IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

PHASE I
LAKE MANAGEMENT PLAN
KELLER LAKE
WAUPACA COUNTY, WISCONSIN

REPORT TO:
WAUPACA COUNTY PARKS AND RECREATION COMMITTEE

August, 1996

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GLOSSARY OF TERMS (1, 2, 3)

Best Management Land use practices to control the interactive **Practices (BMP's)** processes of e
pesticide inflows.

Chlorophyll a Green pigment present in all green plant life and needed in photosynthesis. The amount present in lake water is related to the amount of algae and is therefore used as an indicator of water quality.

Drainage Lake Generally referred to as those natural lakes having inflowing and outflowing streams.

Eutrophication The process of lake aging or enrichment with nutrients, generally with associated increases in algae or weeds. The extent to which this process has progressed is described by trophic status terms, e.g., oligotrophic, mesotrophic, or eutrophic.

Eutrophic From Greek for "well nourished", describes a lake of high photosynthetic activity and low transparency.

Littoral The shallow area of a lake from the shore to the depth where light no longer penetrates to the bottom.

Macrophyte Commonly referred to as lake "weeds", actually aquatic vascular plants that grow either floating, emergent or submergent in a body of water.

Mesotrophic A lake of intermediate productivity and clarity.

Morphometry Pertaining to the shape, depth or structure of a lake.

N/P Ratio Total nitrogen divided by the total phosphorus found in a water sample. A value greater than 15 indicates phosphorus to be limiting primary production.

GLOSSARY OF TERMS
(continued)

Physicochemical Pertaining to physical and/or chemical characteristics.

Secchi Depth A measure of optical water clarity as determined by lowering a weighted Secchi disk (20 cm in diameter) into the water body to a point where it is no longer visible.

SUMMARY

Keller Lake is a 21 acre impoundment of the South Branch Pigeon River located in north central Waupaca County in the townships of DuPont and Wyoming. The impoundment drains a relatively small forested watershed in a glacial moraine region. The upper part of the watershed extends into Shawano County where the South Branch Pigeon River originates.

Lake water quality, according to the Trophic State Index, is **mesotrophic** to **eutrophic**. Highest nutrient levels were at or below those typical of Wisconsin lakes overall and of lakes in the Keller Lake ecoregion; event inflows, however, were considerably higher in plant nutrients.

Sedimentation in Keller Lake is relatively high (like in many impoundments) and contributes to reduced impoundment capacity and increased plant growth. Upstream areas of dense emergent and submergent vegetation help to filter sediment during periods of relatively lower flow.

Macrophytes are widespread and relatively abundant (approaching nuisance conditions). Small duckweed (Lemna minor) and coontail (Ceratophyllum demersum) are the dominant species. Habitat alteration and aesthetics degradation, relative to these aquatic plants, is occurring.

Management recommendations target reduction of nutrient and sediment inflows, prevention of exotic plant/animal introductions, improved recreational and aesthetic properties, and continued water quality monitoring.

- Watershed wide **Best Management Practices (BMP's)** should be implemented to control nutrient and sediment inputs to the resource. Specifically, Waupaca and Shawano Counties should consolidate efforts in pin-pointing areas within the watershed which are contributing to excess nutrient/sediment input. Property owners should then be educated and encouraged to implement BMP'S which are most feasible and suitable for the specific site.

- Measures to prevent or reduce the potential for invasion of Eurasian milfoil and purple loosestrife (exotic species) should be identified and implemented. Signs should be posted to educate landowners and lake users about these resource dangers.

- Limited scale, in-lake plant removal by mechanical or hand harvesting techniques could provide short-term relief from near nuisance aquatic weed problems. Harvesting would

provide some nutrient removal and create edge for fish habitat improvement.

- A review of Park management and maintenance practices relative to erosion and nutrient control should be encouraged. A cost/benefit assessment of stocking efforts vs. trout harvested should be undertaken by the WDNR.

- Regular water quality trend monitoring should continue to supplement the small amount of historic data available and detect major disturbances within the watershed. Event samples should be taken to assess progress of erosion and nutrient controls implemented within the watershed. Volunteers should continue to record **Secchi depth** readings on a regular basis.

[1] Text terms in **bold** print defined in glossary (pp. vi-vii)

INTRODUCTION

Keller Lake is a small impoundment of the South Branch Pigeon River located in north central Waupaca County with an upper portion of watershed located in Shawano County. The impoundment was created in 1939 by the construction of a 19-foot concrete dam as part of a Civilian Conservation Corps project. The dam is presently owned by Waupaca County.

In August of 1993, the Waupaca County Parks and Recreation Department in conjunction with the Waupaca County Water Quality Committee decided to pursue development of a management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program. IPS Environmental & Analytical Services (IPS) of Appleton, Wisconsin was selected as the consultant to develop the plan. The grant application to initiate development of the plan, incorporating required or recommended program components and the following objectives, was prepared, submitted, and approved in October, 1993:

- assessment of current water quality in Keller Lake and implementation of a monitoring strategy to track trends,
- location, quantification and identification of aquatic plant populations,

- determination of nutrient inputs to the lake,
- maintenance and enhancement of recreational and aesthetic potential, and
- education of lake users and establishment of a continuing base of support for lake management efforts.

DESCRIPTION OF AREA

Keller Lake (T25N R12E 13E, S13, S18) is a **drainage lake** (posessing a permanent inlet and outlet) located in DuPont and Wyoming townships (Fig. 1). The lake is actually an impoundment of the South Branch Pigeon River which originates in south central Shawano County and is a clear, hard water tributary of the Pigeon River. It is fed by the North Fork, South Fork, Geske Creek, the Long Lake outlet, and three small, unnamed streams. Keller Lake is located near the junction of the North and South Forks (4).

The general topography near Keller Lake, and of Waupaca County in general, is related to glacial activity; topography adjacent to the lake is nearly level to steep. Major soil types on the lake perimeter are well drained Rosholt sandy loam on 2-6 percent slopes, Rosholt-Rock outcrop complex on 2-10 percent slopes and Seelyeville muck which is nearly level, very poorly drained soil in depressions (5). Soil erosion potential ranges from moderate (Rosholt) to slight (Seelyeville). Soil types adjacent to Keller Lake are generally unsuited for septic systems; the soils either absorb the effluent from the septic tank absorption field, but don't adequately filter, or are poorly drained.

Keller Lake has a surface area of 21 acres, a length of 0.51

Figure 1. Location Map, Keller Lake, Waupaca County, WI.

miles, a width of 0.11 miles, an average depth of 5 feet, a maximum depth of approximately 12 feet and a lake volume of about 105 acre-feet (6). Predominant **littoral** substrates include muck (40%), sand and gravel (35%) and rock (25%) (4). Macrophytes (aquatic plants) are relatively abundant in certain littoral areas. Two exotic nuisance plant species, Eurasian milfoil (Myriophyllum spicatum) and purple loosestrife (Lythrum salicaria), are currently established in Waupaca County and are capable of spreading to Keller Lake.

The Keller Lake watershed is predominantly forested, but some adverse effects of localized agricultural activities have been identified in the past. The watershed downstream, as the Pigeon River flows into Pigeon Lake near Clintonville and eventually into the Wolf River, is more agricultural. Habitat deterioration from streambank pasturing and cropland runoff, occurs and varies from year to year as crops are rotated.

Keller Lake supports warmwater and coldwater fisheries (Table 1). Recent and historic Wisconsin DNR management and stocking efforts have been directed toward the trout fisheries. Records show that trout have been stocked in Keller Lake on an annual basis since 1959 (Table 2). The last reported fish survey was completed on June 14, 1960 (7).

An unpaved public boat ramp is available at the south end of Keller Lake along with a county park and unsupervised beach facilities. A paved public road surrounds the entire shoreline of the lake.

Table 1. Keller Lake Fish Species.

COMMON NAME	SCIENTIFIC NAME
Warmwater Game Fish	
Largemouth bass	*Micropterus salmoides*
Smallmouth bass	*Micropterus dolomieui*
Coldwater Game Fish	
Brown trout	*Salmo trutta*
Rainbow trout	*Salmo gairdneri*
Brook trout	*Salvelinus fontinalis*
Warmwater Panfish	
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lepomis gibbosus*
Rock bass	*Ambloplites rupestris*
Yellow perch	*Perca flavescens*
Black bullhead	*Ictalurus melas*
Yellow bullhead	*Ictalurus natalis*
Forage Fish	
Golden shiner	*Notemigonus crysoleucas*
Bluntnose	*Pimephales notatus*
Fathead minnow	*Pimephales promelas*
Northern common shiner	*Notropis cornutus*
Northern creek chub	*Semotilus atromaculatus*
Sucker	*Catostomus* sp.
Pearl Dace	*Rhinichthys* sp.

