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BIRCH LAKE MANAGEMENT PLAN

Prepared by Agrecol Environmental Consulting
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In cooperation with
Village of Barneveld,
Iowa County Land Conservation Department and
Wisconsin Department of Natural Resources

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Village of Barneveld

This study was funded by two Wisconsin Department of Natural Resources (WDNR) Lake Planning Grants with local match supported by volunteer monitoring efforts, Village administration and meeting coordination, donated use of boats and monitoring equipment, land use inventory and participation of the Iowa County Land Conservation Department, and Natural Resources Conservation Service (NRCS). Al Antonson collected valuable lake and stream water quality data. WDNR Water Resources Biologist Jean Unmuth and intern Jerrod Parker also provided valuable assistance with the project. WDNR Lake Management Specialist Susan Graham provided valuable input with the study methodology and reports.

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Summary - Study Results

Consistent with previous surveys conducted by the WDNR in the early 1990s, lake monitoring results demonstrated that Birch Lake exhibits conditions typical for degraded (eutrophic) impoundments. For four decades, this small impoundment has trapped eroded soil and nutrients from the surrounding watershed depositing sediment as thick as five feet in some areas. These conditions have favored the growths of dense water weed (*Elodea*) beds and filamentous algae. The dense plant growths undermine recreational uses and the ecological balance in the lake. Dissolved oxygen levels fluctuate at extreme levels and create stressful conditions for aquatic life. The water quality problems documented previously and in 2009 will continue unless management is targeted to reverse the long term sedimentation in the lake. In spite of the degraded water quality, the bluegill population offered decent angling opportunities where open water could be found. In May 2009, the average bluegill length was about 6.9 inches with a range of 5.7 inches to 8.1 inches. Panfish typically become stunted in weedy impoundments but that was not the case for Birch Lake. Perhaps low recruitment due to poor water quality prevented overpopulation and stunting?

As would be expected, suspended soil in the stream was higher above the lake than below the dam, particularly during rain events. Reduced turbidity below the dam demonstrated that sediment is trapped within the impoundment. With eutrophic conditions present in the lake, Birch Lake is a significant source of downstream pollutants at certain times. The high ammonia levels, lower dissolved oxygen levels and warmer water temperatures have degraded the trout stream below the dam during much of the summer growing season.

Management Alternatives Summary

1. **Do Nothing**. The impoundment will continue to fill in, reducing recreational potential.

2. **Dredging – No Watershed Diversion**. Excavation without watershed diversion would temporarily restore loss of water storage capacity and improve recreational potential of the lake for boating, swimming and fishing. Initially there would be a reduction of aquatic plant growth, but continued sedimentation would limit the long term effectiveness of the project to control rooted plants. This option offers little or no benefit to the trout stream.

3. **Watershed Diversion and Lake Deepening**. Excavate part or all of the impoundment and use some of the dredge spoil to create a berm that diverts the stream to the west and isolates the lake from most of the watershed sources of sediment and pollutants. The lake would benefit from reduced sediment loads and the stream below the lake would benefit from lower pollutant loadings during the summer growing season.

4. **Dam Removal and Off-channel Pond Construction**. The option was previously proposed by the Natural Resources Conservation Service, Department of Natural Resources and Iowa County Land Conservation Department. The option included restoring the trout stream with links to a hiking trail and off-channel trout fishing pond. This form of watershed diversion option was previously rejected by the community due to significant loss of surface water.

5. **Mechanical Aquatic Plant Harvesting**. Regular mechanical weed harvesting can reduce nuisance growths of weedy aquatic plants and filamentous algae. A maintenance level of control would likely require harvesting two or three times per summer. This method would not reduce long term sedimentation and loss of water storage capacity. Herbicides are not recommended due to potential adverse effects on lake and stream water quality.

6. **Watershed Best Land Use Management Practices**. Controlling sources of polluted runoff is encouraged for any watershed in Wisconsin. However, even with best management practices and substantial reduction of polluted runoff, Birch Lake will continue to trap sediment and nutrients. This effort would offer limited effectiveness without watershed diversion that could represent the most significant pollution reduction to the lake. The rate of sedimentation has already been reduced in recent years.

Lake Management Recommendations

The Village of Barneveld has elected Alternative 3, watershed diversion and lake deepening. This alternative offers the greatest sustainability with clear environmental benefits to both the lake and trout stream.

Introduction

Birch Lake is an eleven acre impoundment that was constructed in 1964 as part of the PL 566 Twin Park Watershed Work Plan. The impoundment was constructed for both permanent pool recreation and flood control. It was originally managed for stocked rainbow trout but as it became degraded, fisheries management shifted to bluegill and largemouth bass.

The watershed to lake surface area ratio is relatively high at 92:1, significantly higher than the more desirable 10:1 or less ratio, where lakes are predicted to have better water quality and management potential. Substantial sources of sediment and nutrients are often found in relatively large agricultural and urbanized watersheds like the Birch Lake watershed. Cheetam and Wilke (1975) had originally predicted that the average annual sediment loading to Birch Lake was 454 tons per square mile (726.4 tons based on 1.6 square mile watershed) but later determined that the soil loss was much higher at 986 tons per square mile. Wisconsin Department of Natural Resources (WDNR) surveys revealed that sediment and nutrient loads had substantially degraded the lake water quality and that the lake had become a point source of pollutants. The continuous release of pollutants from the lake degraded the trout stream by altering the physical and chemical habitat and ultimately the stream ecology.

Trout Creek has five miles of Class I trout waters and three miles of Class II trout waters.
The eight miles of trout water are also classified as an Outstanding Resource Water (ORW) and the stream supports the natural reproduction of brown trout. Although considered one of the best trout streams in southern Wisconsin, Trout Creek is affected by impoundments that undermine cold water habitat. Birch Lake degrades water quality while the dry dam degrades trout habitat. The stream also has some problems with polluted runoff and is considered a high priority for runoff pollution reduction projects. Baseline monitoring was conducted on the stream in the summer of 2000. Much of the stream is in public ownership as the Trout Creek State Fishery Area. The fishery area is approximately 900 acres and offers opportunities for fishing, hiking, and bird watching.

In an effort to better understand the current conditions of Birch Lake and Trout Creek and propose management alternatives to achieve best potential recreational uses of these important Iowa County resources, the Village of Barneveld received two Lake Planning Grants. Part 1 (Diagnostic Study) involved collection of lake and stream water quality data to determine existing conditions. Watershed land use information was also used to project future water quality conditions quality in the lake and stream. Part 2 (Feasibility Study) identifies management alternatives along with the predicted benefits and limitations.

Methods

Lake Sampling - Water clarity was measured every two weeks near the dam, using a standard secchi disk. Agrecol Environmental Consultants, along with the Village of Barneveld volunteer Al Antonson, alternately measured the lake clarity on a bi-weekly basis. On a monthly basis, Agrecol consultants collected vertical profiles of dissolved oxygen, temperature, pH and specific conductance. Water quality monitoring instruments included a Yellow Springs Instruments Inc Model 52 dissolved oxygen/temperature meter and Yellow Springs Instruments Inc Model 63 pH/conductivity meter. The instruments were calibrated according to manufacturer specifications prior to each survey. Water samples were collected and submitted monthly to the State Laboratory of Hygiene for total phosphorus and chlorophyll analysis. The secchi, phosphorus and chlorophyll data were transformed into Trophic State Index (TSI) water quality measurements using Wisconsin Lake Modeling Suite (WILMS).

A WDNR standardized aquatic plant survey was conducted on July 8, 2009. The WDNR Bureau of Integrated Science Services provided the point intercept grid sampling points that were downloaded into a Garmin Model 76 GPS unit. At each GPS sampling point, a rake was used to collect aquatic plants for identification and density.

Watershed Inventory and Phosphorus Loading Estimate - The Iowa County Land Conservation Department coordinated Geographical Information System (GIS) analysis of watershed boundaries and land uses. The various land uses and areas were imported into WILMS Hydrological and Phosphorus Loading Modules to estimate annual phosphorus loading into the lake along with projected changes linked to watershed diversion alternatives.

Stream Monitoring - Agrecol consultants monitored Trout Creek monthly and during selected rainfall events. Two stream monitoring stations were established, one above Birch Lake within the Birch Lake Park and the second immediately downstream of the dam. The Yellow Springs Instruments used for lake monitoring were also used for stream monitoring. Water clarity (turbidity) was measured with a 120 cm transparency secchi tube. Water samples submitted to the State Laboratory of Hygiene included ammonia nitrogen, total phosphorus and suspended solids. A Swoffer Model 2100 digital water current meter was used for flow measurements. A water level staff gage was installed above the lake so that a flow – stage regression could be calculated. Village volunteer Al Antonson recorded water levels from the staff gage and these were transformed into flow measurements using the regression analysis.

In addition to routine summer water quality surveys, Onset Computer Corporation Boxcar Tidbits were installed at both stream locations to measure long term water temperature. Figure 1 identifies the lake and stream water quality sampling locations.

Lake Use Information - During each lake and stream survey, Agrecol consultants and volunteer used a standardized form to record lake user information such as numbers of shore anglers, boats and other lake users.

