutrients, pesticides, and pathogens are often attached to sediment and delivered to surface water with sediment runoff. Habitat is also degraded when nutrients cause excess aquatic plant growth (algae and macrophytes). Phosphorus is the most significant nutrient which promotes aquatic plant growth. As the plants photosynthesize in the daylight they produce abundant oxygen, but the oxygen is used during plant respiration at night. These severe oxygen fluctuations stress aquatic life.

FIGURE 1.

Branch River Priority Watershed



Branch River Priority Watershed

The Branch River from CTH J downstream supports higher quality aquatic life habitat then upstream because the river is more narrow, shallow, has many riffles, pools and a rocky substrate. The lower reaches are not directly impacted by sediment loading because the higher gradient of the river scours the substrate and flushes it downstream; however, the effects of nutrient loading to the river can be seen by the abundant aquatic plant growth on the substrate.

The lower reaches of the Branch River have an excellent anadromous salmonid fishery. The lower Branch River is the site of stocking of thousands of steelhead smolts and has major seasonal runs of anadromous trout and salmon. The fishery for these species is widely known and attracts anglers from all over the midwest to participate in the fishery. Consequently, this section of the river is within the proposed Manitowoc - Branch River Fishery Area (WDNR, 1993). This fishery area designation would protect the developing fishery (especially steelhead) by acquiring riparian lands where possible and by encouraging proper land practices on non-acquired properties. Other goals of the project are to provide adequate public access and other outdoor recreational activities.

Native fish species, including smallmouth bass and northern pike have been on the decline in much of the watershed in recent years, but still are important members of the fish community. Northern pike are found in upstream sections of the Branch River and in tributaries that have warmer water. Smallmouth bass are found in middle sections of the river that have cooler water temperatures. Trout and salmon are found in the lower section of the Branch River that are rocky, have the coolest water temperatures and a good flow. In general, both intermittent and perennial tributaries supply cooler water to the Branch River which ultimately benefits the aquatic communities of the river.

In areas of the Branch River which are intermittent or in tributaries to the Branch River, it is extremely important that any wetlands that are present should be protected or enhanced to provide spawning sites for northern pike. These wetlands would also slow the release of water downstream and permit northern fry to reach the Branch River. Wetlands also filter incoming water and act as a sediment trap which reduces the amount of nutrients and sediment entering the stream and improves water quality. If possible, wetlands should be created in areas that lack them to produce the same effects. Care must be taken in choosing these locations to mimic natural conditions and produce the desired effect.

The watershed includes the village of Whitelaw and several unincorporated villages such as Morrison, Wayside, Branch, Lark, Taus, Reifs Mills, Mechalville, Maple Grove, Grimms, North Grimms, and Cato. Although these urban areas cover only a small part of the land in the watershed, they could cause significant water quality problems including toxic pollution, flooding, and habitat destruction. Nonpoint sources of pollution that originate from these communities and developed areas will be addressed through the information and education program of this watershed project.

Generally, the water resources in the Branch River watershed show significant nonpoint source pollution problems. The sources of these pollutants appears to be from streambank and gully erosion, barnyard/feedlot runoff, upland soil erosion, and possibly the golf course and superfund sites.

Overall, with the reduction of nonpoint source pollution, the Branch River watershed streams have the potential for better aquatic life habitat. An increase in habitat would promote longer residence, greater diversity, and abundance of fish species and macroinvertebrates. A reduction of pollutants to the two lakes in this watershed would only slightly slow their eutrophication. A reduction of pollutants to the wetlands would protect the wetlands from further degradation.

III. APPRAISAL METHODS

Following is a brief description of monitoring activities conducted from September 1993 to August 1994 for the surface water resource appraisal. Monitoring procedures are consistent with the quality assurance/quality control "Field Procedures Manual" (WDNR, 1988). Previous monitoring results from the Department of Natural Resources Water Resources and Fisheries Management files are referred to in the discussion section of this report.

Macroinvertebrate

Aquatic macroinvertebrates were collected at five sites in the watershed using a D-frame net in Fall 1993 and Spring 1994. Sample results were evaluated using the Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1987) or Hilsenhoff Family-level Biotic Index (FBI) (Hilsenhoff, 1988) and Ephemeroptera, Plecoptera, Trichoptera (EPT) Index (Plafkin et al, 1989). The HBI and FBI provide a relative measure of organic loading to the stream. Percent EPT is the percent Ephemeroptera, Plecoptera, Trichoptera genera out of the total number of genera in a sample. These insect orders are generally known to be intolerant of pollution.

Habitat Evaluations

Stream habitat conditions were evaluated throughout the watershed in the spring, summer, and fall. A matrix was used to numerically rank physical habitat characteristics that may limit the quantity and quality of aquatic life (Ball, 1982).

Dissolved Oxygen/Temperature

Continuous dissolved oxygen and temperature meters were placed in the Branch River at Danmar Road and CTH G for 11 day periods in August in addition to grab samples at several other locations. Wisconsin Administrative Code NR 102 establishes dissolved oxygen water quality standards to maintain favorable aquatic life. For warm water streams the standard is 5 mg/L. For great lakes cold water streams the standard is 6 mg/L.

Water Temperature

Water and air temperature was monitored on the Branch River upstream and downstream of the confluence of a perennial tributary (T20N, R22E, S27, NWSW). This monitoring was conducted to determine the effects of the tributary and ambient air temperature on the Branch River water temperature.

Lake Evaluation

Kellners Lake was monitored three times to determine the trophic state index and general condition of the lake. Water quality parameters included specific conductance, temperature, dissolved oxygen, and pH profiles and surface total phosphorus, chlorophyll a, nitrate-nitrogen, ammonia, and total kjeldahl nitrogen.

IV. RESULTS AND DISCUSSION

A summary of the streams in each of the eight subwatersheds in the Branch River Priority Watershed, including monitoring results and observations, problems and/or causes of degradation of the water resources, and the stream water resource potential are presented in Table 1. A summary of monitoring results are presented in Table 2.