Table 2. Stocking Records, 1946 - 1994, Keller Lake, Waupaca County, WI.

Year	Species	Number
1946	Brown	14,000
1959	Rainbow	1,000
1960	Rainbow	1,000
1960	Brown	1,800
1961	Largemouth Bass	5,500
1962	Brown	500
1963	Brown	1,400
1964	Brown	2,500
1964	Brown	1,500
1964	Brown	1,000
1965	Brown	1,500
1966	Brown	1,500
1967	Brown	1,500
1968	Brown	1,500
1969	Brown	1,500
1970	Brook	1,500
1971	Brook	1,500
1972	Brook	1,500
1973	Brook	1,500
1974	Brook	1,000
1977	Brook	1,000
1978	Brook	1,000
1979	Brook	1,000
1980	Brook	1,000
1981	Brook	750
1982	Brook	750
1983	Brook	750
1984	Brook	750
1985	Brook	750
1986	Brook	750
1987	Brook	500
1989	Brook	300
1990	Brook	750
1991	Brook	750
1992	Brook	750
1993	Brook	750
1994	Brook	750

METHODS

FIELD PROGRAM

Water sampling was conducted on January 27, May 10, June 29, July 25, August 4, and September 8, 1994, and February 8, May 16, June 19, July 24, and August 24, 1995 at the inlet or deepest point in Keller Lake (Table 3, Figure 2).

Physicochemical parameters measured in the field were Secchi depth, water temperature, pH, dissolved oxygen (DO), and conductivity. Field measurements were taken using a standard Secchi disk and a Hydrolab Surveyor II multiparameter meter; the Hydrolab unit was calibrated prior to and subsequent to daily use.

Samples were taken for laboratory analyses with a Kemmerer water bottle. Samples were labelled, preserved if necessary, and packed on ice in the field; samples were delivered by overnight carrier to the laboratory. All laboratory analyses were conducted at the State Laboratory of Hygiene (Madison, WI) using WDNR or APHA (8) methods. Spring parameters determined by the laboratory included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen,

Table 3. Sample Station Descriptions, Keller Lake, 1994 - 1995.

WATER QUALITY

Regular Monitoring

Site	**Description**	**Depth**
1901	Deepest point	12.0 feet
1902	Inlet	3.0 feet

Event Monitoring

Site	**Description**
GE1	Geskey Creek at junction with County Highway "E"
PE1	South Branch Pigeon River West of Hunting Road
PE2	South Branch Pigeon River at junction with Brewer Road
PE3	Small unnamed creek at junction with County "E"
PE4	South Branch Pigeon River at junction with County "E" near intersection with County "SS"
PE5	Unnamed creek at junction with Sabrowsky Road
PE6	Unnamed creek at junction with County "J"
PE7	South Branch Pigeon River at junction with Split Rock Road
PE8	Unnamed creek at junction with Split Rock Road (sample taken on North side of road)

MACROPHYTE TRANSECTS

Transect	Origin Latitude/Longitude		Transect Length (m)	Bearing (Degrees)
A	44° 38' 77"	88° 58' 97"	12.4	229°
B	44° 38' 77"	88° 58' 97"	26.8	12°
C	44° 38' 70"	88° 58' 96"	45.8	47°
D	44° 38' 67"	88° 58' 92"	38.1	158°
E	44° 38' 58"	88° 58' 71"	30.5	71°

Figure 2. Sample Station Locations, Keller Lake, Waupaca

County, WI, 1994 - 1995.

total phosphorus and dissolved phosphorus, total solids, and chlorophyll a. Summer and late summer laboratory analyses included total phosphorus, dissolved phosphorus, and chlorophyll a. Winter water quality parameters included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus.

In addition to regular monitoring sites, event (i.e., during or immediately after a major runoff or rain event) sampling was performed on March 7, April 25, June 13, July 5, and August 18, 1994 (Sites GE1, PE1, PE2, PE3, PE4, PE5, PE6, PE7 and PE8). Event sample laboratory analyses included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus.

An aquatic plant survey was conducted on July 6, 1994, using a method developed by Sorge et al and modified by the WDNR-Lake Michigan District (WDNR-LMD) for use in the Long Term Trend Monitoring Program (9). Transect endpoints were established on and off shore for use as reference. Points were determined using a Loran Voyager Sportnav latitude/longitude locator and recorded with bearing and distance of the transect (line of collection) for future surveys. Five transects were chosen and sampled to provide information from various habitats and areas of interest.

Data was recorded from three depth ranges, i.e., 0 to 0.5 meters (1.7 feet), 0.5 to 1.5 meters (5.0 feet), and 1.5 to 3.0 meters (10.0 feet), as appropriate along each transect. Plants were identified (collected for verification as appropriate), density ratings assigned (see below), and substrate type recorded along a six foot wide path on the transect using a garden rake, snorkel gear or SCUBA where necessary. Aquatic plant density ratings, assigned by species, were 1 = Rare, 2 = Occasional, 3 = Common, 4 = Very Common, and 5 = Abundant. These ratings were treated as numeric data points for the purpose of simple descriptive statistics in the Field Data Discussion section of this report.

OTHER

Water Quality Information

Additional lake information was retrieved from the WDNR Surface Water Inventory (4), the WDNR Wisconsin Lakes publication (6), and the Wisconsin Lake Bulletin Board System.

Land Use Information

Details of zoning and specific land uses were obtained from the UW-Extension, Waupaca County zoning maps, United States Soil Conservation Service soil maps (5), aerial photographs, and United States Geological Survey quadrangle maps. This information, when considered questionable or out-dated, was confirmed by field reconnaissance.

Ordinance information was taken from the Waupaca County Zoning Ordinance, and the Waupaca County Soil Erosion Control and Animal Wastewater Pollution Control Plans which were acquired from the Waupaca County Land Conservation Department.

Public Involvement Program

A summary of public involvement activities coordinated with the lake management planning process is outlined in Appendix I.

FIELD DATA DISCUSSION

Impoundments differ from natural lakes in that they characteristically have larger watersheds, exhibit periodic flushing, and "fill in". While natural lakes tend toward a state of dynamic equilibrium, the physical, chemical and biological characteristics of impoundments, especially small impoundments, are variable. Impoundments in general, have extensive shallow shelf areas, exhibit periodic flushing and "filling in" and are often prone to problems associated with non-point source nutrient and sediment inputs. Basin **morphometry** and chemical and biological dynamics are often directly related to the relatively extensive watersheds and effects of changing flow conditions in the parent river.

Keller Lake, by definition, is a drainage lake because it has a permanent inlet and outlet stream. Shoreline areas immediately adjacent to Keller Lake are predominantly wooded with low to moderate potential for surface runoff (Fig. 3).

Phosphorus is often the limiting major nutrient in algal and plant production in lakes. In-lake (station 1901) surface total

phosphorus during 1994 - 1995 monitoring ranged from 0.015 to 0.059 mg/l [Table 4 (summary statistics; average = 0.028, median

= 0.026, standard deviation (σ) = 0.013 mg/l)]. Total

phosphorus

Figure 3. Land Uses in the Keller Lake Watershed, Waupaca

County, WI.

at Station 1902 (Pigeon River inflow) ranged from 0.016 to 0.059 mg/l [Table 5 (average = 0.036, median = 0.036, σ = 0.013 mg/l)] over the same period. With the exception of inlet phosphorus on June 29, 1994, inlet and in-lake site phosphorus levels generally showed similar temporal trends (Fig. 4). Lowest concentrations of phosphorus occurred under winter conditions; highest levels were evident in summer.

In lake surface phosphorus levels during summer, 1994 and 1995 (0.026 to 0.059 mg/l; average = 0.034, median = 0.027, (σ) = 0.013 mg/l) at Site 1901 were, according to a recent compilation of summer total phosphorus levels in upper Midwestern lakes (10), relatively typical (.030 to .050 mg/l) for lakes in the transitional region in which Keller Lake is located. The average summer surface total phosphorus value for Keller Lake was somewhat lower than that found in a summary of 100 Wisconsin impoundments (ave. = 0.064, median = 0.035, σ = 0.100 mg/l) and well below that for impoundments with 0-14 day residence times (ave. = 0.094, median = 0.075, σ = 0.079) (11).