Figure 1: Map of sampling locations

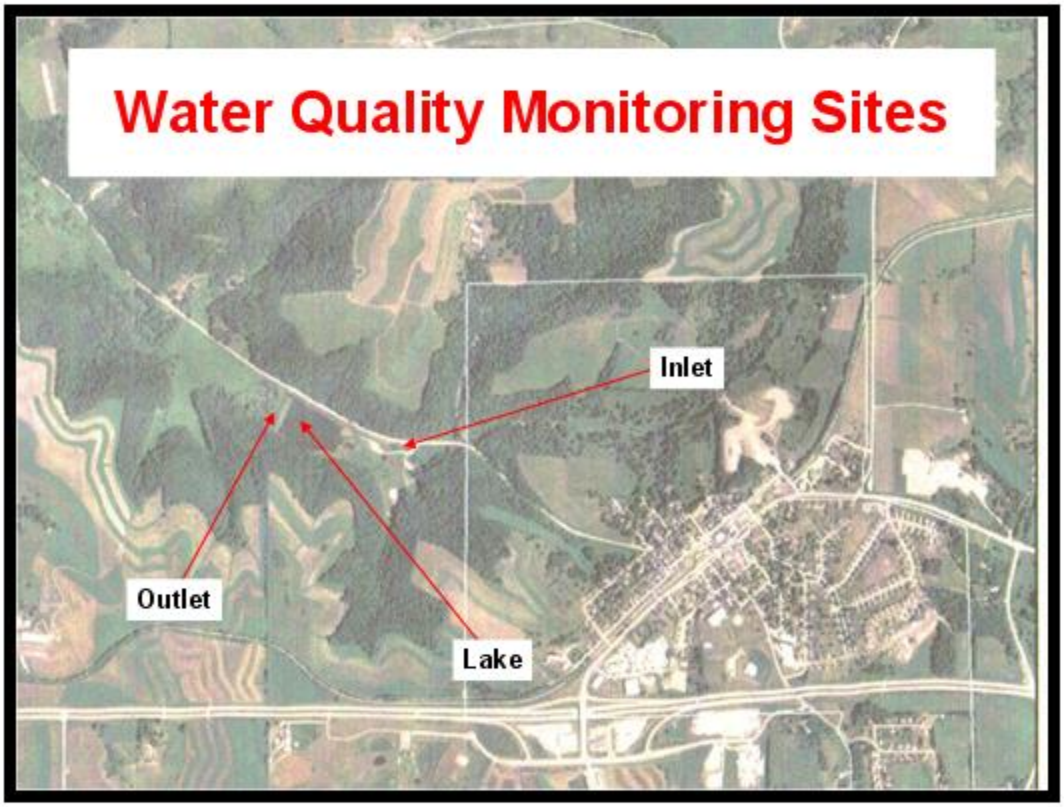

Figure 1

Lake Monitoring Results

Secchi Water Clarity – A total of ten secchi water clarity measurements were made during the summer of 2009 (Figure 2). The lake maintained fairly good water clarity in 2009 with measurements ranging from 5' to 15' (mean = 7.9'). The favorable water clarity was largely due to suppression of planktonic algae by the very dense growths of aquatic plants. The water clarity declined in August and September, 2009, as aquatic plant growth peaked and the plants began to gradually die back. In Figure 3, the TSI values for the August 2009 water clarity measurements indicated eutrophic, or poor, conditions in the lake. The reduced late summer water clarity likely reflected reduced suppression of phytoplankton and nutrient release from the decomposing rooted plants.

Figure 2: Birch Lake Secchi Measurements

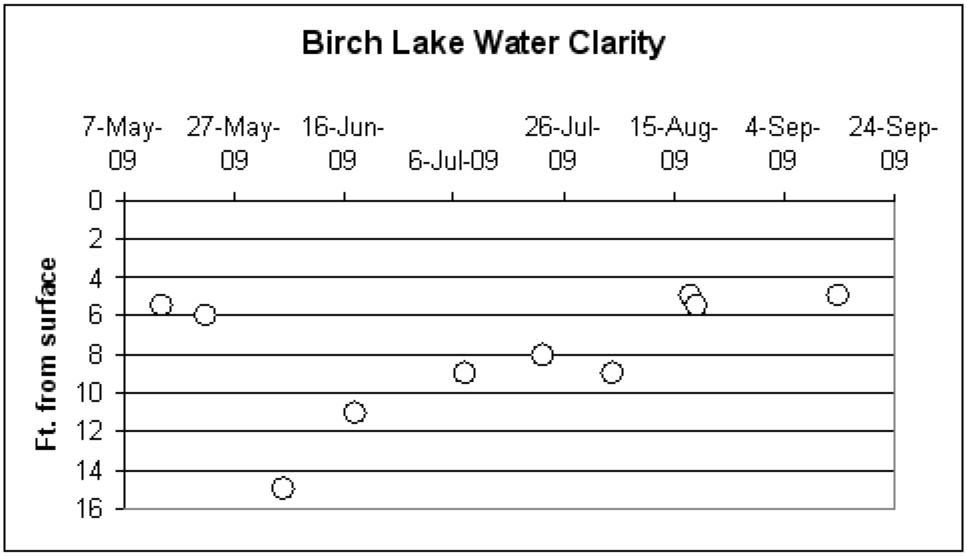

Figure 2

Total Phosphorus - In Birch Lake, the suppression of planktonic algae by rooted plants reduced the importance of total phosphorus concentrations. However, the concentrations found in the lake were high enough to support, water clouding, free-floating algae throughout the summer. The water column phosphorus concentration in June and July, 2009 (24 and 26 ug/l respectively) increased substantially in August 2009 (46 *u*g/l) and likely reflected release from decaying rooted aquatic plants and filamentous algae. The higher late summer phosphorus level in the water column also coincided with reduced secchi water clarity in the lake (Figure 3).

Figure 3: TSI Water Quality Transformed Secchi, Phosphorus and Chlorophyll Data

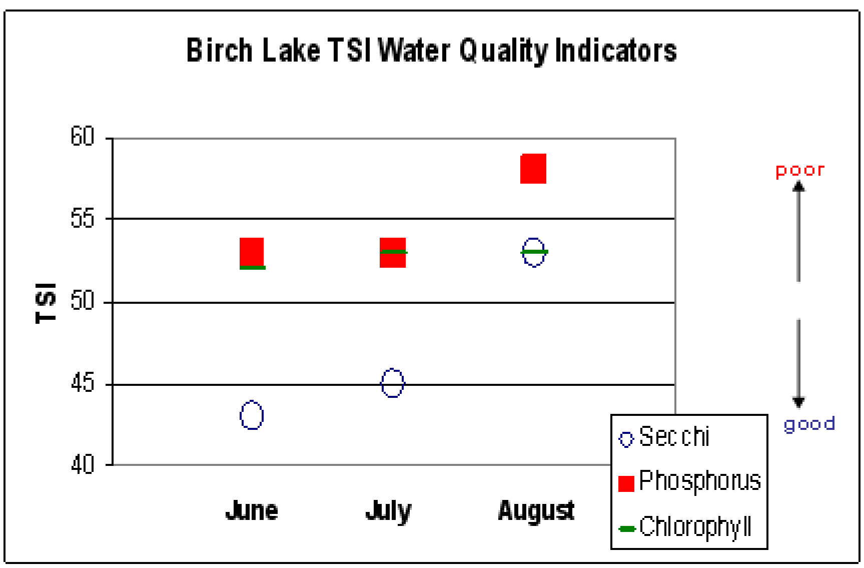

Figure 3

Chlorophyll-a - The concentration of the photosynthetic pigment chlorophyll is an indirect measure of planktonic or free-floating algae in a lake. In Birch Lake, chlorophyll concentrations indicated moderately eutrophic conditions (Figure 3) but, as mentioned above, were likely suppressed by dense rooted plant growth in the lake. Chlorophyll concentrations remained between 9 and 11 *u*g/l during the primary 2009 growing season. A massive die-off of dense common water weed could greatly increase chlorophyll or algal levels in the lake.

Dissolved oxygen (D.O.) - The minimum State water quality criterion for D.O. is 5 mg/l (ppm) and is the level established to protect fish and aquatic life in warm water habitats. This level is not maintained in the deeper areas of Birch Lake, particularly in late summer when organic decomposition occurs in the lake sediment and as aquatic plants begin to die (Figure 4). At other times, extremely high D.O. was measured and reflects photosynthesis of dense rooted plants and filamentous algae. The supersaturated levels of D.O. can be environmentally stressful for fish and aquatic life by causing gas bubble disease. The extremely high levels are measured during the daytime hours. However, at night the opposite extreme will occur as plants respire and levels can drop below the minimum criterion for warm water fisheries. Normal concentrations of D.O. range from about 5 mg/l to 12 mg/l.

Figure 4: Birch Lake Dissolved Oxygen Profiles

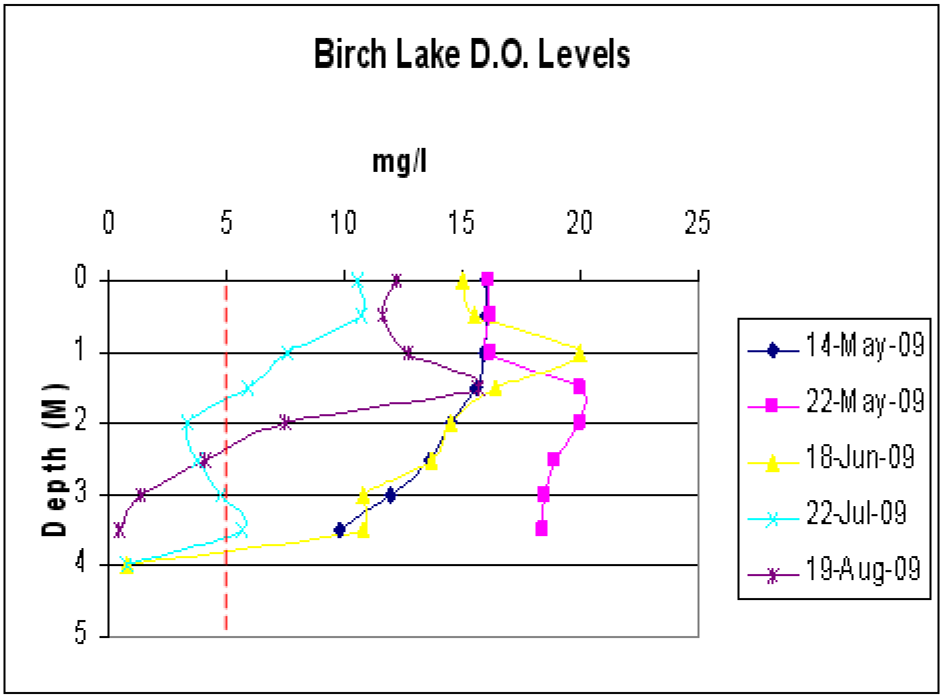

Figure 4

Temperature - In most lakes with maximum depths greater than twenty-five feet, cold dense water remains isolated from surface where continual wind mixing occurs. In the bottom waters D.O. depletion often occurs due to decomposition of detritus and organic compounds near the bottom. With a maximum depth of about 15', Birch Lake lacks the deeper water that typically results in thermal stratification. However, cold groundwater seepage combined with a small surface area does result in some stratification as displayed in Figure 5. At certain times of the year, anoxia near the bottom results in sediment release of nutrients including ammonia and phosphorus. The partial bottom water discharge from Birch Lake causes severe water quality problems below the dam. In early to mid June, 2009, the release of high nutrients from the bottom of Birch Lake resulted in significant growths of filamentous bacteria and fungi ("sewage slime community") below the dam. Strong hydrogen sulfide (rotten egg) odors coincided with the pollution. These conditions were previously documented by WDNR.