The following subwatershed descriptions provide a summary of current and potential water resource conditions, sources of pollution and other factors causing surface water quality problems, and preliminary surface water resource management goals and objectives.

SAINT JOHNS SUBWATERSHED

Saint Johns subwatershed consist of the Branch River from its headwaters to Hwy 96 and nine intermittent and two perennial tributaries to the Branch River. Continuous flow starts in the Branch River at approximately Hwy 96. Upstream the river and its tributaries only flow during runoff events.

The Branch River in this section is classified as warm water forage fish communities. In summer, water ponds in the river channel and becomes stagnate with low dissolved oxygen levels and thick duck weed growth. In this headwater area, the river banks appear to be well buffered with dense tree and shrub growth. The river bed is mostly soft sediment. Several of the intermittent tributaries have been ditched to accommodate rapid field drainage.

The Branch River and its tributaries in this subwatershed are most significantly limited by flow during most of the year.

Table 1. Summary of Water Resource Conditions, Limiting Factors, and Potential

SAINT JOHNS SUBWATERSHED

STREAM	BRANCH RIVER, TWO PERENNIAL, AND NINE INTERMITTENT TRIBUTARIES
EXISTING CONDITION/OBSERVATIONS	Branch River: flow starts at about Hwy 96 WWFF[1] classified - river is meeting its classification water ponds, low dissolved oxygen and thick duck weed banks buffered soft substrate Tributaries: many are ditched
WATER RESOURCE PROBLEMS/LIMITING FACTORS	flow
WATER RESOURCE POTENTIAL	nonpoint source reduction would benefit downstream water quality

MORRISON SUBWATERSHED

STREAM	BRANCH RIVER, ONE PERENNIAL, AND ELEVEN INTERMITTENT TRIBUTARIES
EXISTING CONDITION/OBSERVATIONS	Branch River: WWFF classified - river is not meeting its classification low gradient turbid good to poor habitat macroinvertebrates indicate poor to fair water quality significant bank erosion abundant macrophytes depleted oxygen silted substrate, channelized Intermittent Tributary (T21N,R21E,S9,NESW): ditched in sections Morrison Sanitary District discharge Intermittent Tributary (21N,R21E,S33,NENE): macroinvertebrates indicate very poor water quality WWFF classification - stream is probably meeting its classification Perennial Tributary (T21N,R21E,S21,NESE): fair habitat banks buffered some silt
WATER RESOURCE PROBLEMS/LIMITING FACTORS	lack stable habitat channelized low gradient silt covered substrate bank erosion - pastured dense macrophyte growth oxygen depletion
WATER RESOURCE POTENTIAL	increase aquatic life habitat by preventing sedimentation of pools, limiting nutrient loading which causes plant growth and fluctuating dissolved oxygen levels, and eliminating livestock pasturing

(Table 1 continued) COOPERSTOWN SUBWATERSHED

STREAM	BRANCH RIVER, ONE PERENNIAL, AND ONE INTERMITTENT STREAM	KELLNERS LAKE
EXISTING CONDITION/OBSERVATIONS	Branch River: GLAC[2] classified - river is probably not meeting its classification significant bank erosion exceptional resource waters[3] Perennial Tributary (T20N,R22E,S6,SENE): ditched in some stretches black organic matter covers substrate, muck dense macrophyte growth low dissolved oxygen fair habitat stained water wetlands impact creeks (Cooperstown Swamp) Intermittent Tributary (T20N,R22E,S6,NESE): stable banks fair habitat clear water	no public access, undeveloped 14.6 acre size muck bottom - anoxic in winter cattail/wetland riparian area dense plant and algae growth larger game fish not present because winter kill phosphorus limiting factor for plant growth eutrophic 5-6 feet deep about two square mile drainage basin
WATER RESOURCE PROBLEMS/LIMITING FACTORS	sand and muck substrate dense macrophyte growth channelization wetlands source of organic matter bank erosion	eutrophic - dense macrophyte and algae growth winterkill muck bottom - anoxic in winter nutrient and sediment loading from drainage basin
WATER RESOURCE POTENTIAL	potential same as current biological use because of wetland influences	The lake could never be mesotrophic because of the existing nutrients in the sediments and the morphology of the lake. Preventing additional nutrients and sediment would protect it from becoming more eutrophic

(Table 1 continued)

GRIMMS SUBWATERSHED

STREAM	BRANCH RIVER, HEMPTON LAKE, ONE PERENNIAL, SEVENTEEN INTERMITTENT TRIBUTARIES
EXISTING CONDITION/OBSERVATIONS	Branch River: GLAC classified - river is probably not meeting its classification exceptional resource waters good to fair habitat banks buffered but still eroding silt and sediment cover rock and rubble substrate upper reaches slow, lower reaches faster current turbid fish kill August 1994 - complete kill Lemberger Landfill superfund site (WPDES permit to treat groundwater) perennial tributary decreases Branch River water temperature Intermittent Tributary (T19N,R22E,S3,SWNE) - (tributary to Hempton Lake): Whitelaw wastewater treatment plant discharge LFF[4] classified - stream is meeting its classification channelized Perennial Tributary (T20N,R22E,S27,NWSW): plant growth thick - dissolved oxygen swings severe fair habitat macroinvertebrates indicate fairly poor water quality - family biotic index Hempton Lake: no public access historically poor water quality - 1977
WATER RESOURCE PROBLEMS/LIMITING FACTORS	silt and sediment cover substrate slow stream flow and little scouring bank erosion turbid dense macrophyte growth channelized possible effects from superfund sites
WATER RESOURCE POTENTIAL	increase aquatic life habitat by preventing sedimentation of pools and riffles, and limiting nutrient loading which causes plant growth and fluctuating dissolved oxygen levels. Potential of Hempton Lake unknown

(Table 1 continued)