Nitrogen is highly variable among lakes and should only be related on a relative scale within the same lake. The total in-lake surface nitrogen levels ranged from 0.90 to 1.67 mg/l for the 1994 - 1995 monitoring period. The levels were slightly

higher than expected for impoundments (ave. = 1.06, median =
0.94,

Table 4. Water Quality Parameters, Station 1901, Keller Lake, Waupaca County, WI.

PARAMETER	SAMPLE[1]	DATE 1/27/94	5/10/94	6/29/94	7/25/94	8/4/94	9/8/94	2/8/95	5/16/95	6/19/95	7/24/95	8/24/95
Secchi (feet)		NR[2]	6.0	>10.0	>6.0	NR	7.2	NR	5.2	5.1	5.0	3.9
Cloud Cover (percent)		100	0	100	100	NR	0 NR	60	5	20	70	
Temperature (degrees Celsius)	S	0.34	13.91	21.23	19.52	NR	NR	0.76	14.44	26.83	24.33	NR
	B	0.42	13.43	21.17	NR	NR	16.75	NR	13.88	16.99	21.42	NR
pH (surface units)	S	6.45	7.08	7.80	7.46	NR	NR	7.30	7.79 8.26	8.72	7.8	
	B	6.40	7.05	7.80	NR	NR	7.68	NR	7.59 7.75	7.92	NR	
D.O. (mg/l)	S	11.76	10.0	9.46	7.34	NR	NR	13.22	9.95 8.21	10.87		NR
	B	11.40	9.79	9.27	NR	NR	8.42	NR	8.96 10.02	5.22 NR		
Conductivity (umhos/cm)	S	417	313	381	341	NR	374	461	322	433	423	307
	B	419	312	381	NR	NR	NR	NR	321	401	453	NR
Laboratory pH (surface units)	S	NR	8.13	NR	NR	NR	NR	NR	8.31 NR	NR	NR	
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Alkalinity (mg/l)	S	NR	164	NR	NR	NR	NR	NR	158	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Solids (mg/l)	S	NR	228	NR	NR	NR	NR	NR	220	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tot. Kjeld. Nitrogen (mg/l)	S	0.3	0.6	NR	NR	NR	NR	0.3	0.6	NR	NR	NR
	B	0.4	0.6	NR	NR	NR	NR	NR	0.8	NR	NR	NR
Ammonia Nitrogen (mg/l)	S	0.048	0.018	NR	NR	NR	NR	0.027	ND[3] NR	NR		NR
	B	0.066	0.019	NR	NR	NR	NR	NR	0.051	NR	NR	NR
$NO_2 + NO_3$ Nit. (mg/l)	S	1.25	0.310	NR	NR	NR	NR	1.37	0.302	NR	NR	NR
	B	1.29	0.356	NR	NR	NR	NR	NR	0.312	NR	NR	NR
Total Nitrogen (mg/l)	S	1.55	0.91	NR	NR	NR	NR	1.67	0.902	NR	NR	NR
	B	1.69	0.956	NR	NR	NR	NR	NR	1.112	NR	NR	NR
Total Phosphorus (mg/l)	S	0.015	0.024	0.026	NR	0.027	0.026[4]	0.012	0.023	0.027	0.037	0.059
	B	0.020	0.027	NR	NR	NR	NR	NR	0.044	0.460	0.101	0.077
Dissolved Phos. (mg/l)	S	0.009	0.002	ND	0.016	NR	ND	0.006	0.003	ND	0.003	0.028
	B	0.007	0.003	NR	NR	NR	NR	NR	0.008	0.014	0.005	0.039
Nit./Phos Ratio	S	103.3	37.9	--	--	--	--	139.2	39.22	--	--	--
	B	84.5	35.4	--	--	--	--	--	25.27	--	--	--
Chlorophyll a (ug/l)	S	NR	5.50	12.3	7.71	NR	12.8	NR	3.17 2.29	0.1	6.0	

[1] S = surface, B = bottom; [2] NR = no reading; [3] ND = not detectable; [4] holding time exceeded by SLOH

Table 5. Water Quality Parameters, Station 1902, Keller Lake - Inlet, Waupaca County, WI.

PARAMETER	SAMPLE[1]	1/27/94	5/10/94	6/29/94	7/25/94	8/4/94	9/8/94	2/8/95	5/16/95	6/19/95	7/24/95	8/24/95
Secchi (feet)		NR[2]	NR	>1.0	NR	NR	>1.0	NR	NR	NR	NR	NR
Cloud Cover (percent)		NR	100	90	100	NR	0	0	0	0	20	70
Temperature (degrees Celsius)	M	NR	NR	18.87	16.34	NR	14.56	NR	NR	25.89	24.98	NR
pH (surface units)	M	NR	NR	7.52	7.54	NR	7.50	NR	NR	8.07	8.47	NR
D.O. (mg/l)	M	NR	NR	NR	NR	NR	7.32	NR	NR	6.45	8.17	NR
Conductivity (umhos/cm)	M	NR	352	376	390	NR	395	NR	NR	471	416	NR
Laboratory pH (surface units)	M	NR	8.18	NR	NR	NR	NR	NR	8.25	NR	NR	NR
Total Alkalinity (mg/l)	M	NR	173	NR	NR	NR	NR	NR	163	NR	NR	NR
Total Solids (mg/l)	M	NR	236	NR	NR	NR	NR	NR	232	NR	NR	NR
Tot. Kjeld. Nitrogen (mg/l)	M	NR	0.5	NR	NR	NR	NR	0.4	0.8	NR	NR	NR
Ammonia Nitrogen (mg/l)	M	NR	0.015	NR	NR	NR	NR	ND	ND[3]	NR	NR	NR
NO_2 + NO_3 Nit. (mg/l)	M	NR	0.453	NR	NR	NR	NR	1.48	0.246	NR	NR	NR
Total Nitrogen (mg/l)	M	NR	0.953	--	NR	NR	NR	1.88	1.046	NR	NR	NR
Total Phosphorus (mg/l)	M	NR	0.021	0.048	NR	0.034	0.030[4]	0.016	0.038	0.036	0.042	0.059
Dissolved Phos. (mg/l)	M	NR	0.006	0.016	0.022	NR	0.006	0.007	0.004	0.012	0.007	0.026
Nit./Phos Ratio	M	NR	45.4	--	--	--	--	117.5	27.53	--	--	--
Chlorophyll a (ug/l)	M	NR	4.84	6.92	3.24	NR	5.22	NR	4.69	NR	0.08	NR

[1] M = mid-depth; [2] NR = no reading; [3] ND = not detectable;
[4] holding time exceeded by SLOH

Figure 4. Surface Total Phosphorus Levels, Keller Lake, 1994 - 1995.

σ = 0.54 mg/l), drainage lakes (ave. = 0.95, median = 0.83, σ = 0.55 mg/l), and lakes in the central region of Wisconsin (ave. = 0.72, median = 0.69, σ = 0.31 mg/l) (11). Inlet total nitrogen levels (ave. = 1.29, median = 1.05, σ = 0.51 mg/l) were slightly higher than those in-lake. Surface nitrogen to phosphorus ratios (**N/P ratio**) generally greater than 15 (for regular monitoring) indicated Keller Lake to be phosphorus limited.

__Figure 5. Surface Total Nitrogen Levels, Keller Lake, 1994 - 1995.

Significantly higher levels of total phosphorus [range: 0.019 mg/l (Site PE6) to 0.29 mg/l (Site PE1)] and total nitrogen [range: 0.65 mg/l (Site PE3) to 3.42 mg/l (Site PE7)] were observed during event monitoring (Tables 6 - 10). Highest total phosphorus levels, during a respective event, occurred at sites PE1, PE3, PE7, and PE8; site PE7 consistently exhibited the highest total nitrogen levels.

Table 6. Event Water Quality Parameters, Keller Lake, March 7, 1994.