Figure 5: Birch Lake Temperature Profiles

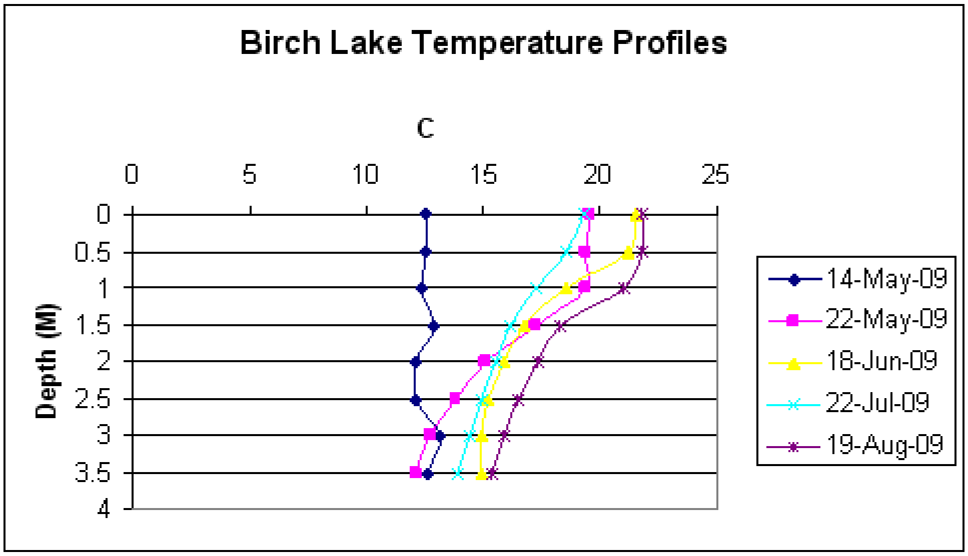

Figure 5

Specific Conductance - The conductivity level in water is a measure of electrical conductance and reflects the amount of dissolved chemicals in water. Higher conductivity indicates higher levels of dissolved chemicals. Higher conductance levels were observed near the bottom where nutrients are released from bottom mud or later in the summer as decomposing plants release nutrients (Figure 6). Groundwater also contains dissolved minerals and has higher conductivity than does soft rainwater. The higher conductivity near the bottom may reflect some of the spring flow to the lake.

Figure 6: Birch Lake Specific Conductance Profiles

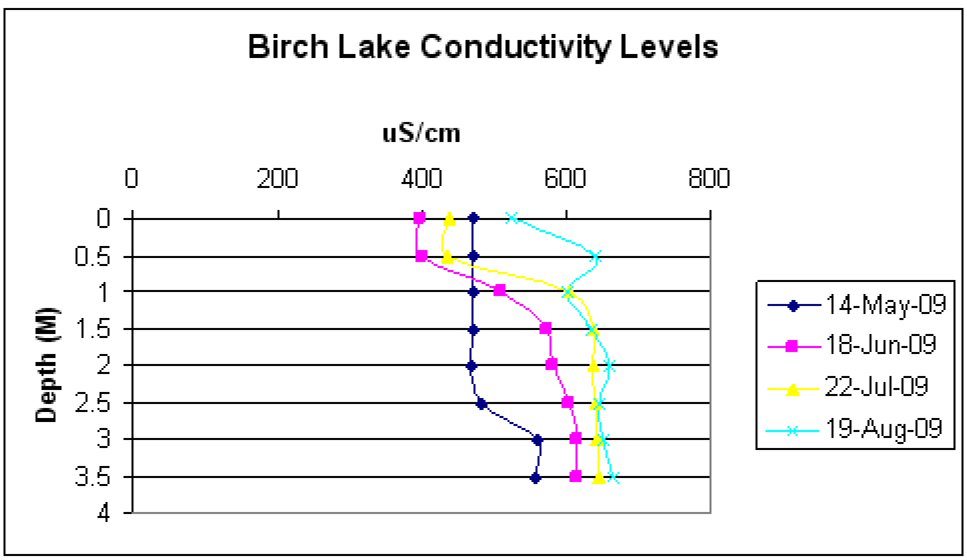

Figure 6

pH - Consistent with the limestone geology of the southwest Wisconsin driftless area, the pH levels in Birch Lake (Figure 7), were above the neutral level of seven and reflected alkaline conditions. Very high pH levels (above 9 s.u.) reflected photosynthesis of the dense growths of aquatic plants and filamentous algae. Just as D.O. will decline at night, pH measurements will drop (hydrogen ions increase) as a result of plant respiration.

Figure 7: Birch Lake pH Profiles

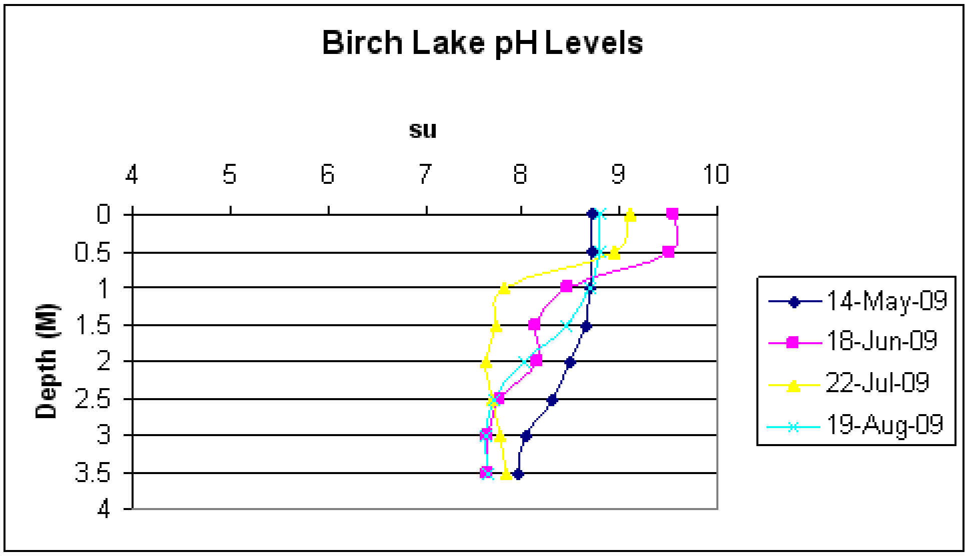

Figure 7

Aquatic Plant Survey - The WDNR baseline point intercept aquatic plant survey was conducted on July 8, 2009. Very dense growths of rooted plants were found with common water weed (Elodea canadense) comprising most of the plant biomass in the lake. The dense common water weed growth is not uncommon for high nutrient lakes with groundwater seepage and was the primary ecological problem in nearby Stewart Lake as well (Dane County Department of Land and Water Resources). Figure 8 is a histogram that compares common water weed along with the other aquatic plants found in Birch Lake. Figure 9 is a map showing the distribution and density of common water weed. The results of the aquatic plant survey demonstrated that common water weed (combined with filamentous algae growing near the surface) caused substantial recreational nuisances and negative environmental impacts (see cover photo).