CHERNEY SUBWATERSHED

STREAM	BRANCH RIVER, ONE PERENNIAL AND FOUR INTERMITTENT TRIBUTARIES
EXISTING CONDITION/OBSERVATIONS	Branch River: GLAC classified - river is probably not meeting its classification increased velocity starts in this subwatershed higher quality habitat than upstream macroinvertebrates indicate good water quality - some organic pollution banks well buffered nutrients and shallow depth cause periphyton growth on rocky substrate exceptional resource waters Perennial Tributary (T20N,R22E,S24,NESW): good to poor habitat horse pasture in tributary destroys habitat and warms water some soft sediment accumulation
WATER RESOURCE PROBLEMS/LIMITING FACTORS	nutrients and shallow depth cause periphyton growth on substrate pasturing of banks destroy habitat and warms water sedimentation of pools
WATER RESOURCE POTENTIAL	increase aquatic life habitat by limiting nutrient loading which causes plant growth, eliminate stream bank pasturing and warming water, and prevent sedimentation of pools and riffles

REIFS MILLS SUBWATERSHED

STREAM	BRANCH RIVER AND THREE INTERMITTENT TRIBUTARIES
EXISTING CONDITION/OBSERVATIONS	Branch River: GLAC classified - river is not meeting its classification good to excellent habitat rocky substrate - good riffles and pools banks well buffered - no erosion dissolved oxygen swings below 6 mg/l standard exceptional resource waters
WATER RESOURCE PROBLEMS/LIMITING FACTORS	nutrient enrichment causes plant growth and dissolved oxygen violations
WATER RESOURCE POTENTIAL	increase aquatic life habitat by limiting nutrient loading which causes plant growth and fluctuating oxygen levels

(Table 1 continued)

RAHR SUBWATERSHED

STREAM	BRANCH RIVER AND TWO INTERMITTENT TRIBUTARIES
EXISTING CONDITION/OBSERVATIONS	Branch River: GLAC classified - river is meeting its classification rocky substrate - good riffles and pools springs on Rahr property stabalizes water temperature and flow exceptional resource waters dissolved oxygen swings
WATER RESOURCE PROBLEMS/LIMITING FACTORS	nutrient enrichment causes plant growth and fluctuating dissolved oxygen levels
WATER RESOURCE POTENTIAL	increase aquatic life habitat by limiting nutrient loading which causes plant growth and fluctuating oxygen levels

LOWER BRANCH SUBWATERSHED

STREAM	BRANCH RIVER AND TWO INTERMITTENT TRIBUTARIES
EXISTING CONDITION/OBSERVATIONS	Branch River: GLAC classified - river is meeting its classification fast current, rocky substrate upper reaches - slow current, deep, muddy bottom lower reaches good to fair habitat algae growth on rocks golf course may contribute nutrients B.C. Acquisition wastewater discharge macroinvertebrates indicate very good to good water quality exceptional resource waters
WATER RESOURCE PROBLEMS/LIMITING FACTORS	excess nutrients cause plant growth on rocks and oxygen fluctuations in upper reaches sediment accumulation in lower reaches golf course may contribute nutrients
WATER RESOURCE POTENTIAL	increase aquatic life habitat by limiting nutrient loading which causes plant growth and fluctuating oxygen levels in the upper reaches and decrease sedimentation in the lower reaches of the Branch River

[1] WWFF - warmwater forage fish communities; [2] GLAC - great lakes aquatic communities; [3] exceptional resource waters - excellent water quality but may receive wastewater discharge; [4] LFF - limited forage fish communities.

Table 2: Monitoring Summary of Streams in the Branch River Watershed

Subwatershed	Stream Name	Habitat Rating[1]	% EPT[2]	Biotic Index[3] - Water Quality
St. Johns		No data		
Morrison	Branch River	148 - fair (ave.) (Mill Rd.) 158 - fair (ave.) (CTH G) 134 - fair (ave.) (Way-Morr Park) 215 - poor (Hill Rd) 161 - fair (River Rd)	23% (10/93) 15% (3/94) 13% (10/93) 13% (3/94)	8.03 - poor (10/93) 7.98 - poor (3/94) 6.47 - fair (1987 Ave.) 8.15 - poor (10/93) 7.68 - poor (3/94)
	Unnamed Perennial Tributary (T21N R21E S21 NESE)	170 - fair (CTH N)		
	Unnamed Intermittent Tributary (T21N R21E S33 NENE)			8.9 - Very Poor[5] (1987 Ave.) (CTH G & Wayside Rd)
Cooperstown	Unnamed Perennial Tributary (T20N R22E S6 SENE)	177 - fair (Kocian Rd) 173 - fair (Grimms Rd)		
	Unnamed Intermittent Tributary (T20N R22E S6 NESE)	185 - fair (Grimms Rd)		
Grimms	Branch River	139 - fair (CTH K) 127 - good (CTH J) 121 - good (Taus Rd)		
	Unnamed Perennial Tributary (T20N R22E S27 NWSW)	199 - fair (Sunny Slope & San Rd)		6.45 - Fairly poor (9/94) (FBI)[4] Stream Mouth
Cherney	Branch River	78 - good (W. Hillcrest Rd West Crossing) 109 - good (ave.) (W. Hillcrest Rd Middle Crossing)	 44% (10/93) 36% (3/94)	 4.55 - Good (10/93) 4.59 - Good (3/94)
	Unnamed Perennial Tributary (T20N R22E S24 NESW)	218 - poor (N. Madson Rd) 123 - good (W. Hillcrest Rd)		
Reifs Mills	Branch River	114 - good (CTH T) 69 - excellent (Danmar Rd)		

Table 2 Continued

Rahr		No data		
Lower Branch	Branch River	105 - good (ave.) (Branch River Rd) 198 - fair (N. Union Rd)	53% (9/93) 40% (3/94)	3.96 - V. good (9/93) 5.15 - Good (3/94) 2.73 - good (1984 Ave.) above B.C. Acquisitions discharge

1. Habitat Rating:

0-70....excellent habitat
71-129....good habitat
130-200....fair habitat
>200....poor habitat

2. % EPT:

Percent Ephemeroptera, Plecoptera, and Trichoptera insect orders in macroinvertebrate sample.