PARAMETER	**SITE**								
	GE1	**PE1**	**PE2**	**PE3**	**PE4**	**PE5**	**PE6**	**PE7**	**PE8**
Total Kjeldahl N (mg/l)	**0.9**	**0.8**	**0.8**	**0.7**	**1.2**	**1.1**	**0.2**	**2.2**	**1.8**
Ammonia Nitrogen (mg/l)	**0.055**	**ND**	**0.095**	**0.056**	**0.150**	**0.183**	**ND**	**0.178**	**0.107**
NO_2 + NO_3 Nitrogen (mg/l)	**0.331**	**0.204**	**0.660**	**0.219**	**0.681**	**0.376**	**0.724**	**1.22**	**0.638**
Total Nitrogen (mg/l)	**1.231**	**1.004**	**1.46**	**0.919**	**1.881**	**1.476**	**0.924**	**3.42**	**2.438**
Total Phosphorus (mg/l)	**0.059**	**0.29**	**0.078**	**0.064**	**0.135**	**0.101**	**0.019**	**0.24**	**0.19**
Diss. Phosphorus (mg/l)	**0.014**	**0.232**	**0.040**	**0.028**	**0.064**	**0.040**	**0.013**	**0.080**	**0.049**
N/P Ratio	**20.86**	**3.46**	**18.72**	**14.36**	**13.93**	**14.61**	**48.63**	**14.25**	**12.83**

Table 7. Event Water Quality Parameters, Keller Lake, April 25, 1994.

PARAMETER	SITE								
	GE1	PE1	PE2	PE3	PE4	PE5	PE6	PE7	PE8
Total Kjeldahl N (mg/l)	1.0	0.8	0.8	0.7	0.7	0.8	0.9	1.0	0.7
Ammonia Nitrogen (mg/l)	0.029	0.034	0.032	0.052	0.035	0.052	0.017	0.054	0.019
NO_2 + NO_3 Nitrogen (mg/l)	0.122	0.171	0.253	0.134	0.215	0.090	0.040	0.385	0.173
Total Nitrogen (mg/l) 1.122	0.971	1.053	0.834	0.915	0.89	0.94	1.385	0.873	
Total Phosphorus (mg/l)	0.060	0.052	0.053	0.068	0.070	0.051	0.072	0.087	0.046
Diss. Phosphorus (mg/l)	0.009	0.009	0.016	0.020	0.017	0.011	0.023	0.025	0.014
N/P Ratio	18.7	18.67	19.87	12.26	13.07	17.45	13.01	15.92	18.98

Table 8. Event Water Quality Parameters, Keller Lake, June 13, 1994.

PARAMETER	SITE								
	GE1	PE1	PE2	PE3	PE4	PE5	PE6	PE7	PE8
Total Kjeldahl N (mg/l)	0.5	0.5	0.5	0.6	0.6	0.4	0.7	0.6	1.0
Ammonia Nitrogen (mg/l)	0.058	0.064	0.055	0.127	0.042	0.041	0.049	0.035	0.063
NO_2 + NO_3 Nitrogen (mg/l)	0.163	0.705	0.778	0.055	0.941	0.454	0.186	1.26	0.769
Total Nitrogen (mg/l) 0.663	1.205	1.278	0.655	1.541	0.854	0.886	1.86	1.769	
Total Phosphorus (mg/l)	0.045	0.034	0.032	0.068	0.030	0.048	0.067	0.040	0.058
Diss. Phosphorus (mg/l)	0.003	0.006	0.009	0.028	0.010	0.031	0.019	0.009	0.012
N/P Ratio	14.73	35.44	39.94	9.63	51.37	17.79	13.22	46.5	30.5

Table 9. Event Water Quality Parameters, Keller Lake, July 5, 1994.

PARAMETER	SITE								
	GE1	PE1	PE2	PE3	PE4	PE5	PE6	PE7	PE8
Total Kjeldahl N (mg/l)	0.5	1.3	1.0	0.7	0.9	0.8	0.6	0.7	1.3
Ammonia Nitrogen (mg/l)	0.064	0.055	0.065	0.099	0.053	0.057	0.046	0.037	0.065
NO_2 + NO_3 Nitrogen (mg/l)	0.211	0.019	0.796	0.021	0.936	0.316	0.388	1.40	0.632
Total Nitrogen (mg/l)	0.711	1.319	1.796	0.721	1.836	1.116	0.988	2.1	1.932
Total Phosphorus (mg/l)	0.045	0.066	0.067	0.101	0.065	0.120	0.083	0.058	0.122
Diss. Phosphorus (mg/l)	0.003	0.033	0.005	0.029	0.006	0.030	0.030	0.006	0.016
N/P Ratio	15.8	19.98	26.80	7.14	28.25	9.30	11.90	36.21	15.84

Table 10. Event Water Quality Parameters, Keller Lake, August 18, 1994.

PARAMETER	SITE								
	GE1	PE1	PE2	PE3	PE4	PE5	PE6	PE7	PE8
Total Kjeldahl N (mg/l)	NS[1]	0.51	0.47	0.85	0.52	0.64	0.94	0.65	0.76
Ammonia Nitrogen (mg/l)	NS	0.025	0.021	0.184	0.016	0.025	0.037	0.017	0.047
NO_2 + NO_3 Nitrogen (mg/l)	NS	0.779	0.969	0.079	1.25	0.335	0.683	1.59	1.33
Total Nitrogen (mg/l)	NS	1.289	1.439	0.929	1.77	0.975	1.623	2.24	2.09
Total Phosphorus (mg/l)	NS	0.026	0.030	0.097	0.031	0.080	0.082	0.034	0.045
Diss. Phosphorus (mg/l)	NS	0.002	0.006	0.024	0.010	0.026	0.029	0.006	0.011
N/P Ratio	NS	49.58	47.97	9.58	57.10	12.19	19.79	65.89	46.44

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[1] NS = no sample collected

Other indicators of lake **eutrophication** include light penetration and algal production. Numerous summarative indices have been developed to indicate lake eutrophication status based on water quality parameters. The Trophic State Index (TSI) developed by

Carlson (12) utilizes Secchi transparency, chlorophyll a, and total phosphorus. As with most indices, application is generally most appropriate on a relative and trend monitoring basis. This particular index does not account for natural, regional variability in total phosphorus levels nor in Secchi transparency reduction unrelated to algal growth (e.g. that associated with color). TSI numbers for the Keller Lake sampling sites generally indicated mesotrophic to eutrophic conditions for total phosphorus and oligotrophic to mesotrophic conditions for secchi depth and chlorophyll a (Fig. 6). No readily discernable trend was evident in recent data.

_Figure 6. Trophic State Index for Secchi Depth, Total Phosphorus and Chlorophyll a, Keller Lake, 1994 - 1995.

During aquatic plant surveys, aquatic plants (Table 11) were found at 14 of the 15 sample sites (sample sites = number of depth ranges sampled). Small duckweed (Lemna minor) and Coontail (Ceratophyllum demersum) were widely distributed (at 10 of 15 sites), and the most abundant macrophytes overall (Tables 12 and 13). Small duckweed, a small green surface plant with a single root, is very common and easily distributed by wind, or carried to new waters on the bodies of birds, muskrats and other animals (14). Coontail has worldwide range, is a submergent plant typically found on soft substrates, and often does well in turbid water where most plants do not. It is rated as a fair waterfowl food and provides fish forage and spawning habitat. Coontail has been known to reach nuisance levels and does so in part because the plant can grow to over six feet long with numerous branches (13). Thorny seeds are produced underwater during the growing season but coontail reproduces primarily by the formation of winter buds which fall to the bottom and form new plants in the Spring (14).

Common waterweed (Elodea canadensis) was also abundant (at 7 of 15 sites) and is also a common nuisance plant in Wisconsin (13). Common waterweed also favors soft substrates and grows completely submerged (rooted or free-floating) and often in thick beds. It is also a perennial and the plant can often survive under ice cover and thus get a earlier start than other plants in the

Spring. Reproduction is almost entirely by plant fragmentation and the plant foliage provides fair waterfowl food (14).

Purple loosestrife was not observed during the grant period but is established in other areas of Waupaca County with the capability of spreading. Purple Loosestrife is an exotic plant with a bright purple flower, originally propagated in the United States by the horticulture industry for flower gardens. It blooms late June to July and produces seeds soon after. The plant is able to outcompete native wetland vegetation and modify entire plant (and thus animal) assemblages.

Aquatic herbicide treatment, mechanical harvest, benthic barriers and SCUBA cutting, among others, were evaluated for aquatic plant control based upon their applicability for Keller Lake (Table 14). It is important to note that chemical treatment and mechanical harvesting are applicable for extensive or lake-wide treatments (e.g., acres); benthic barriers and SCUBA cutting are more intensive, localized applications, applicable for small treatment areas (e.g., square feet).

Table 11. Macrophyte Species Observed, Keller Lake, July, 1994.