Figure 8: Birch Lake Aquatic Plants and Frequency of Occurrence

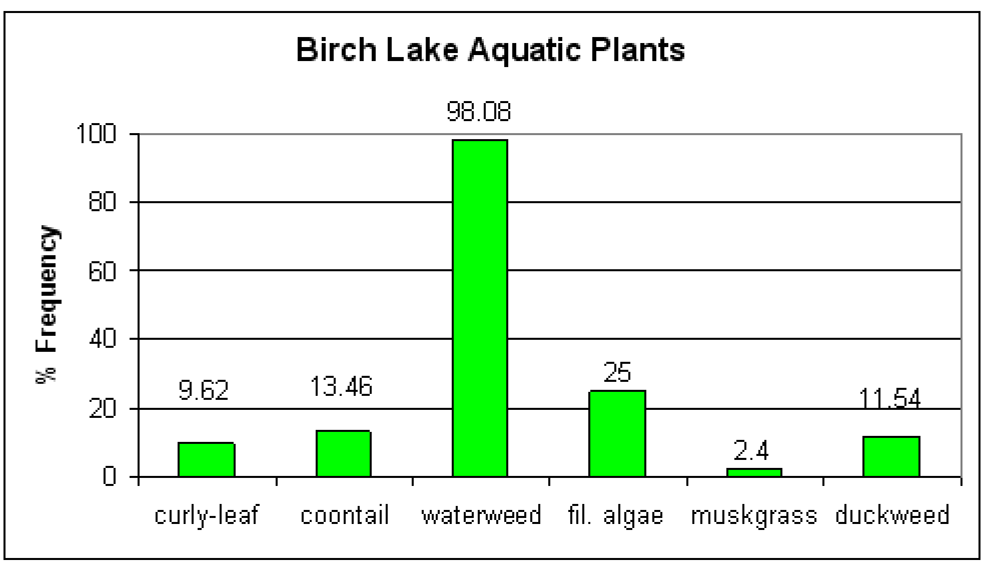

Figure 8

Figure 9: Distribution and Density of Common Water Weed in Birch Lake (3 = highest)

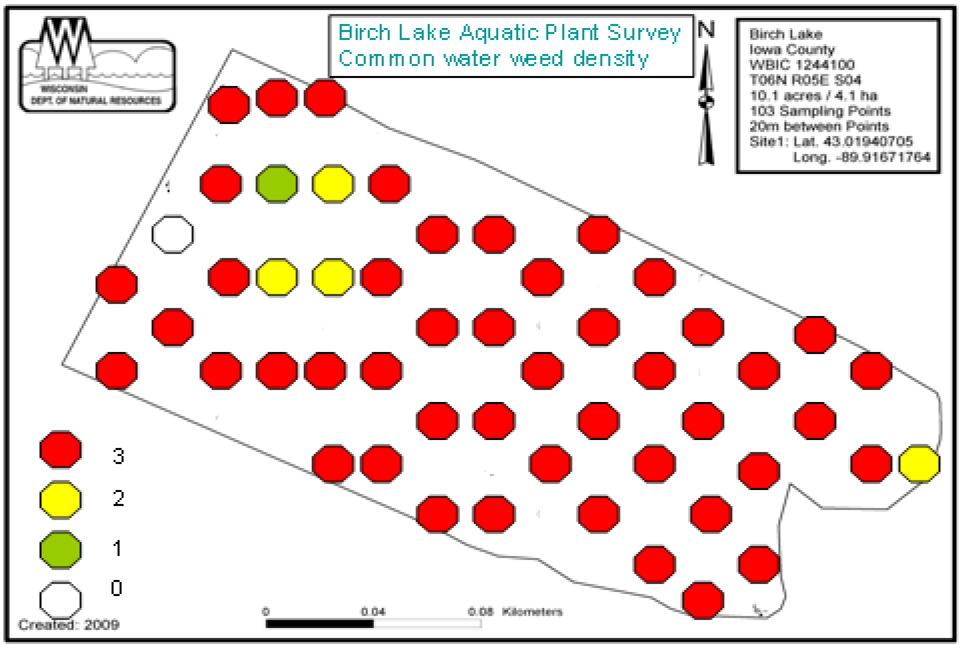

Figure 9

Table 1: Aquatic Plant Survey Summary Statistics

Total number of points sampled	52
Total number of sites with vegetation	51
Total number of sites shallower than maximum depth of plants	52
Frequency of occurrence at sites shallower than maximum depth of plants	98.08
Simpson Diversity Index	0.59
Maximum depth of plants (ft)	15.00
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	1
Average number of all species per site (shallower than max depth)	1.62
Average number of all species per site (veg. sites only)	1.65
Average number of native species per site (shallower than max depth)	1.29
Average number of native species per site (veg. sites only)	1.55
Species Richness	6
Species Richness (including visuals)	9

Table 1

Angling Survey - In May 2009, Agrecol consultants and two volunteers conducted a hook and line survey of Birch Lake fishes. Twenty-eight fish specimens representing two species were caught, measured and released. The results of the survey demonstrated that bluegills, and to a lesser extent, black crappie provided favorable catch sizes (Figure 10). The panfish sizes were somewhat of a surprise given the very dense plant growths that often result in over-population and stunted growth. The environmentally stressful conditions found in the lake may reduce recruitment and over-population but a more detailed ecological study would be needed to adequately evaluate the fisheries and reason for these results.

Figure 10: May 22, 2009 Birch Lake Hook and Line Survey (mean length bluegill = 6.9”)

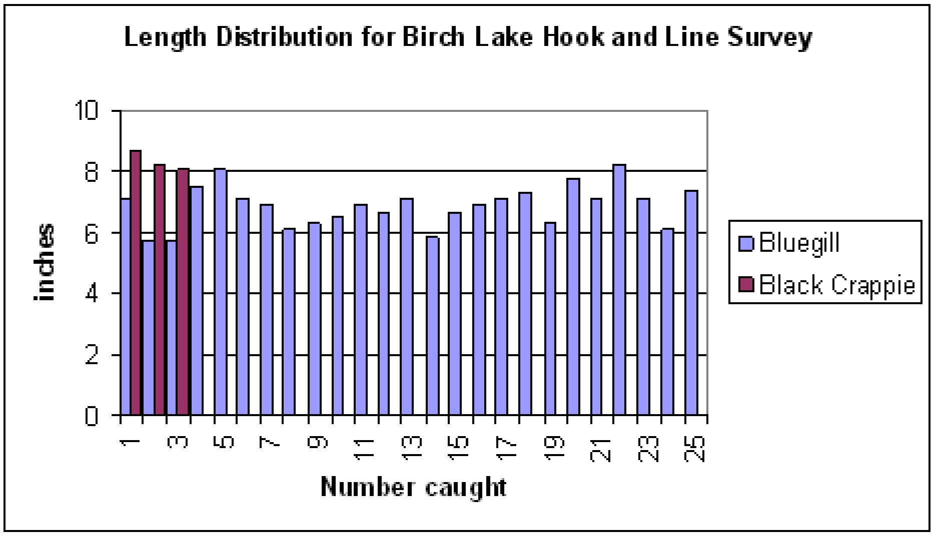

Figure 10

Birch Lake Recreational Use Survey - For many, Birch Lake is the centerpiece of the community park. Lake user information was recorded during each lake and stream survey. The results indicated that modest lake use occurred in spring, before dense aquatic plant growths limited fishing and recreational opportunities. On May 22nd, 2009, three shore anglers were also observed fishing the plunge pool below the dam. The results of these observations appear below in Table 2.

Table 2: Results of Birch Lake Recreational Use Survey

Date 2009	Shore Anglers	Boats	Other
May 9	0	0	0
May 15	5	0	0
May 22	0	0	0
May 26	0	0	0
June 6	1	0	0
June 7	2	1	0
June 18	0	0	0
June 27	0	0	0
July 8	0	0	0
July 12	0	0	0
July 22	0	0	0
August 4	0	0	0
August 18	0	0	0
August 19	0	0	0
September 14	0	0	0
Total Number	8	1	0
Total Days	3	1	0

Table 2

Other Biological Observations - In addition to aquatic plant and fish surveys, these other bird and animal species were observed in and around the lake: Canada geese (*Branta canadensis*), swallows (*Hirundo rustica*), redwing black birds (*Agelaius phoeniceus*), American toad (*Buffo americanus*), green frog (*Rana clamitans*), pickerel frog (*Rana palustris*), and damselflies and dragonflies (Odonata). No turtles were observed during the surveys.

Stream Monitoring Results

Stage and Flow - Above Birch Lake, thirteen flow measurements were recorded along with nineteen staff gage recordings (Figure 11). Since the summer of 2009 was relatively dry, most of the flow data collected is representative of low flow, or base flow, conditions. During dry periods, groundwater discharge to the stream sustains a relatively constant flow of approximately 1-1.5 cubic feet per second (cfs). The highest flow rate (6.48 cfs) was measured during a one inch rain event. Below the lake, average flow rates increased except when runoff occurred during storms (Figure 12). The higher flow rate below the lake represents groundwater seepage that is in excess of losses due to lake evaporation.