3. Hilsenhoff Biotic Index (HBI):

Biotic Index	Water Quality	Degree of Organic Pollution
0-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.0	Very poor	Severe organic pollution

4. Family Biotic Index (FBI):

Biotic Index	Water Quality	Degree of Organic Pollution
0-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.0	Very poor	Severe organic pollution likely

5. Expect very poor biotic index results in intermittent flowing streams.

A reduction of sediment and nutrient loading would have minimal benefits to the water resources in this subwatershed, however, would improve water quality downstream. The protection, enhancement, or creation of wetlands would provide spawning sites for northern pike.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Saint Johns subwatershed:

A. Reduce sediment and nutrient loading by a high level during runoff events to enhance downstream aquatic life habitat.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

C. Protect, enhance, or create wetlands to provide spawning sites for northern pike.

MORRISON SUBWATERSHED

Morrison subwatershed consists of the Branch River from Hwy 96 downstream to the Brown - Manitowoc County line, one perennial and eleven intermittent drainage streams. The large Morrison Swamp is located in this subwatershed. There is also a golf course in this subwatershed. Several of the intermittent tributaries have been ditched.

Morrison Sanitary District #1 dischargers to an unnamed intermittent tributary (T21N, R21E, S9, NESW) to the Branch River.

At CTH G and Wayside Road, an unnamed intermittent tributary (T21N, R21E, S33, NENE) received an average macroinvertebrate biotic index value of 8.9 in 1987. This value indicates very poor water quality; however, biotic index values would not be expected to be much better given that this stream only flows intermittently. This stream is classified as warm water forage fish communities.

The only perennial tributary (T21N, R21E, S21, NESE) in this subwatershed discharges to the Branch River between the two CTH G crossings. This unnamed tributary received a fair aquatic life habitat rating. It has well

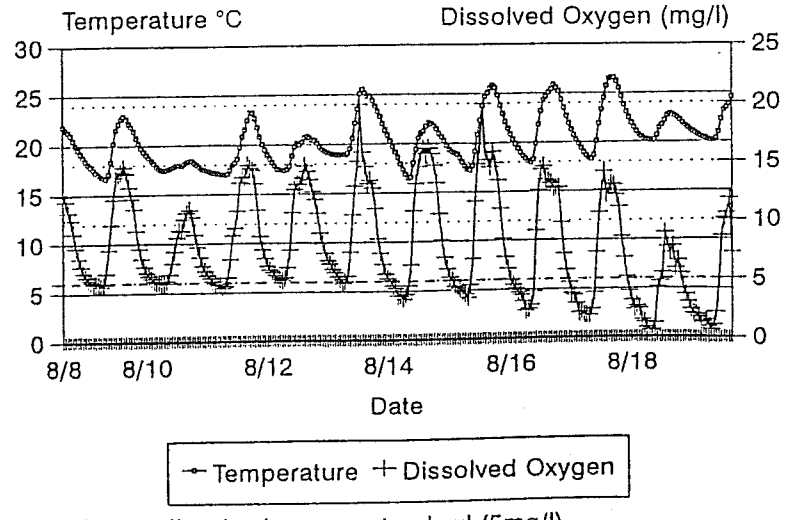
buffered banks, 10-30% gravel and rubble substrate and some silt deposition near the banks and slow areas.

The Branch River in this section is classified as warm water forage fish communities. The river is very slow moving and stagnant. The river is especially turbid after runoff events. The Branch River received aquatic life habitat ratings ranging from good to fair at four different locations. At Hill Road, the Branch River received a poor rating, however, in 1987 it received a fair rating. Generally, the river has 30-50% rubble, gravel and other stable substrate. A layer of fine silt covers the substrate and is easily suspended with disturbance. Bank erosion is severe in some locations, but uncommon in most. Portions of the river banks are pastured and eroding. Macrophytes such as filamentous algae, duck weed, and Elodea are abundant in the slower portions of the river. The river appears to have been channelized at Way-Morr Park.

Macroinvertebrate samples ranged from fair at CTH G (HBI of 6.47) in 1987 to poor (HBI of 8.03 and 7.98 at Mill Road; 8.15 and 7.68 at Way-Morr Park) in 1993. The EPT was 23 to 15% at Mill Road and 13% at Way-Morr Park. Lack of suitable habitat is the most significant limiting factor for abundance and diversity of macroinvertebrates at these locations.

The Branch River has severe dissolved oxygen problems as indicated in Figure 2 below. Dissolved oxygen swings below five and even close to zero during early morning hours on a regular basis. This is extremely stressful to aquatic life. These diurnal fluctuations are caused by nutrient enrichment and algal photosynthesis and respiration when higher temperatures depress oxygen solubility.

Figure 2. Branch River - CTH G
Dissolved Oxygen and Temperature
August 8-19, 1994



Note: --- indicates dissolved oxygen standard (5mg/l)

The Branch River and its tributaries in this subwatershed are limited by the lack of stable aquatic life habitat, channelization, low stream gradient, turbid waters, silt covered substrate, bank erosion, livestock pasturing, dense macrophyte growth, and severe oxygen depletion.

A reduction of sediment and nutrient loading to this subwatershed would significantly increase aquatic life habitat by preventing sedimentation of pools, limiting plant growth, and stabilizing dissolved oxygen swings. Eliminating pasturing in the stream corridor would greatly improve habitat. Protecting, enhancing, or creating wetlands would provide spawning sites for northern pike.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Morrison subwatershed:

A. Improve water quality and aquatic life in the streams by improving overall habitat conditions by:
   * reducing sedimentation rates by a high level to waters other than to Morrison Swamp
   * reducing nutrient/phosphorus loading by a high level to waters other than Morrison Swamp which will reduce macrophyte growth and stabilize oxygen levels
   * enhancing existing or degraded wetlands to filter runoff water, provide spawning sites for northern pike, and slow the release of water downstream to permit northern fry to reach the Branch River
   * reducing stream bank erosion.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

C. Reduce sediment and nutrient loading to Morrison Swamp by a low level.

D. Protect and enhance natural and existing fish reproductive areas.

E. Develop a warmwater sport fishery in the lower half of this subwatershed.

COOPERSTOWN SUBWATERSHED

Cooperstown subwatershed consists of the Branch River from the Brown - Manitowoc county line to approximately one river mile downstream. It also includes one perennial tributary that originates in the Cooperstown Swamp and one intermittent tributary to the Branch River. Kellners Lake is located in this subwatershed.