Taxa	Code
Coontail (Ceratophyllum demersum)	CERDE
Common Waterweed (Elodea canadensis)	ELOCA
Filamentous algae	FILAL
Small duckweed (Lemna minor)	LEMMI
Water Milfoil (other than Eurasian)	MYRSPE
White water lily (Nymphaea sp.)	NYMSP
Yellow water lily (Nuphar sp.)	NUPSP
Leafy pondweed (Potamogeton foliosus)	POTFO
Broad-leaf cattail (Typha latifolia)	TYPLA
Pondweed (Potamogeton sp.)	POTSP

Table 12. Occurrence and Abundance of Macrophytes by Depth, Keller Lake, 1994.

CODE	Depth Ranges: 1 (N=5) % of Sites	1 (N=5) Abundance (range)	2 (N=5) % of Sites	2 (N=5) Abundance (range)	3 (N=5) % of Sites	3 (N=5) Abundance (range)
LEMMI	100	10 (1-3)	100	8 (1-3)	20	1 (1)
CERDE	80	8 (1-3)	80	11 (2-4)	60	6 (1-3)
ELOCA	60	7 (2-3)	60	6 (1-3)	20	1 (1)
FILAL	60	6 (1-3)	80	8 (1-3)	20	1 (1)
MYRSPE	20	3 (3)	20	2 (2)	0	0 (0)
NYMSP	0	0 (0)	20	1 (1)	0	0 (0)
NUPSP	40	5 (2-3)	60	5 (1-2)	40	3 (1-2)
POTFO	20	2 (2)	0	0 (0)	0	0 (0)
TYPLA	20	2 (2)	0	0 (0)	0	0 (0)
POTSP	20	4 (4)	60	11 (1-4)	40	5 (2-3)

Table 13. Abundance Distribution and Substrate Relations for Selected Macrophytes, Keller Lake, July, 1994.

Transect	Substrate	Species Code: CERDE	ELOCA	FILAL	LEMMI	MYRSPE	NYMSP	NUPSP	POTFO	TYPLA	POTSP
A1	sand/silt/detritus	0	0	2	2	0	0	0	0	2	0
A2	sand/silt/detritus	0	0	1	1	0	0	0	0	0	0
A3	sand/silt/detritus/ gravel/rock	0	0	1	1	0	0	0	0	0	0
B1	muck/rock	2	2	3	3	0	0	0	2	0	0
B2	muck 2	2	3	3	0	1		0 0	0	1	
B3	sand/silt/muck/rock	0	0	0	0	0	0	0	0	0	0
C1	sand/silt/rock	3	2	1	2	0	0	2	0	0	0
C2	silt	4	1	3	1	0	0	2	0	0	3
C3	silt	0	0	0	0	0	0	0	0	0	0
D1	sand/rock/silt	1	0	0	2	0	0	0	0	0	0
D2	silt/sand/gravel/rock	3	0	1	2	0	0	2	0	0	3
D3	silt/sand/gravel/rock	2	0	0	0	0	0	2	0	0	2
E1	sand/silt	2	3	0	1	3	0	1	0	0	4
E2	silt/sand/rock	2	3	0	1	2	0	1	0	0	4
E3	silt/sand/rock	3	1	0	0	0	0	0	0	0	3

Table 14. Comparison of Aquatic Plant Control Alternatives for Keller Lake, Waupaca County, WI.

	MECHANICAL HARVESTING	AQUATIC HERBICIDES	DREDGE	ROTOTIL	SCUBA	BOTTOM SCREENS	DRAWDOWN	BIOLOGICAL
Effects on Ecosystem	Removes plant material, some small fish	possible residual effects	removes preferred habitat, disturbs sediment	disturbs sediments	removes plant material	covers plants	decreased water quality downstream, possible fishery effects	needs more research
Effective Large-scale	yes	yes	yes	yes	no	no	yes	yes
Effective Small-scale	no	yes	yes	no	yes	yes	no	no
Species Selective	possibly	possibly	yes	no	yes	no	no	yes
Removes Nutrients	yes	no	yes	no	yes	no	no	no
WDNR Acceptability	high-minimal environmental impacts	medium-permit required	low-many environmental impacts	medium-sediment impacts	high-minimal impacts	medium-for small areas permit required	medium-limited success	low-many unknowns
Public Acceptability	high-immediate benefits	medium/low-many "anti-chemical" advocates	medium	medium/low-new technology	high-immediate effects	medium-difficult to maintain	medium/high-will allow frontage clean-up	low
Specific Concerns	basin config cut depth bottom materials	downstream effects	cost bottom materials	basin config cost	moderate sediment	vandalism	downstream effects	unknown

Table format taken from "Minnesota Aquatic Plant Control Draft Reconnaissance Report," August 1989.

BASELINE CONCLUSIONS

Keller Lake is a small impoundment of the Pigeon River located in the Towns of DuPont and Wyoming, north central Waupaca County. Physical characteristics of the impoundment make Keller Lake prone to sedimentation, prolific plant growth, non-point source nutrient inflows, and variable water quality as affected by parent river watershed and flow conditions.

Overall, water quality is fair to good for all parameters measured and generally indicated mesotrophic to eutrophic classifications. Nitrogen levels, despite a primarily forested watershed, were slightly higher than expected for natural lakes in the region and higher than average for impoundments. Other nutrient parameters were below expected levels for lakes in the region or impoundments. Event samples also showed considerably higher (but variable) levels of nutrients entering the system during/after major runoff events.

Water clarity was poor to very poor which is attributable to the dark color of the Pigeon River and turbidity from relatively high flushing. These conditions of reduced water clarity appear to enhance the growth potential for milfoil and Coontail since both species have a high tolerance for conditions that would inhibit other plants, such as fluctuating water levels and turbidity (14).

Macrophytes are considered an increasing problem in Keller Lake due to increasing nutrient and sediment inputs. Aesthetic appeal for lake users (accentuated by County Park status for the lake), is being compromised by the aquatic plant conditions. Continued development of current weed conditions will also have negative impact on the lake fishery (loss of spawning areas, increased risk of dissolved oxygen depletion, etc.).

Waupaca County has well established areas of Eurasian milfoil and Purple loosestrife which may serve as sources for these exotic and harmful species. Introduction of these plants to Keller Lake via resource users carries a high potential. Public education regarding recognition and preventative measures to stop their spread must be encouraged. Eradication/control strategies, in the eventuality that any exotic becomes established, must be developed.

MANAGEMENT ALTERNATIVES DISCUSSION

WATER QUALITY AND SEDIMENTATION

Keller Lake, as an impoundment, has basin characteristics which make it prone to sedimentation, non-point source runoff and changing water quality. Water quality is good but macrophyte growth has increased and is dominated by a few species at potentially nuisance levels. Sedimentation is probably significant and may be severe, especially in the upstream reaches of the impoundment. The silt contributes to the weed problem by providing absorbed nutrients such as phosphorus which can lead to algae blooms and excessive rooted aquatic vegetation.

Before drastic management measures are taken to reclaim or "rejuvenate" the resource, steps must be taken to reduce sediment and nutrient inputs to the extent possible and/or practical. Efforts should be made to identify runoff or erosion prone areas and control nutrient and sediment inflows on a watershed-wide basis. Major emphasis should be given to implementation of BMP's to reduce these loadings and inputs within the drainage basin. Activities covered under the heading of BMP are addressed in Appendix II. Applicable practices for the Keller Lake watershed include: streamside management zones, range and pasture management, maintenance of natural waterways, conservation tillage, and any techniques related to erosion control from forested lands.

Lake perimeter erosion and nutrient control, relate directly to park operation and maintenance and visitor intensity. Footpaths, parking areas, and roadways represent potential sources for lake sediments; control measures to reduce wind and/or water movement of particulates from these sources to the lake should be implemented. Park visitors should be informed about restroom availability and trash disposal facilities to assist in nutrient control. If park maintenance requires "leaf collection and disposal", composting piles or fire pits should be well away from the lake to prevent nutrient loading (15). The application of fertilizers in the immediate lake area should be discouraged.

A number of informational sources regarding land management are outlined in Appendix III.

MACROPHYTES

Management of macrophyte populations is often a major objective for lakes and particularly shallow impoundments. Macrophytic growth can positively affect the resource through fish forage and wildlife production/protection, shoreline stabilization and nutrient uptake. Nuisance levels of macrophytes, however, can cause organic sediment build-up, preclude development of desirable diverse plant populations, reduce aesthetics, reduce DO (potential fishkills), impair recreational use and contribute to the development of stunted panfish populations. Macrophyte management should be carefully implemented and may consider different use areas of the lake. Numerous methods of macrophyte control and management are available ranging from radical habitat alteration to more subtle habitat manipulation and are discussed below relative to Keller Lake applicability..