Figure 11: Flow Stage Relationship in Trout Creek above Birch Lake

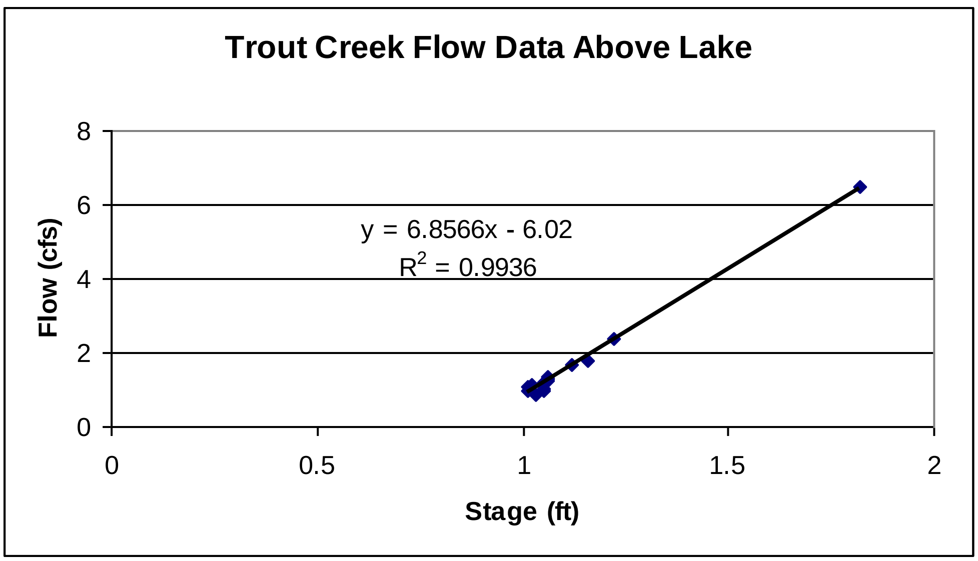

Figure 11

Figure 12: Trout Creek Flows Above and Below Birch Lake

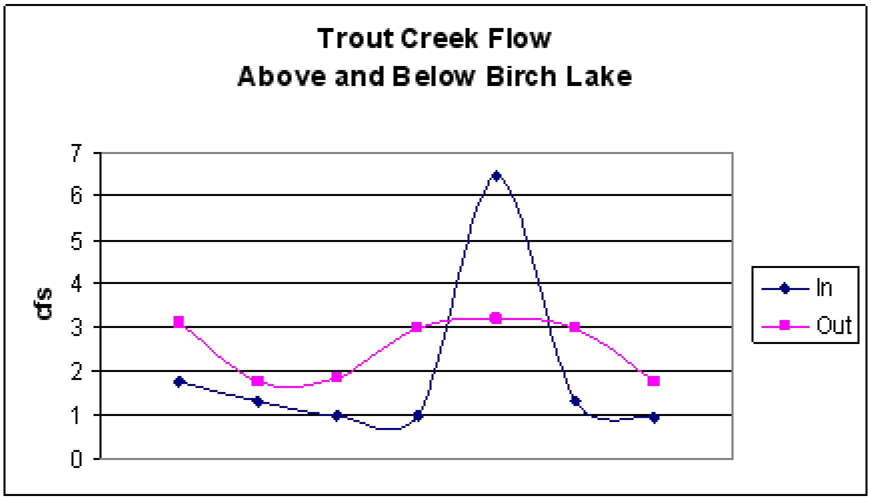

Figure 12

Transparency Secchi Tube - During dry periods, the water in the stream above the lake was very clear. During the few modest rainfall events that were monitored, the transparency dropped significantly below the maximum reading of 120 cm (Figure 13). The lowest transparency measurement was recorded during the one inch rainfall when the flow exceeded six cfs. Below the lake, maximum or near maximum transparency occurred at all times, revealing the sediment retention capacity of the lake. While water clarity was always very good below the lake, the water was often tinted due to the leaching of organic compounds released from the bottom mud or decomposing aquatic plants.

Figure 13: Trout Creek Transparency Measurements

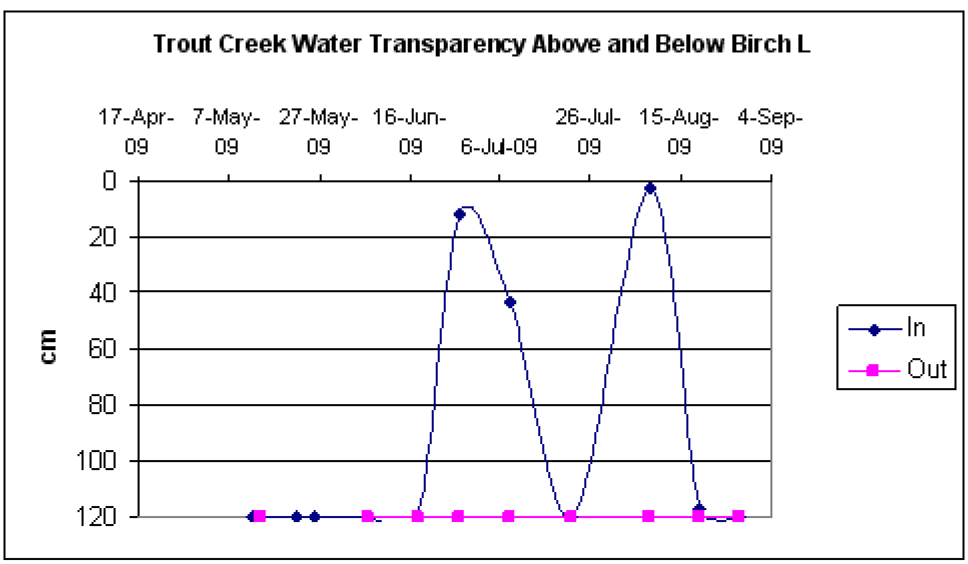

Figure 13

Dissolved Oxygen - No D.O. measurements taken in the stream, either above or below the lake, were less than the cold water quality criterion of 6 mg/l (Figure 14). However, lower D.O. was observed routinely below the dam. Lower D.O. below the dam indicates organic decomposition in the lake and lower dissolved oxygen saturation levels linked to warmer water temperatures.

Figure 14: Trout Creek Dissolved Oxygen Levels

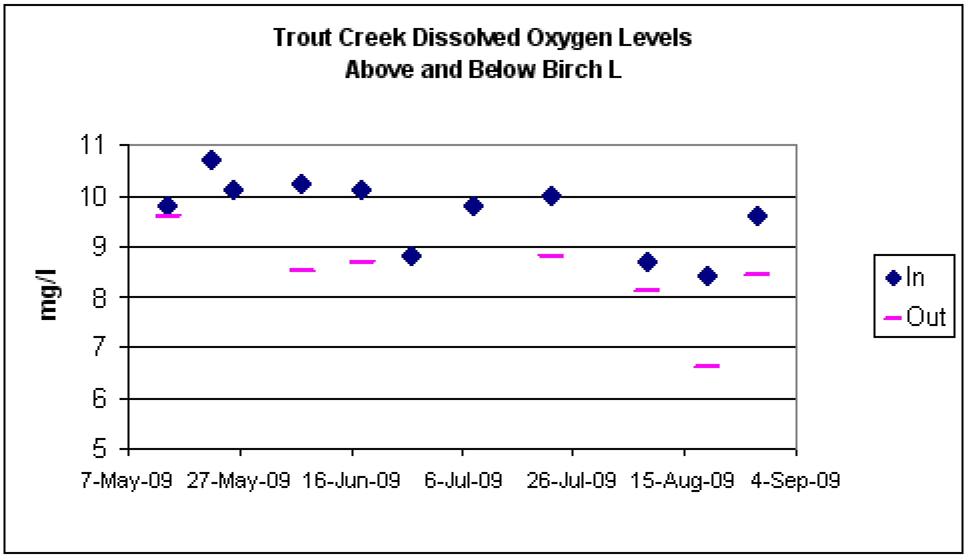

Figure 14

Phosphorus - Phosphorus is typically a limiting factor for plant growths in lakes and is normally the pollutant that is targeted for control. Sampling indicated that more phosphorus is entering the lake than is leaving, as would be expected given the sediment and nutrient trapping capacities of the lake (Figure 15). The highest concentration of phosphorus was measured when the inlet flow rate exceeded six cubic feet per second. The total estimated phosphorus loading to the lake is presented in the Watershed Land Use Inventory and WILMS section below.

Figure 15: Trout Creek Phosphorus Concentrations

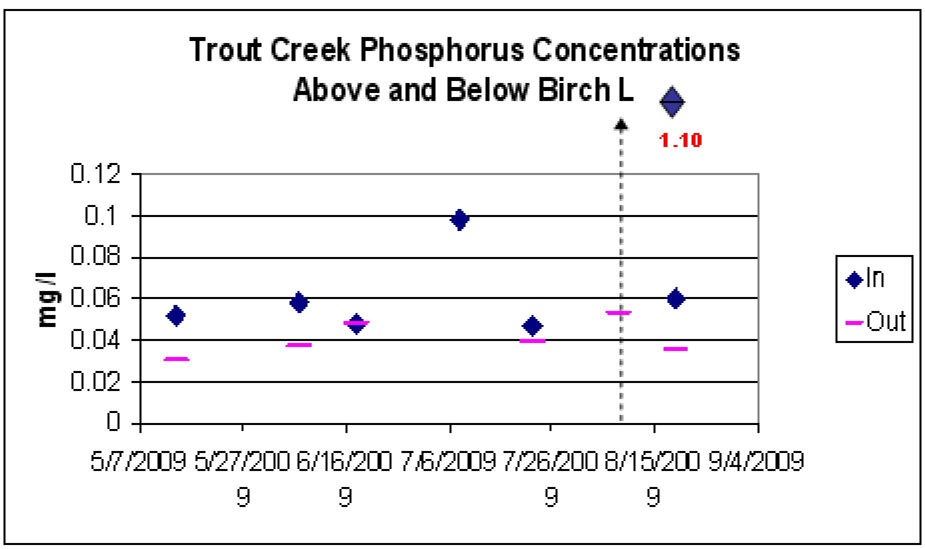

Figure 15

Ammonia Nitrogen (NH3) - Ammonia can appear in toxic, un-ionized forms, and indicates organic decomposition. Nitrogen usually appears as inorganic nitrates when found in groundwater, but in surface waters where significant pollution occurs, nitrogen is primarily in the form of ammonia. The 2009 sampling effort demonstrated that ammonia levels were higher below the lake that reflected nutrient release from bottom mud and decomposition of aquatic plants in the lake. Ammonia was one of the organic compounds that fed "slime" growths and dense filamentous algae below the lake.