The Branch River is classified as great lakes aquatic community from the county line downstream to its mouth. The characteristic of the Branch River in this subwatershed are similar to the characteristics of the Branch River in the Morrison subwatershed; however, bank erosion is more frequent in this stretch.

The perennial tributary (T20N, R22E, S6, SENE) exhibits changing characteristics as it flows downstream. At the first road crossing from Cooperstown Swamp, the tributary has been ditched. The straight slow moving creek has ideal conditions for thick macrophyte growth because the wetland supplies sufficient rich organic matter. An evaluation ranked this section as fair aquatic life habitat. Dissolved oxygen was low at 5.5 mg/l. The banks are covered by tall grasses and the substrate is mostly muck. Downstream at County Line Road, the flow is also slow and the deep water is a stained color. Further downstream at Grimms Road, the sand substrate inhibits macrophyte growth and flow increases. At this location, the banks are stable with good tree and shrub growth. Here the dissolved oxygen level increased to 7.5 mg/l. An evaluation ranked this section also as fair aquatic life habitat.

The small intermittent tributary (T20N, R22E, S6, NESE) has much cooler clear water. The banks are stable with tree and shrub cover. A fine layer of black organic matter covers the sand substrate. Aquatic life habitat was ranked as fair. This tributary flows through a wetland area before entering into the Branch River.

Kellners Lake, located in T20N, R22E, S3 of Manitowoc County, encompasses 14.65 acres, has a maximum depth of five feet, a shoreline totaling 0.70 miles and a predominately agricultural drainage basin of approximately two square miles. The property surrounding the lake is owned by one family and there is no public access. The riparian areas consist of a near monotypic stand of cattail. Surrounding the cattails is a conifer swamp.

This is a seepage lake whose entire bottom is in the littoral zone and which consists entirely of muck. There is extensive aquatic plant growth which is dominated by coontail. In summer months, the lake is ringed by a thick mat of floating algae. The combination of shallow depth and extensive weed growth

promote severe winterkill conditions allowing only the most low oxygen tolerant minnow species to survive. Larger game and panfish are not present because of winterkill conditions.

Water chemistry data was obtained during three sampling visits. These data are displayed in Figure 3 below.

Figure 3. Water Chemistry Data for Kellners Lake

Date	Temp. (°C)	Dissolved Oxygen (mg/L)	pH	Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a ug/L	Conductivity umhos/cm
5/31/94	23.0	5.8	8.08	1.6	0.04	1.40	360
7/28/94	23.1	10.6	9.19	1.46	0.049	11.7	314
8/26/94	24.0	8.85	9.21	1.23	0.03	3.26	294

This lake is probably quite resistant to acidification because of the buffering capacity generated by the limestone bedrock underlying this waterbody. This is evidenced by the relatively high pH exhibited here and also by the conductivity levels. The ratio of total nitrogen to total phosphorus averaged 37, which indicates that phosphorus is the limiting nutrient for plant growth in the lake. Phosphorus, however, may be tied up in the biomass of the plants which would cause the low measured levels.

Kellners lake has a drainage basin to lake area (DB:LA) ratio of 87.4:1. This ratio is an indicator of the susceptibility of a water body to watershed influences. This lake is at risk because of nutrient inputs from the intensive agriculture in the surrounding watershed. These nutrient inputs are partially the reason for eutrophic status indicated by the trophic status index (TSI) values for phosphorus (Figure 4 below). The TSI reflects a lake's nutrient and clarity levels. Although the average TSI value for chlorophyll a is in the mesotrophic range, phosphorus values are the dominant indicator for the system. The density of aquatic macrophytes and algae are consistent with the eutrophic rating.

Figure 4. Wisconsin Trophic Status Index		
Date	TSI Phosphorus	TSI Chlorophyll a
5/31/94	56.7	37.3
7/28/94	58.3	53.4
8/26/94	54.5	43.7
Average	56.5	44.8

Trophic Category Descriptions

Category	TSI	Lake Characteristics
Oligotrophic	1 - 40	Clear water, oxygen rich at all depths except if close mesotrophic border; then may have low or no oxygen; cold-water fish likely in deeper lakes
Mesotrophic	41 - 50	Moderately clear; increasing probability of low to no oxygen in bottom waters.
Eutrophic	51 - 70	Decreased water clarity; probably no oxygen in bottom waters during summer; warm-water fishery only; blue-green algae likely in summer in upper range; plants also excessive.
Hypereutrophic	70 -100	Heavy algal blooms throughout the summer; if >80, fish kills likely in summer and rough fish dominate

The wetlands surrounding the lake act as a filter to some of the nutrients and sediment from the watershed. However, because this system has no outlet there is little opportunity for the flushing of excess nutrients. The shallow water allows for recycling of nutrients from bottom sediments into the water column. In addition, the anoxic conditions prevalent in winter allow for the further release of phosphorus from bottom sediments. These give plants access to the nutrients and cause the dense aquatic macrophyte growth and algal blooms. Even with the wetland buffer surrounding the lake, improper land use in the past or small nutrient inputs in the present have had a cumulative effect to cause the eutrophication occurring here.

Overall, the wetlands have the most significant impact on the Branch River and its tributary streams in this subwatershed. The sand and muck substrate, stream channelization in some stretches, bank erosion, and macrophyte growth all limit aquatic life habitat. Kellners Lake is limited by the existing nutrients in the sediment, additional nutrients from the drainage basin, dense macrophyte and algae growth, and winterkill conditions.