Dredging is a drastic and costly form of habitat alteration. Before any dredge plan is developed or implemented on Keller Lake, the lake bottom must be studied (chemical and physical features) and steps must be taken to ensure the dredging will be cost-effective (i.e., last as long as possible). Only when erosion and nutrient control measures are implemented (to the extent practical) on a watershed-wide basis, should a dredging plan be considered. A dredge plan should involve as little sediment removal as possible to create access and edge (removal to a depth at which macrophyte growth would be retarded due to reduced sunlight). A basic plan for Keller Lake could involve dredging a relatively small area in the upstream reach (wildlife/fish production/protection zone) as a catchment basin for future sedimentation and a larger area in the lower reaches adjacent to deepest areas for increased access and edge.

Chemical treatment for macrophyte control has been shown to eradicate some undesirable species and leave others intact. The WDNR strongly discourages the use of chemicals because of nutrient release, oxygen depletion, sediment accumulation, bioaccumulation and other unknown environmental hazards including invasion potential from nuisance exotics. Chemical effects are nondiscriminate and may harm desirable or beneficial plant populations. Chemical use in the past has shown no lasting effect on controlling plant populations and should not be considered for Keller Lake at this time.

Aquatic plant screens have been shown to reduce plant densities in other lakes and may be applicable in near-shore areas here. A fiberglass screen or plastic sheet is placed and anchored on the sediment to prevent plants from growing. This may also make some sediment nutrients unavailable for algal growth. Screens should be removed each fall and cleaned in order to last a number of years. Screens are generally used in small areas of concern, e.g., around beaches, landings or piers. The Keller Lake beach/access area may be suitable for screening, although relatively high visitor use in this area might promote vandalism problems.

Installation of floating platforms (black plastic attached to restrict plant growth and help to open corridors for swimming or boat navigation. Shading is usually required for three weeks to two months to impact nuisance plant growth (16). A drawback is that the area cannot be used while the platform is in place. This control technique is not recommended for Keller Lake at this time.

Remaining control methods consist, in one form or another, of macrophyte harvest. It is a commonly used technique which can be applied on a widespread or localized basis. Its efficiency, based on method of harvest, can vary substantially with depth and lake basin configuration. Several conditions should be considered with respect to macrophyte harvest. Macrophyte growth on Keller Lake is dense and widespread; even intense harvest efforts will probably not manage all areas of concern in the impoundment. Milfoils, coontail and common waterweed all spread easily by fragmentation; strong consideration should be given to the potential of these species to become even more dominant by becoming better established where competing macrophytes have been removed. Macrophyte harvesting is typically conducted with a mechanical harvester which cuts the vegetation and removes (harvests) it onto a platform for out-lake disposal. Given the precautions regarding potential nuisance species dispersal and the ability of some plants to survive and spread when detached from the substrate, harvest practices may even enhance the nuisance macrophyte problem through seed dispersal, fragmentation or incomplete removal. Harvest is, however, area selective, relatively inexpensive and removes nutrients from the lake system.

SCUBA assisted harvest has also been shown to selectively manage macrophytes. It can be used in deeper areas and to target only specific species or nuisance growth areas. This method is labor intensive, but has effectively reduce nuisance plant levels for up to two years (17). Because only limited areas are available for potential macrophyte management in Keller Lake, SCUBA assisted harvest may be a viable option.

Raking weeds (using an ordinary garden rake) in the near shore zone can be a very effective localized plant control method when done on a regular basis. Concerned individuals, lake users and/or landowners may want to organize a concentrated effort on individual problem areas using this specific method. This option appears viable for the Keller Lake beach/access area to improve aesthetics and reduce efforts expended on other control methods.

A newer technique of rototilling sediments to destroy plant roots appears to be effective in controlling plant growth for relatively longer period than harvesting. The process is about a the same cost per hour as a contracted macrophyte harvester (18). A potential problem is disturbance of the sediments and resuspension of nutrients.

Any macrophyte management efforts should be proceeded or accompanied by landowner/resource user education and watershed-wide best management practices (BMP's) to reduce nutrient and sediment inflows. Macrophyte management, in addition to enhancing the aesthetic aspects of Keller Lake will also, at least marginally, improve the fish habitat.

MANAGEMENT RECOMMENDATIONS

1). Maintain/improve water quality and reduce lake sedimentation through a watershed-wide BMP implementation and educational program. With assistance from Waupaca and Shawano Counties, the Keller Lake watershed should be approached as if it were a priority watershed. A reconnaisance of the watershed would pin-point agricultural and most concerned areas contributing to excess sedimentation and nutrient input. Landowners should then be educated and given viable options on how certain BMP'S could be implemented.

2.) Land use practices should reflect current advances in erosion control (conservation tillage, use of buffer strips, vegetated drainage ways, etc.) and nutrient control (limited fertilizer application, proper manure handling, etc.). Protective legislation, drafted at the local (township and county) and State levels, should be encouraged. Efforts should continue to pursue the designation of the Pigeon River Watershed as a priority watershed to obtain cost-share funding to implement long term conservation practices. Waupaca County ordinances and plans possibly pertinent to Keller Lake are summarized in Appendix IV.

3). Land purchase may be pursued for wetland protection near the impoundment and/or throughout the watershed. Wetland protection will help to increase awareness and protect water quality. Potential sources of funding are listed in Appendix V.

4). Upgrade park operation and maintenance practices to minimize immediate lake perimeter damage due to visitor use. Access roads, pathways, and parking areas, should be assessed for erodibility and improvements made as needed. Park users should be encouraged to "pack-out" recyclable and trash materials.

5). Localized and limited macrophyte control should be used to improve lake aesthetics to the extent warranted by park visitation. Documentation of park use may be required to assess the cost/benefit ratio for macrophyte control.

6). Relatively little is known about historic water quality on Keller Lake; efforts should be made to continue regular water quality monitoring. Monitoring should also include event testing of areas of concern (e.g., South Branch Pigeon River at junction with Split Rock Road and West of Hunting Road, small unnamed creek at junction with County "E" and unnamed creek at junction with Split Rock Road). Regular monitoring should be conducted in a similar schedule; event testing should be conducted after major rain or snowmelt runoff events. Self-Help secchi disk monitoring should be continued by volunteers.

7). The introduction of exotic species (e.g., Purple loosestrife or Eurasian milfoil) may be slowed or prevented by posting signs, providing brochures or other materials to educate the public about harmful, invasive species and their prevention.

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APPENDIX I

SUMMARY OF PUBLIC INVOLVEMENT ACTIVITIES

Keller Lake Management Plan

The Waupaca County Land Conservation Committee initiated steps to develop comprehensive lake management plans under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program in the fall of 1993. The grant was received on October 25, 1993. A public involvement program was immediately initiated as part of the planning process. The following is a summary of major public involvement efforts.

Planning Advisory Committee

An advisory committee comprised of representatives from WDNR, IPS, and Waupaca County was established at the start of the program. The committee provided direction during the planning program and served as main reviewer of the draft plan documents.

Print Media

An IPS newsletter entitled "Lake Management News" was developed and distributed for the Board's use and distribution to the public. A special "Keller Lakes Edition" was also developed to notify the committee of any late developments in the planning program.

A draft and final report on the information and analyses conducted was prepared and distributed to the DNR - Lake Michigan District, Waupaca County Water Quality Advisory Committee, the townships of DuPont and Wyoming, and other interested parties.

Meetings

IPS presented a progress report and provided information about the resource to the Waupaca County Water Quality Advisory Committee in March of 1996. A public meeting will be held to inform local citizens and landowners of the recommendations developed during Phase I of the Keller Lake Management Plan.