Figure 16: Trout Creek Ammonia Concentrations

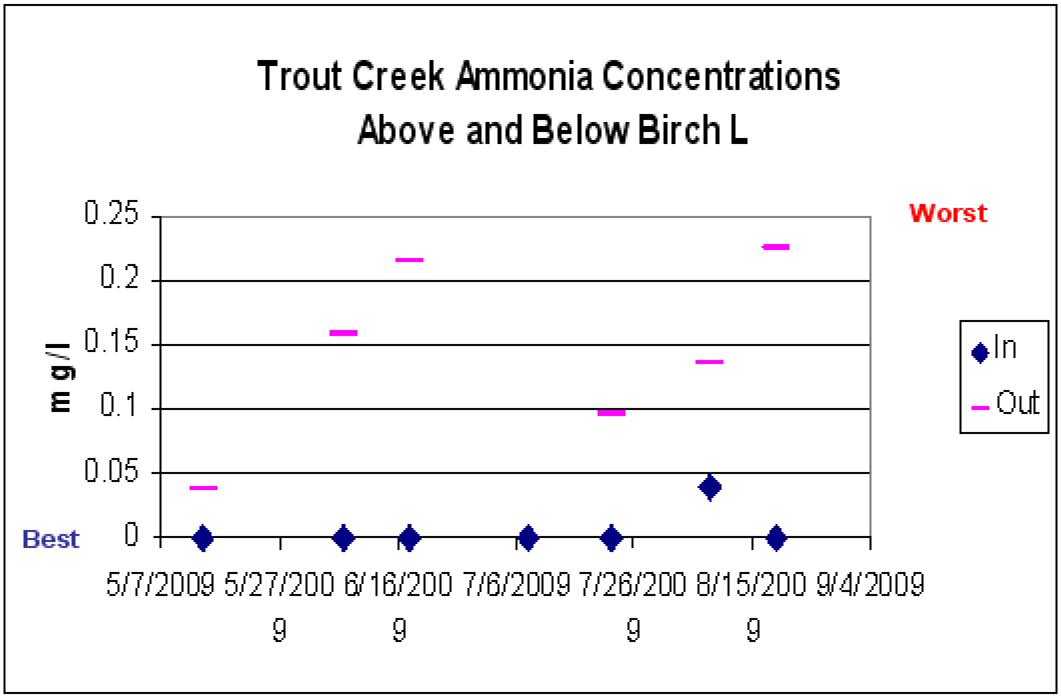

Figure 16

Suspended Solids - Floating or suspended particles in water can be quantified by measuring the suspended solids. In Trout Creek, the suspended solids typically reflect fine soil particles washed off the surrounding land. The surveys demonstrated that the stream transported sediment loads to the lake and that sediment was retained in the lake.   Consistent with the highest flow rate, the highest suspended solids measurement occurred when the flow exceeded 6 cfs (Figure 17). The increase in sediment loading during rain events is graphically captured in the Figure 18 photo. It is important to mention that the suspended solids measurements did not reflect the bed load transport that can exceed suspended solids loading. The coarse bed load likely created the delta plus additional, finer material that is continuously deposited further out into the lake.

Figure 17: Trout Creek Suspended Solids Measurements

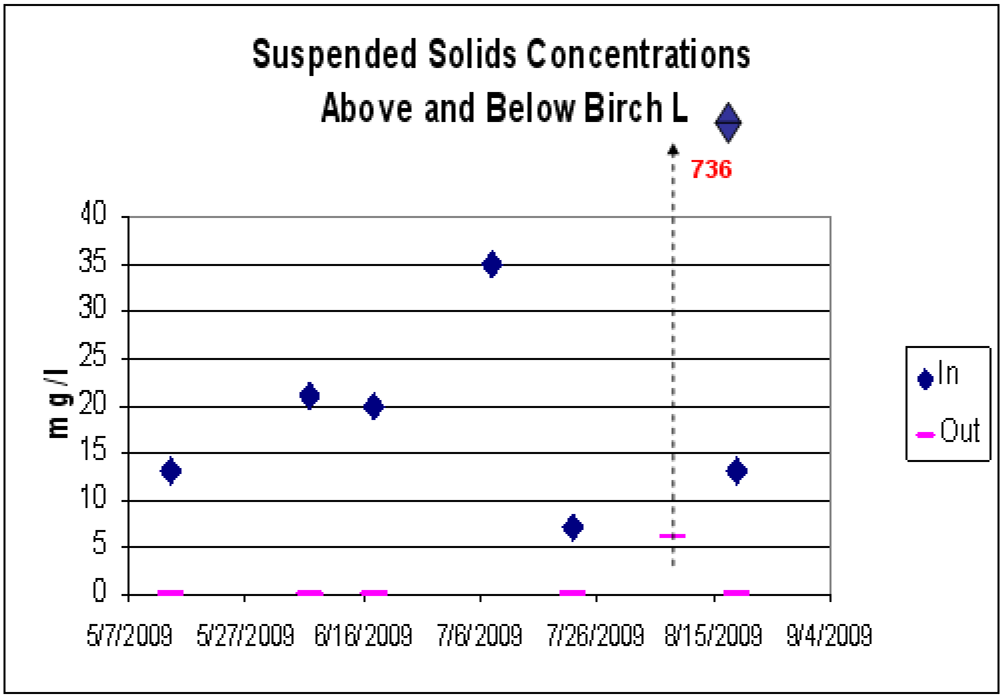

Figure 17

Figure 18: Comparison Photo of Trout Creek Water

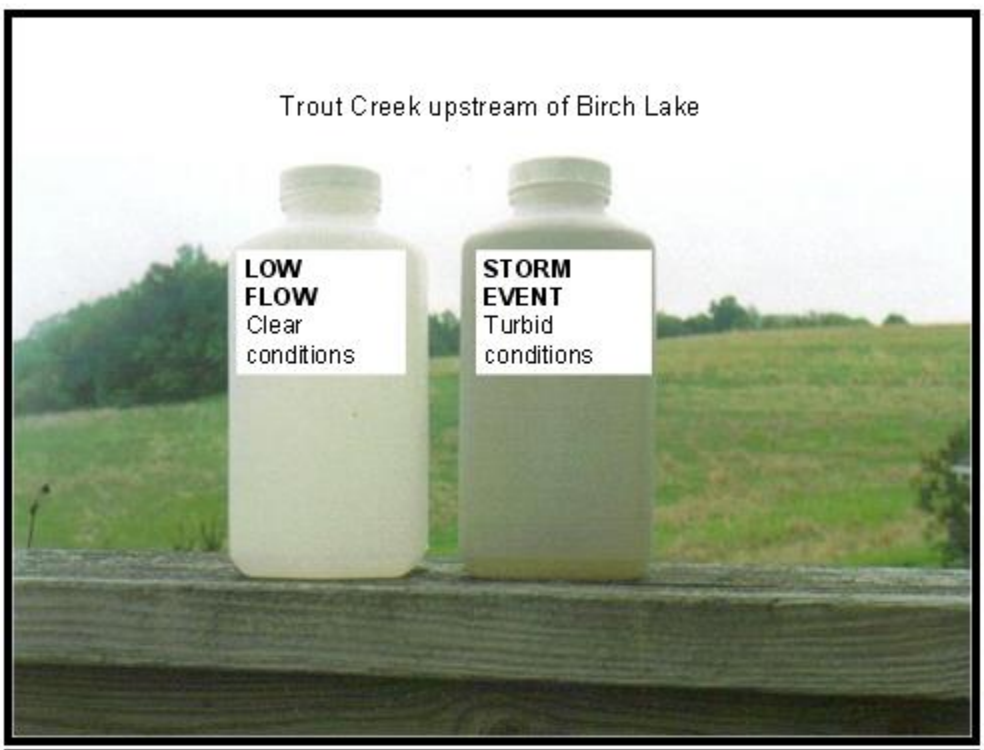

Figure 18

Temperature - The Onset data loggers provided a comprehensive comparison of stream temperatures above and below the lake (Figure 19). Above the lake, ideal trout stream temperatures were sustained throughout 2009. Below the lake, water temperatures were typically high and on occasion very warm water temperatures were detected. The warmer temperatures below the dam occurred even though a bottom discharge was designed to release water cold. In similar studies of PL 566 impoundments, bottom discharge systems often were unable to sustain cold temperatures and also released significant concentrations of pollutants (Marshall et al. 2006).

Figure 19: Trout Creek Temperature Data

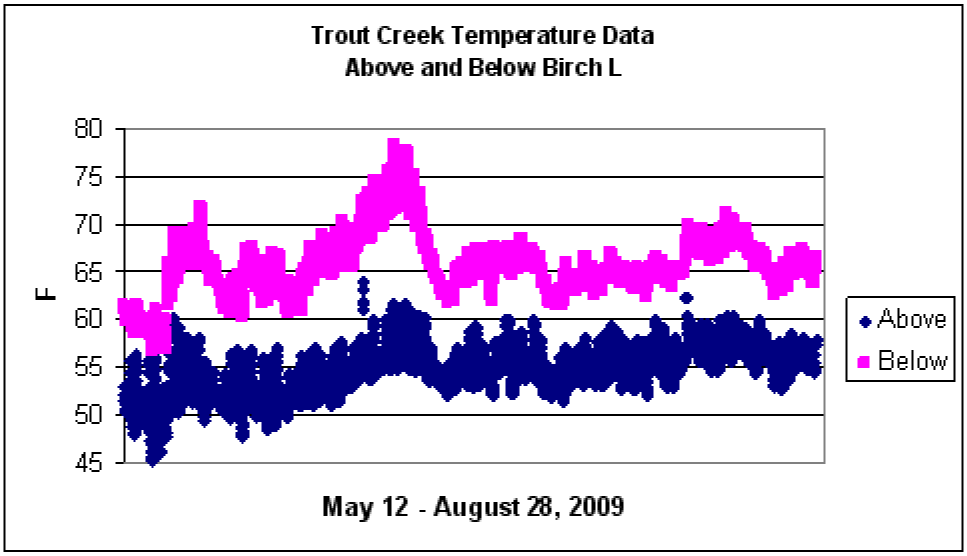

Figure 19

Watershed Land Use Inventory and Phosphorus Loading Estimates - Figure 20 shows the GIS map of the Birch Lake watershed with various land uses identified. The watershed area is 1012 acres compared to the lake area of only 11 acres. The relatively large land mass that drains into the lake represents a watershed to lake area ratio of 92:1. With the steep gradients present in this area, significant amounts of soil erosion can be lost from the landscape and then be easily carried to the lake. Certain watershed management practices can reduce soil runoff and should be encouraged to protect water quality, however the vast watershed compared to the much smaller lake and steep gradients pose a lake management problem. The estimated annual phosphorus loading to the lake is 604 lbs/year, a level that far exceeds the amount that can create water quality problems in the lake. Figure 21 displays a breakdown of watershed land uses in acres and phosphorus loading sources in kilograms per year.