Generally, the Branch River and tributaries would not support more aquatic life than they currently support because of the wetland influences. Kellners Lake would never be mesotrophic because of the existing nutrients in the sediment and the lake morphology. Preventing additional nutrient and sediment delivery to the lake would, however, prevent it from becoming even more eutrophic.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Cooperstown subwatershed:

A. Protect wildlife and aquatic life habitat by:
   * reducing sediment and nutrient loading by a low level to the wetlands that currently exist in this subwatershed
   * reducing sediment and nutrient loading by a high level to the Branch River and its tributaries.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

C. Maintain current wildlife values of Kellners Lake.

GRIMMS SUBWATERSHED

The Grimms subwatershed consists of the section of the Branch River from approximately one river mile below the Brown - Manitowoc County line downstream to Taus Road. It also includes Hemptons Lake, one perennial stream (T20N, R22E, S27, NWSW), and seventeen intermittent tributaries to the Branch River.

In this subwatershed, the Branch River is classified as great lake aquatic communities. It received good to fair aquatic life habitat ratings. In the upper reaches of this subwatershed, the Branch River is deep and slow moving with little scouring of the substrate. No riffle areas are present. In the lower reaches, the river flow increases and becomes somewhat more shallow with some riffles and pools. The banks are well buffered, however, bank erosion is still evident. The substrate is a combination of rocks, rubble and clay with a fine layer of silt which is easily suspended. The water is generally turbid especially after rain events.

A fish kill on the Branch River in August 1994 claimed 274 fish including 58 northern pike in the stretch between Grimms Road and West Hillcrest Road. The kill was near complete because of the presence of dead carp and bullheads. No apparent source of the kill was identified, however, it is believed that manure was the cause and was carried into the river during a major rain event on August 26, 1994.

The Lemberger Landfill and Lemberger Transport and Recycling, Inc., Superfund sites are located in this subwatershed. Currently, a Wisconsin Pollution Discharge Elimination System Permit is being developed to discharge treated groundwater from this site to the Branch River.

Whitelaw Wastewater Treatment Plant discharges to a small intermittent (T19N, R22E, S3, SWNE) limited forage fish communities classified tributary to Hemptons Lake. Hemptons Lake is a shallow ten acre drainage lake with a history of poor water quality. The lack of public access prevented current monitoring of this lake. Hemptons Lake discharges to a perennial tributary (T20N, R22E, S27,NWSW) to the Branch River. This perennial tributary received a fair aquatic life habitat rating. At Sunny Slope and San Road, thick macrophyte growth caused dissolved oxygen levels to become supersaturated (greater than 20 mg/l) during daylight hours. Dissolved oxygen probably drops very low or even to zero at night during plant respiration. A macroinvertebrate sample at the mouth of this tributary received a FBI rating of 6.45 which indicates fairly poor water quality with substantial organic pollution likely. Sections of this tributary and several others have been channelized which decreases aquatic life habitat.

Temperature data was gathered continuously from June 21 until August 30, 1994 in the Branch River upstream and downstream of the perennial tributary along with ambient air temperature (August 2-16 results graphed - see appendix A). The average temperature was 6.3°C cooler below the confluence of the tributary than above. This indicates that this tributary has a cooling, not warming, effect on the Branch River which ultimately benefits the fish communities. Average temperature upstream of the tributary was 3.1°C warmer than the average ambient air temperature. This was either caused by inflow of warmer water upstream in the Branch or by the incidence of solar radiation on the stream. Data analysis also revealed that the tributary tended to minimize the diurnal temperature oscillations (Figure 5 below).

Figure 5. Average daily temperature in degrees celsius.

	Air	Upstream	Downstream
Ave. daily temperature	18.2	21.3	15.0
Ave. daily temp. swing	8.5	5.1	4.0

The Branch River and its tributaries in this subwatershed are limited by silt and sediment covering substrate for aquatic life habitat, limited stream flow that is needed to scour substrate, bank erosion, turbid waters, macrophyte growth in the tributary from excess nutrients, possibly effects from the superfund sites, and stream channelization.

A reduction of sediment and nutrients in this subwatershed would benefit aquatic life habitat in the Branch River and its tributaries by preventing sedimentation of pools and riffles, limiting plant growth, and stabilizing dissolved oxygen swings.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Grimms subwatershed:

A. Improve water quality and aquatic life in the streams by improving overall habitat conditions by:
   * reducing sedimentation by a high level
   * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth and stabilize oxygen levels
   * enhancing existing or degraded wetland which act as filtering area and moderate water level fluctuation extremes
   * reducing streambank erosion.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

C. Improve wildlife values of Hemptons Lake.

D. Protect natural springhead areas.

E. Evaluate water resource improvements through the use of DNR "Signs of Success" evaluation procedures (Cahow, 1995).

CHERNEY SUBWATERSHED

The Cherney subwatershed consist of the section of the Branch River from Taus Road downstream to 1/4 mile before CTH T, one perennial tributary and four intermittent tributaries to the Branch River.

In this subwatershed, velocity of the Branch River increases significantly which scours the rock/rubble substrate producing higher quality aquatic life habitat. Habitat evaluations at West Hillcrest Road (west and middle crossings) rated this section of the Branch River as good. Macroinvertebrate samples received HBI values of 4.55 and 4.59 which indicates good water quality with some organic pollution present. The EPT was 44 to 36% at the middle road crossing at West Hillcrest Road. Banks are well buffered from erosion with a diverse mix of trees and shrubs. With the shallower water in this section, light penetration increases causing periphyton and attached algae growth on the rocks and substrate. This does not occur in the upper reaches of the Branch River because of the deeper, turbid water. Abundant plant growth is a result of excess nutrients in the water column. This section of the Branch River is classified as great lake aquatic communities.

The four mile long perennial tributary (T20N, R22E, S24, NESW) to the Branch River received a habitat rating of poor at North Madson Road, but good downstream at West Hillcrest Road. The perennial flow starts at about Polifka Road. A horse pasture upstream of North Madson Road causes the water to be warmer here than upstream at Polifka Road, however still cooler than the Branch River itself. The banks are trampled and have no vegetative buffer. At West Hillcrest Road, the flow increases somewhat, banks are well buffered, and the substrate is more stable producing better aquatic life habitat than upstream; however, some soft sediment has accumulated near the bridge and lower banks.