APPENDIX II
Review of Best Management Practices (BMP's)(1)

Conservation Tillage: A farming practice that leaves stalks or stems and roots intact in the field after harvest. Its purpose is to reduce water runoff and soil erosion compared to conventional tillage where the topsoil is mixed and turned over by a plow. Conservation tillage is an umbrella term that includes any farming practice that reduces the number of times the topsoil is mixed. Other terms that are used instead of conservation tillage are (1) minimum tillage where one or more operations that mixed the topsoil are eliminated; and (2) no-till where the topsoil is left essentially undisturbed.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Fair to excellent, decreases sediment input to streams and lakes. (40-90% reduced tillage, 50-95% no tillage).
	b) Nitrogen (N)	Poor, no effect on nitrogen input to streams and lakes.
	c) Phosphorus (P)	Fair to excellent, can reduce the amount of phosphorus input to streams and lakes. (40-90% reduced tillage, 50-95% no tillage).
	d) Runoff	Fair to excellent, decreases amount of water running off fields carrying sediment and phosphorus.
2.	Capital Costs	High, because requires purchase of new equipment by farmer.
3.	Operation and Maintenance	Less expensive than conventional tillage. Potential increase in herbicide costs. Potential increase in net farm income.
4.	Longevity	Good, approximately every five years the soil has to be turned over.
5.	Confidence	Fair to excellent.
6.	Adaptability	Good, but may be limited in northern areas that experience late cool springs, or in heavy, poorly drained soils.
7.	Potential Treatment Side Effects	Potential increase in herbicide effects and insecticide contamination of surface and groundwater. Nitrogen contamination of groundwater.
8.	Concurrent Land Management Practices	Consider fertilizer management and integrated pest management.

Integrated Pest Management: Pests are any organisms that are harmful to desired plants, and they are controlled with chemical agents called pesticides. Integrated pest management considers factors such as how much pesticide is enough to control a problem, the best method of applying the pesticides, the appropriate time for application and the safe handling, storage and disposal of pesticides and their containers. Other considerations include using resistant crop varieties, optimizing crop planting time, optimizing time of day application, rotating crops and biological controls.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	No effect, but pesticides attached to soil particles can be carried to streams and lakes.
	b) Nitrogen (N)	No effect.
	c) Phosphorus (P)	No effect.
	d) Runoff	No effect, but water is the primary route for transporting pesticides to lakes and streams.
2.	Capital Costs	No effect.
3.	Operation and Maintenance	Farming cost, potential reduction in pesticide costs and an increase in net farm income.
4.	Longevity	Poor, as pesticides are applied one or more times per year to address different pests and different crops.
5.	Confidence	Fair to excellent, reported pollutant reductions range from 20-90%.
6.	Adaptability	Methods are generally applicable wherever pesticides are used: forest, farms, homes.
7.	Potential Treatment Side Effects	Potential for ground and surface water contamination. Toxic components may be available to aquatic plants and animals.
8.	Concurrent Land Management Practices	See crop rotation, conservation tillage.

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Street Cleaning: Streets and parking lots can be cleaned by sweeping which removes large dust and dirt particles or by flushing which removes finer particles. Sweeping actually removes solids so pollutants do not reach receiving waters. Flushing just moves the pollutants to the drainage system unless the drainage system is part of the sewer system. When the drainage system is part of the sewer system, the pollutants will be treated as wastes in the sewer treatment plant.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Poor, not proven to be effective.
	b) Nitrogen (N)	Poor, not proven to be effective.
	c) Phosphorus (P)	Poor, not proven to be effective.
	d) Runoff	No effect.
2.	Capital Costs	High, because it requires the purchase of equipment by community.
3.	Operation and Maintenance	Unknown but reasonable vehicular maintenance would be expected.
4.	Longevity	Poor, have to sweep frequently throughout the year.
5.	Confidence	Poor.
6.	Adaptability	To paved roads, might not be considered a worthwhile expenditure of funds in communities less than 10,000.
7.	Potential Treatment Side Effects	Unknown.
8.	Concurrent Land Management Practices	Detention/Sedimentation basins.

Streamside Management Zones (Buffer strips): Considerations in streamside management include maintaining the natural vegetation along a stream, limiting livestock access to the stream, and where vegetation has been removed, planting buffer strips. Buffer strips are strips of plants (grass, trees, shrubs) between a stream and an area being disturbed by man's activities that protects the stream from erosion and nutrient impacts.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good to excellent, reported to reduce sediment from feedlots on 4% slope by 79%.
	b) Nitrogen (N)	Good to excellent, reported to reduce nitrogen from feedlots on 4% slope by 84%.
	c) Phosphorus (P)	Good to excellent, reported to reduce phosphorus from feedlots on 4% slope by 67%.
	d) Runoff	Good to excellent, reported to reduce runoff from feedlots on 4% slope by 67%.
2.	Capital Costs	Good, moderate costs for fencing material to keep out livestock and for seeds for plants.
3.	Operation and Maintenance	Excellent, minimal upkeep.
4.	Longevity	Excellent, maintains itself indefinitely.
5.	Confidence	Fair, because of the lack of intensive scientific research.
6.	Adaptability	May be used anywhere. Limitations on types of plants that may be used between geographic areas.
7.	Potential Treatment Side Effects	With trees, shading may increase the diversity and number of organisms in the stream with the possible reduction of algae.
8.	Concurrent Land Management Practices	Conservation tillage, animal waste management, livestock exclusion, fertilizer management, pesticide management, ground cover maintenance, proper construction, use, maintenance of haul roads and skid trails.

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Contour Farming: A practice where the farmer plows across the slope of the land. This practice is applicable on farm land with a 2-8 percent slope.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Good on moderate slopes (2 to 8 percent slopes), fair on steep slopes (50 percent reduction).**
	b) Nitrogen (N)	**Unknown.**
	c) Phosphorus (P)	**Fair.**
	d) Runoff	**Fair to good, depends on storm intensity.**
2.	**Capital Costs**	**No special effect.**
3.	**Operation and Maintenance**	**No special effect.**
4.	**Longevity**	**Poor, it must be practiced every time the field is plowed.**
5.	**Confidence**	**Poor, not enough information.**
6.	**Adaptability**	**Good, limited by soil, climate, and slope of land. May not work with large farming equipment on steep slopes.**
7.	**Potential Treatment Side Effects**	**Side effects not identified.**
8.	**Concurrent Land Management Practices**	**Fertilizer management, integrated pesticide management, possibly streamside management.**

Contour Stripcropping: This practice is similar to contour farming where the farmer plows across the slope of the land. The difference is that strips of close growing crops or meadow grasses are planted between strips of row crops like corn or soybeans. Whereas contour farming can be used on 2-8 percent slopes, contour stripcropping can be used on 8-15 percent slopes.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Good, 8 to 15 percent slopes, provides the benefits of contour plowing plus buffer strips.**
	b) Nitrogen (N)	**Unknown, assumed to be fair to good.**
	c) Phosphorus (P)	**Unknown, assumed to be fair to good.**
	d) Runoff	**Good to excellent.**
2.	**Capital Costs**	**No special effect unless farmer cannot use the two crops.**
3.	**Operation and Maintenance**	**No special effect.**
4.	**Longevity**	**Poor, must be practiced year after year.**
5.	**Confidence**	**Poor, not enough information.**
6.	**Adaptability**	**Fair to good, may not work with large farming equipment on steep slopes.**
7.	**Potential Treatment Side Effects**	**Side effects not identified.**
8.	**Concurrent Land Management Practices**	**Fertilizer management, integrated pesticide management.**

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Range and Pasture Management: The objective of range and pasture management is to prevent overgrazing because of too many animals in a given area. Management practices include spreading water supplies, rotating animals between pastures, spreading mineral and feed supplements or allowing animals to graze only when a particular plant food is growing rapidly.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good, prevents soil compaction which reduces infiltration rates.
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Good, maintains some cover which reduces runoff rates.
2.	Capital Costs	Low, but may have to develop additional water sources.
3.	Operation and Maintenance	Low.
4.	Longevity	Excellent.
5.	Confidence	Good to excellent. Farmer must have a knowledge of stocking rates, vegetation types, and vegetative conditions.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Livestock exclusion, riparian zone management and crop rotation.

Crop Rotation: Where a planned sequence of crops are planted in the same area of land. For example, plow based crops are followed by pasture crops such as grass or legumes in two to four year rotations.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good when field is in grasses or legumes.
	b) Nitrogen (N)	Fair to good.
	c) Phosphorus (P)	Fair to good.
	d) Runoff	Good when field is in grasses or legumes.
2.	Capital Costs	High if farm economy reduced. Less of a problem with livestock which can use plants as food.
3.	Operation and Maintenance	Moderate, increased labor requirements. May be offset by lower nitrogen additions to the soil when corn is planted after legumes, and reduction in pesticide application.
4.	Longevity	Good.
5.	Confidence	Fair to good.
6.	Adaptability	Good, but some climatic restrictions.
7.	Potential Treatment Side Effects	Reduction in possibility of groundwater contamination.
8.	Concurrent Land Management Practices	Range and pasture management.