Figure 20: Birch Lake Watershed Land Use Inventory

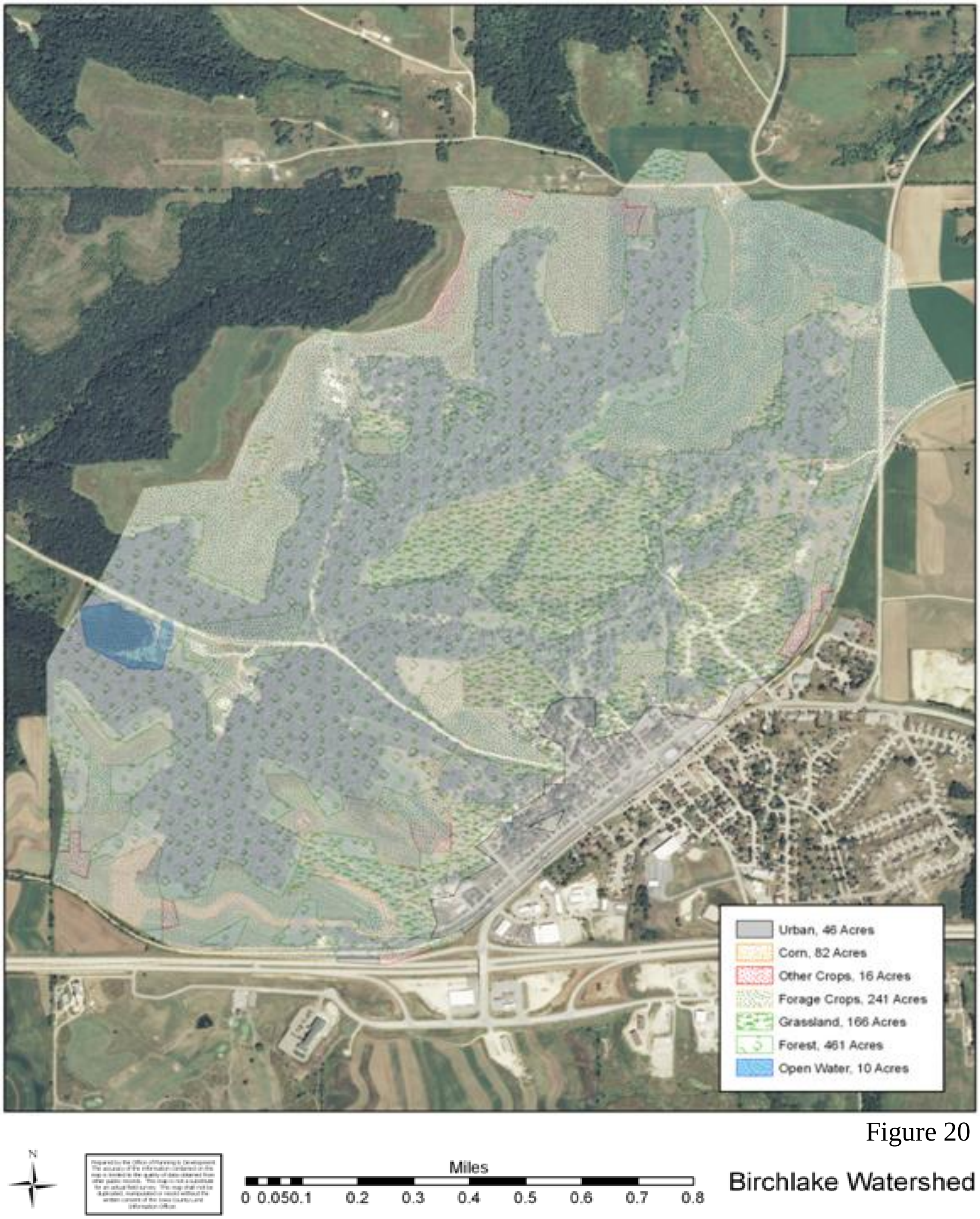

Figure 20

Figure 21: Birch Lake Watershed Phosphorus Loading Information

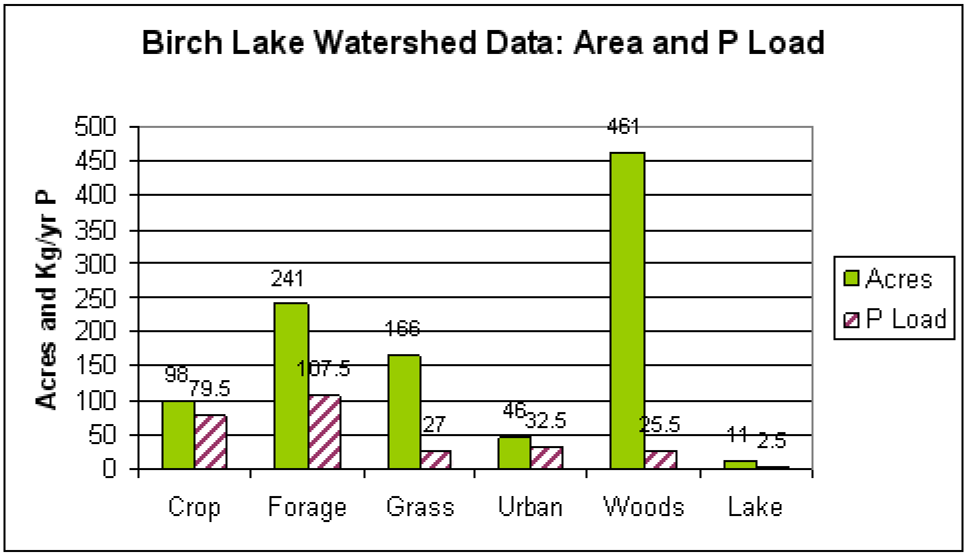

Figure 21

<u>Lake Sediment Volume and Composition</u> - Lake sediment surveys were conducted by the NRCS in 1975 and again in 2002. In 1975 the thickness of the sediment ranged from five inches to twenty-six inches, with the average thickness being nineteen inches. In 1975 the volume of sediment was calculated to be 10.23 acre-feet or approximately 16,000 cubic yards of accumulated sediment over an eleven year period.

In 2002 sediment surveys showed thickness to vary from nine inches to five feet. The volume of the accumulated sediment was calculated to be 18.6 acre-feet or approximately 30,000 cubic yards of accumulated sediment over a period of thirty-eight years.

On average, Birch Lake has been retaining about 500 cubic yards of sediment each year since it was first constructed in 1964. However the rate of sediment being trapped has decreased from 0.9 acre-feet/year in the first eleven years of construction to 0.3 acre-feet/year for the last twenty-seven years. This decrease in sediment accumulation has been attributed to changes in land use and improved conservation practices in the watershed.

The bottom sediments in the 1975 survey had an average composition of 34% sand, 52% silt, and 11% clay. Organic matter in the sediment averaged 3%.

Lake sediments were also tested for a wide variety of contaminants in 2002 (Table 3). The testing showed less than detectable amount of common agricultural chemicals and arsenic. In general the sediments appear not to have significant contaminants although this data does not reflect any recent contamination that may have occurred.

Table 3. Sediment Composition

Birch Lake
(Twin Parks Watershed Structure #7)
Sediment Testing Results

Contaminant Tested	Sample 1 Northeast Hole 1104 0-3.9 feet	Sample 2 Southeast Hole 1109 0-4.0 ft.	Sample 3 Northwest Hole 117 0-3.4 feet	Sample 4 Southwest Hole 101 0-3.1 ft.	Background Soil Sample 1.1 0-1 ft.	Background Soil Sample 2.1 0-1 ft.
Total Phosphorus (mg/kg)	520	400	70	51		
Nitrogen* (mg/kg)	<61	<54	<37	<39		
Nitrogen (Ammonia)	75	81	<37	<39		
Arsenic (mg/kg)	5.1	4.5	1.5	1.8	0.79	0.74
Desethylatrazine (ug/kg)	<6.0	<6.0	<6.0	<6.0		
Desisopropylatrazine (ug/kg)	<9.5	<9.5	<9.5	<9.5		
Atrazine (ug/kg)	<2.1	<2.1	<2.1	<2.1		
Alachlor (ug/kg)	<10	<10	<10	<10		
Metolachlor (ug/kg)	<22	<22	<22	<22		
Cyanazine (ug/kg)	<4.0	<4.0	<4.0	<4.0		
4,4' DDE (ug/kg)	<0.80	<0.80	<0.80	<0.80		
4,4'-DDD (ug/kg)	<1.2	<1.2	<1.2	<1.2		
4,4'-DDT (ug/kg)	<1.0	<1.0	<1.0	<1.0		

*nitrate and nitrite
Sediment samples collected February 7, 2002
Background soil samples collected June 12, 2002

Table 3

Management Alternatives

The following alternatives have been developed to help the Village of Barneveld develop a management strategy for Birch Lake and the community park. The alternatives presented are certainly not all inclusive, however experience has been that the ideas presented here would serve as a good starting point for developing an action strategy.

Do Nothing – Birch Lake has been in existence for over forty years and is nearing its fifty year design life expectancy. While the lake still provides some recreational value it is used much less than it was in the past. Without any lake specific action, sediment will continue to be delivered and deposited in the lake. Over the next few decades the lake's sediment storage capacity will be exhausted and the lake will become mostly a wetland community, dominated by emergent vegetation with a small impounded stream running through it.

The dam will always require maintenance. Maintaining the embankment by mowing and tree control will be necessary on a yearly basis. Regular inspections of the embankment and of the structural components, such as the concrete and steel control structure and outlet, also require periodic monitoring, ideally on a yearly basis. The overall life expectancy of the dam and outlet structure is difficult to predict, however at some point major reconstruction will be required.