The Branch River and its tributaries in this subwatershed are limited by nutrients and shallow depth causing algae and periphyton growth on the substrate, stream bank pasturing destroying habitat and warming water, and sediment filling in pools.

A reduction of sediment and nutrients in this subwatershed would benefit aquatic life habitat by limiting periphyton growth and sedimentation of pools and riffles. Eliminating pasturing in the tributary would greatly improve habitat and keep the water cooler.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Cherney subwatershed:

A. Improve water quality and aquatic life in the streams by improving overall habitat conditions by:
   * reducing sedimentation by a medium level
   * reducing nutrient/phosphorus loading by a medium level which will reduce macrophyte growth and stabilize oxygen levels
   * enhancing existing or degraded wetland which act as filtering area and moderate water level fluctuation extremes
   * reducing streambank erosion.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

REIFS MILLS SUBWATERSHED

The Reifs Mills subwatershed consists of the section of the Branch River from 1/4 mile upstream of CTH T downstream to Danmar Road and three intermittent tributaries to the Branch River.

The Branch River characteristics in this subwatershed are similar to the Cherney subwatershed. As the velocity steadily increases downstream, aquatic life habitat improves. Habitat evaluations at CTH T received good ratings while downstream at Danmar Road, rated excellent. The rocky substrate is well scoured with plenty of riffles and pools. The banks are well buffered with diverse trees and shrubs. The Branch River is classified as great lake aquatic communities.

Dissolved oxygen and temperature monitoring for nine days in August 1994 at Danmar Road shows daily diurnal fluctuations. Dissolved oxygen drops significantly during very early morning hours and comes very close to just below the 6 mg/L state standard, but then as daylight comes, oxygen increases to as high as 13 mg/L. These early morning hours are critical periods for aquatic life stability. Dissolved oxygen fluctuations are caused by nutrient enrichment and algae and periphyton photosynthesis and respiration.

The Branch River in this subwatershed is limited by nutrient enrichment causing algae and periphyton growth which in turn, effects oxygen levels. Nutrients may be coming from the upstream subwatersheds.

A reduction of nutrient loading to this subwatershed would benefit aquatic life by limiting plant growth and dissolved oxygen swings in the Branch River. A reduction of sediment loading would prevent downstream accumulations.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Reifs Mills subwatershed:

A. Improve water quality and aquatic life in the streams by improving overall habitat conditions by:
   * reducing sedimentation by a high level
   * reducing nutrient/phosphorus loading by a high level which will reduce macrophyte growth and stabilize oxygen levels
   * enhancing existing or degraded wetland which act as filtering area and moderate water level fluctuation extremes.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

C. Protect natural springhead areas.

RAHR SUBWATERSHED

The Rahr subwatershed consist of the section of the Branch River from just below Danmar Road downstream to above Hwy 10 and two perennial tributaries to the Branch River.

The characteristics of the Branch River in this subwatershed are similar to the Reifs Mills subwatershed. The Branch River is classified as great lake aquatic communities. The river velocity and substrate are ideal for aquatic life habitat. The only road crossing in this subwatershed is just above Hwy 10. About one mile of the Branch River runs through the Rahr Game Farm. There are several large and stable springs on the Rahr property which contribute significant volume and cool, clean water during the warm summer months. Conversely, during the cold months, this added water moderates stream temperatures. Fish

are then able to inhabit these stream reaches for a longer period of time each year, adding stability to the system. This stretch of the Branch River has several excellent adult steelhead holding areas (WDNR, 1993).

The Branch River in this subwatershed is limited by nutrient enrichment causing algae and periphyton growth which in turn effects oxygen levels. Nutrients may be coming from the upstream subwatersheds.

A reduction of nutrient loading to this subwatershed would benefit aquatic life by limiting plant growth and dissolved oxygen swings in the Branch River. A reduction of sediment loading would prevent downstream accumulations.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Rahr subwatershed:

A. Improve water quality and aquatic life the streams by improving overall habitat conditions by:
   * reducing sedimentation by a high level
   * reducing nutrient/phosphorus loading by a high level which will reduce macrophyte growth and stabilize oxygen levels
   * enhancing existing or degraded wetland which act as filtering area and moderate water level fluctuation extremes
   * protecting the natural springheads which provide flow and cool water.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

LOWER BRANCH SUBWATERSHED

The Lower Branch subwatershed consists of the Branch River just above Hwy 10 to the confluence of the Manitowoc River and two intermittent tributaries.

The Branch River in this subwatershed changes from shallow, high velocity rocky substrate in the upper reaches to slow, deep, with a muddy bottom near North Union Road downstream to the river mouth. Habitat evaluations at Branch River Road on two occasions found good habitat present. The shallow, rocky substrate has abundant filamentous algae and periphyton growth caused

by excess nutrients. Excess plant growth causes fluctuating dissolved oxygen levels in the river. The banks are stable and erosion does not appear to be a problem. Macroinvertebrate samples indicate very good to good water quality with HBI values of 3.96 and 5.15 at Branch River Road indicating possible slight to some organic pollution present. The EPT was 53 to 40% at Branch River Road. Above B.C. Acquisitions, the average HBI value was 2.73 in 1984 indicating good water quality. The creamery discharges to the Branch River about one mile above the river mouth. The old waste treatment ponds were abandoned. At North Union Road, habitat was rated as fair. Riffles are absent with a deep muddy bottom. There is public access off this road.

A golf course located near the village of Branch may contribute nutrients to the Branch River during runoff events; however, no specific monitoring was conducted to determine impacts.

The Branch River in this subwatershed is limited by excess nutrients causing algae growth on the rocks and oxygen fluctuations in the upper reaches and sediment accumulation in the lower reaches. The golf course may be one source of nutrients. Nutrients and sediment may also be coming from the upstream subwatersheds.

A reduction of nutrient and sediment loading in this subwatershed would benefit aquatic life habitat by limiting plant growth on the rocky substrate, stabilizing dissolved oxygen levels in the upper reaches and decreasing sedimentation in the lower reaches of the Branch River.