Dredging – No Watershed Diversion. Excavation without watershed diversion would restore loss of water storage capacity and improve recreational potential of the lake for boating, swimming and fishing.

Removal of the entire amount of accumulated sediment in the lake would most likely be completed using standard excavation practices with the lake being drawn down. Costs of removal would be highly dependent upon the potential disposal areas. At $10/yd removal of 30,000 yards would be $300,000. As an example, if all of the sediment were deposited evenly over a four acre area of the park, land elevations would be increased by an average of four feet (Figure 22).

Deepening the lake to its original contours would provide an average increased depth of less than two feet. Exposure of nutrient poor soils would initially limit aquatic plant growth in shallow areas but the majority of the lake would still provide favorable habitat for rooted aquatic plants over most of the lake's surface area. Only those areas deeper than twelve feet, the area nearest the dam, would be expected to be plant free over the summer growing season. Density of plants would initially be less, but as sediment once again accumulated in the lake, their growth would begin to return to current densities.

Overall water quality of the lake would not be expected to be significantly changed by a dredging project that removed even all of the 30,000 cubic yards of accumulated material.

Prior to any dredging, detailed engineering plans and permits would be required from the DNR for sediment removal and placement of spoils.

Figure 22. Example Area Needed if All Lake Sediment Was Placed Four Feet Deep

Figure 22

Watershed Diversion and Creation of Separate Lake - To separate the lake from the incoming stream, a berm approximately 1100 feet long could be constructed to pass the majority of flow events past the lake, directly to the dam's outlet (Figure 23). Minimal modification to the dam would be required with lake and stream elevations maintained at current levels.

The berm would be designed to overtop at larger flow events, e.g. once every fifty years, so that flood capacity of the impoundment would not be affected. Under normal conditions the inflow would be routed along the western edged of the lake, in essence forming a very small impoundment. Water residence times of the new channel would be reduced significantly and incoming cold water would pass out of the dam with minimal temperature increases.

Some of the material currently present in the lake could be used for construction of this diversion berm although imported materials may be necessary to maintain a stable embankment.

The embankment would be designed with a top width sufficient to allow access for maintenance vehicles and for use as a walking path that could provide fishing and wildlife viewing along its length.

Costs for construction of a diversion berm are estimated to be between $50,000 and $100,000 but are highly dependent upon more detailed engineering design.

The new lake could be deepened during the construction of the berm to provide deeper water habitat. Ideally the lake would have water depths of twelve feet or more at its deepest location. Final design of lake depth and contours would be dependent upon costs and availability of land for sediment disposal.

Water in the new lake would be maintained primarily by the extensive groundwater inputs currently entering the lake along CTH T. With a much reduced nutrient and sediment input, the quality of the lake would be quite high with minimal potential for obnoxious algae and weed growth. Phosphorus loading would decline by over 95% and the watershed drainage area would decline by roughly the same percentage. Lake flushing rate would decline from about 10X per year to about 0.4X per year. A major spring that enters the east side of the lake along with surface runoff from about 35 acres would sustain the lake.

Figure 23. Potential Location of Diversion Berm

Figure 23

Figure 24. Reduced Watershed Loadings From Diversion

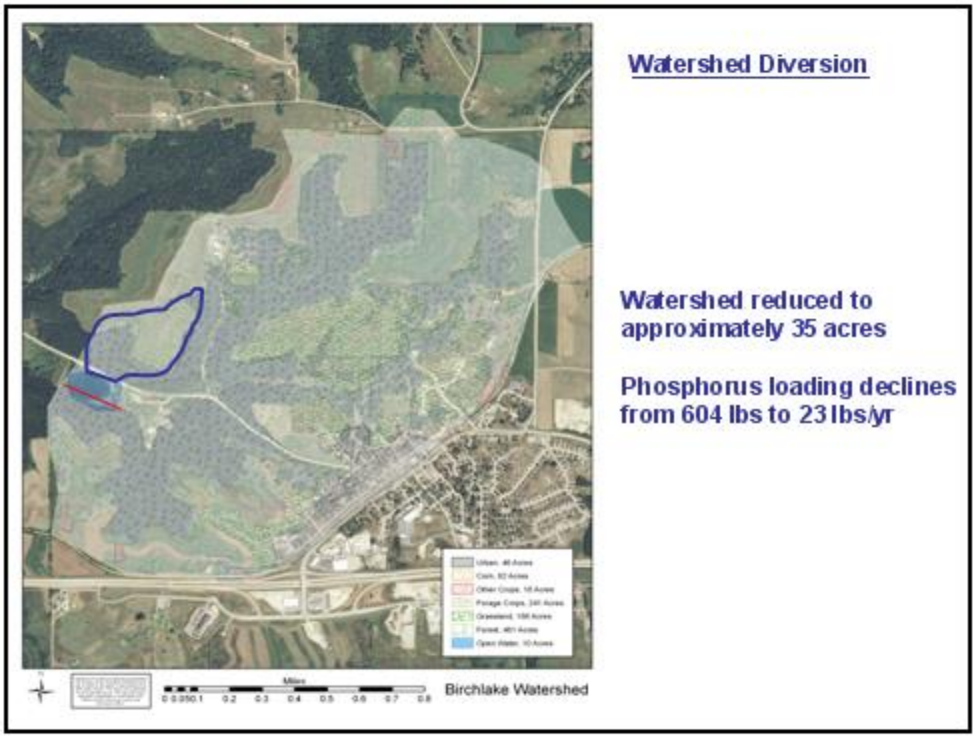

Figure 24

Dam Removal and Off-channel Pond Construction - This option was previously proposed by the Natural Resources Conservation Service, Department of Natural Resources and Iowa County Land Conservation Department. The option included restoring the trout stream with links to a hiking trail and off-channel trout fishing pond. This option was previously rejected by the community due to loss of significant surface area that forms an important viewshed for the park.

Mechanical Aquatic Plant Harvesting - Regular mechanical weed harvesting can reduce nuisance growths of weedy aquatic plants and filamentous algae. A maintenance level of control would likely require harvesting two or three times per summer. This method would not reduce long term sedimentation and loss of water storage capacity. Mechanical harvesting can be an expensive maintenance program since the mechanical control of aquatic plants is both a biological and materials handling problem (Cooke et al. 2005). Herbicides are not recommended due to potential adverse effects on lake and stream water quality, including potential shifts from rooted plant problems to toxic algae problems.

Watershed Best Land Use Management Practices - The water quality condition of most lakes directly reflect the both the size and land uses of the watershed. The amounts of sediment and nutrient loading to Birch Lake has declined significantly since the lake was constructed but the current loading still represents a long term threat to the lake. A watershed best land use management effort could further reduce sediment loading to the lake but this effort would not likely yield the same level of benefits that a watershed diversion effort could provide.

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Birch Lake User Survey Results

The Village of Barneveld applied and received a grant to do a study of the water quality at Birch Lake. Part of that grant is to complete a survey of how people are currently using the lake. Another part of the survey is to see if people would like to see the lake improved and how they would like to see it improved.

Surveys were sent out with the December Utility bills. Thirty-five surveys were returned. Here are the results of those returned.

1. How many times did you visit Birch Lake in 2009?

    - ☐ 1 time __4__
    - ☐ 2-5 times __14__
    - ☐ 6 or more times __17__

2. Why did you visit Birch Lake?
    - ☐ Fishing __19__
    - ☐ Camping _____
    - ☐ Swimming _____
    - ☐ Use the Park Shelters __ 21__
    - Use the Ball Park Area __ 26__
    - Other ____

3. What activities did you participate in when you visited Birch Lake?
    - ☐ Camping ____
    - ☐ Fishing _ 17__
    - ☐ Boating __7_
    - ☐ Swimming ____
    - ☐ Wildlife observation __7_
    - ☐ Picnicking _ 18__
    - ☐ Ball Park _ 25_
    - Other ____

4. What is your perception of the water quality of Birch Lake?
    - ☐ Excellent _____
    - ☐ Good _____
    - ☐ Fair __10__
    - ☐ Poor __19__
    - ☐ It depends on the time of year __13__

5. What influences your perception of the water quality of Birch Lake?

    - ☐ Clear water __7__
    - ☐ Green water __24_
    - ☐ Amount of aquatic plants __19_
    - ☐ Smell __15_
    - ☐ Depth __10_
    - ☐ Fishing success __ 8_
    - ☐ Boating experience __ 8_
    - ☐ Other ____

6. Management actions are being considered for Birch Lake, which can cause different kinds of changes in the lake. Which changes do you feel would improve your experience at Birch Lake the most?
   - ☐ Reduce algae, which will keep water clearer in late summer. __29_
   - ☐ Prevent sediment from coming in the lake, which keep it deeper. __21_
   - ☐ Increase the number of larger game fish to catch. __15_
   - ☐ Increase the number of fish for kids to catch. __16_
   - ☐ Limit the amount of aquatic plants. __20_
   - ☐ Other ____

7. Please rate the following item (1=poor, 5=excellent)

☐ Camp Sites	1)poor=6, 2=8, 3=6, 4=2, 5)excellent=0
☐ Bathrooms	1)poor=20, 2=4, 3=4, 4=2, 5)excellent=0
Shelters	1)poor=1, 2=3,3=15, 4=11, 5)excellent=0
Playground	1)poor=0, 2=3, 3=9, 4=16, 5)excellent=2
Ball Park	1)poor=1, 2=5, 3=11, 4=12, 5)excellent=0
☐ Overall experience	1)poor=0, 2=8, 3=14, 4=8, 5)excellent=1

8. Do you feel that the Village of Barneveld should go forward at looking at ways to improve Birch Lake?

   No, I don't feel that this is a Village of Barneveld Concern __1____

   Yes, I feel that the Village should look at ways to try and improve the quality of the lake. __30____

9. Other comments that you would like to make about Birch Lake.

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