Water Resources Goals and Objectives

The following objectives are recommended for the surface water resources of Lower Branch subwatershed:

A. Improve water quality and aquatic life in the streams and river mouth by improving overall habitat conditions by:
   * reducing sedimentation by a low level
   * reducing nutrient/phosphorus loading by a medium level which will reduce macrophyte growth and stabilize oxygen levels
   * enhancing existing or degraded wetland which act as filtering area and moderate water level fluctuation extremes.

B. Maintain or develop stream woodland and grassland corridors by developing buffers. Corridors provide wildlife habitat, canopy, bank stabilization, and sediment retention.

V. REFERENCES

Ball, Joe. (1982). Stream Classification Guidelines for Wisconsin. Wisconsin Department of Natural Resources.

Wisconsin Department of Natural Resources. (1988). Field Procedures Manual. Draft 2nd Edition.

Wisconsin Department of Natural Resources. (1991). Manitowoc River Water Quality Management Plan.

Hilsenhoff, William. (1988). Rapid Field Assessment of Organic Pollution With A Family-level Biotic Index.

Hilsenhoff, William. (1987). An Improved Biotic Index of Organic Pollution.

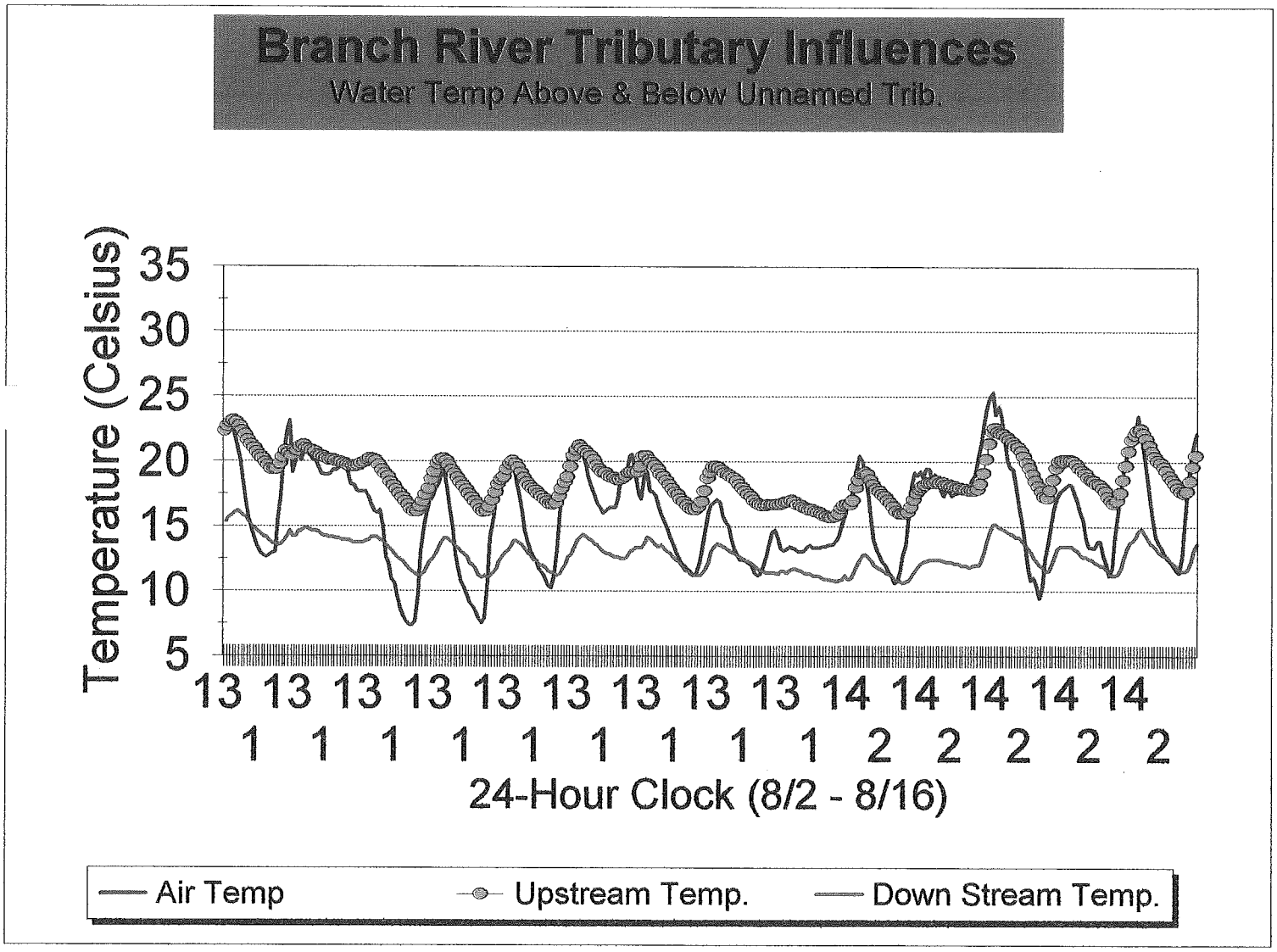
Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. (1989). Rapid Bioassessment Protocols for use in Streams and Rivers. U.S. Environmental Protection Agency, Office of Water, EPA/444/4-89-001, Wash. D.C. 20460.

Wisconsin Department of Natural Resources. (1993). Manitowoc-Branch River Fishery Area Feasibility Study/Environmental Analysis.

Wisconsin Department of Natural Resources. Lake Michigan District: Water Resources Management and Fisheries Management files.

Cahow, Jim. (1995). Guidelines for Conducting Signs of Success (S.O.S) Monitoring in Wisconsin Priority Watersheds. Wisconsin Department of Natural Resources.

Appendix A


Branch River Tributary Influences
Water Temp Above & Below Unnamed Trib.
Temperature (Celsius)
35
30
25
20
15
10
5
13 13 13 13 13 13 13 13 13 14 14 14 14 14
1 1 1 1 1 1 1 1 1 2 2 2 2 2
24-Hour Clock (8/2 - 8/16)
Air Temp
Upstream Temp.
Down Stream Temp.

Appendix A
Appendix A
Appendix A