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Terraces: Terraces are used where contouring, contour strip cropping, or conservation tillage do not offer sufficient soil protection. Used in long slopes and slopes up to 12 percent; terraces are small dams or a combination of small dams and ditches that reduce the slope by breaking it into lesser or near horizontal slopes.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Fair to good.**
	b) Nitrogen (N)	**Unknown.**
	c) Phosphorus (P)	**Unknown.**
	d) Runoff	**Fair, more effective in reducing erosion than total runoff volume.**
2.	**Capital Costs**	**High initial costs.**
3.	**Operation and Maintenance**	**Periodic maintenance cost, but generally offset by increased income.**
4.	**Longevity**	**Good with proper maintenance.**
5.	**Confidence**	**Good to excellent.**
6.	**Adaptability**	**Fair, limited to long slopes and slopes up to 12 percent.**
7.	**Potential Treatment Side Effects**	**If improperly designed or used with poor cultural and management practices, they may increase soil erosion.**
8.	**Concurrent Land Management Practices**	**Fertilizer and pesticide management.**

Animal Waste Management: A practice where animal wastes are temporarily held in waste storage structures until they can be utilized or safely disposed. Storage units can be constructed or reinforced concrete or coated steel. Wastes are also stored in earthen ponds.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Not applicable.**
	b) Nitrogen (N)	**Good to excellent.**
	c) Phosphorus (P)	**Good to excellent.**
	d) Runoff	**Not applicable.**
2.	**Capital Costs**	**High because of the necessity of construction and disposal equipment.**
3.	**Operation and Maintenance**	**Unknown.**
4.	**Longevity**	**Unknown.**
5.	**Confidence**	**Fair to excellent if properly managed.**
6.	**Adaptability**	**Good.**
7.	**Potential Treatment Side Effects**	**The use of earthen ponds can possibly lead to groundwater contamination.**
8.	**Concurrent Land Management Practices**	**Fertilizer management.**

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Nonvegetative Soil Stabilization: Examples of temporary soil stabilizers include mulches, nettings, chemical binders, crushed stone, and blankets or mats from textile material. Permanent soil stabilizers include coarse rock, concrete, and asphalt. The purpose of soil stabilizers is to reduce erosion from construction sites.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Excellent.**
	b) Nitrogen (N)	**Poor.**
	c) Phosphorus (P)	**Poor.**
	d) Runoff	**Poor on steep slopes with straw mulch, otherwise good.**
2.	**Capital Costs**	**Low to high, depending on technique applied.**
3.	**Operation and Maintenance**	**Moderate.**
4.	**Longevity**	**Generally a temporary solution until a more permanent cover is developed. Excellent for permanent soil stabilizer.**
5.	**Confidence**	**Good.**
6.	**Adaptability**	**Excellent.**
7.	**Potential Treatment Side Effects**	**No effect on soluble pollutants.**
8.	**Concurrent Land Management Practices**	**Runoff detention/retention.**

Porous Pavement: Porous pavement is asphalt without fine filling particles on a gravel.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Good.**
	b) Nitrogen (N)	**Good.**
	c) Phosphorus (P)	**Good.**
	d) Runoff	**Good to excellent.**
2.	**Capital Costs**	**Moderate, slightly more expensive than conventional surfaces.**
3.	**Operation and Maintenance**	**Potentially expensive, requires regular street maintenance program and can be destroyed in freezing climates.**
4.	**Longevity**	**Good, with regular maintenance (i.e., street cleaning), in southern climates. In cold climates, freezing and expansion can destroy.**
5.	**Confidence**	**Unknown.**
6.	**Adaptability**	**Excellent.**
7.	**Potential Treatment Side Effects**	**Groundwater contamination from infiltration of soluble pollutants.**
8.	**Concurrent Land Management Practices**	**Runoff detention/retention.**

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Flood Storage (Runoff Detention/Retention): Detention facilities treat or filter out pollutants or hold water until treated. Retention facilities provide no treatment. Examples of detention/retention facilities include ponds, surface basins, underground tunnels, excess sewer storage and underwater flexible or collapsible holding tanks.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Poor to excellent, design dependent.
	b) Nitrogen (N)	Very poor to excellent, design dependent.
	c) Phosphorus (P)	Very poor to excellent, design dependent.
	d) Runoff	Poor to excellent, design dependent.
2.	Capital Costs	Dependent on type and size. Range from $100 to $1,000, per acre served, depending on site. These costs include capital costs and operational costs.
3.	Operation and Maintenance	Annual cost per acre of urban area served has ranged from $10 to $125 depending on site.
4.	Longevity	Good to excellent, should last several years.
5.	Confidence	Good, if properly designed.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	Groundwater contamination with retention basins.
8.	Concurrent Land Management Practices	Porous pavements.

Sediment Traps: Sediment traps are temporary structures made of sandbags, straw bales, or stone. Their purpose is to detain runoff for short periods of time so heavy sediment particles will drop out. Typically, they are applied within and at the periphery of disturbed areas.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good, coarse particles.
	b) Nitrogen (N)	Poor.
	c) Phosphorus (P)	Poor.
	d) Runoff	Fair.
2.	Capital Costs	Low.
3.	Operation and Maintenance	Low, require occasional inspection and prompt maintenance.
4.	Longevity	Poor to good.
5.	Confidence	Poor.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Agricultural, silviculture or other construction best management practices could be incorporated depending on situation.

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Surface Roughening: On construction sites, the surface of the exposed soil can be roughened with conventional construction equipment to decrease water runoff and slow the downhill movement of water. Grooves are cut along the contour of a slope to spread runoff horizontally and increase the water infiltration rate.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Good.**
	b) Nitrogen (N)	**Unknown.**
	c) Phosphorus (P)	**Unknown.**
	d) Runoff	**Good.**
2.	**Capital Costs**	**Low, but requires timing and coordination.**
3.	**Operation and Maintenance**	**Low, temporary protective measure.**
4.	**Longevity**	**Short-term.**
5.	**Confidence**	**Unknown.**
6.	**Adaptability**	**Excellent.**
7.	**Potential Treatment Side Effects**	**None identified.**
8.	**Concurrent Land Management Practices**	**Nonvegetative soil stabilization.**

Riprap: A layer or loose rock or aggregate placed over a soil surface susceptible to erosion.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Good, based on visual observations.**
	b) Nitrogen (N)	**Unknown.**
	c) Phosphorus (P)	**Unknown.**
	d) Runoff	**Poor.**
2.	**Capital Costs**	**Low to high, varies greatly.**
3.	**Operation and Maintenance**	**Low.**
4.	**Longevity**	**Good, with proper rock size.**
5.	**Confidence**	**Poor to good.**
6.	**Adaptability**	**Excellent.**
7.	**Potential Treatment Side Effects**	**In streams, erosion may start in a new, unprotected place.**
8.	**Concurrent Land Management Practices**	**Streamside (lake) management zone.**

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Interception or Diversion Practices: Designed to protect bottom land from hillside runoff, divert water from areal sources of pollution such as barnyards or to protect structures from runoff. Diversion structures are represented by any modification of the surface that intercepts or diverts runoff so that the distance of flow to a channel system is increased.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Fair to good (30 to 60 percent reduction).
	b) Nitrogen (N)	Fair to good (30 to 60 percent reduction).
	c) Phosphorus (P)	Fair to good (30 to 60 percent reduction).
	d) Runoff	Poor, not designed to reduce runoff but divert runoff.
2.	Capital Costs	Moderate to high, may entail engineering design and structures.
3.	Operation and Maintenance	Fair to good.
4.	Longevity	Good.
5.	Confidence	Poor to good, largely unknown.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Since the technique can be applied under multiple situations (i.e., agriculture, silviculture, construction) appropriate best management practices associated with individual situations should also be applied.

Grassed Waterways: A practice where broad and shallow drainage channels (natural or constructed) are planted with erosion-resistant grasses.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good to excellent (60 to 80 percent reduction).
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Moderate to good.
2.	Capital Costs	Moderate.
3.	Operation and Maintenance	Low, but may interfere with the use of large equipment.
4.	Longevity	Excellent.
5.	Confidence	Good.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Conservative tillage, integrated pest management, fertilizer management, animal waste management.

APPENDIX II
Review of Best Management Practices (BMP's)
(continued)

Maintain Natural Waterways: This practice disposes of tree tops and slash in areas away from waterways. Prevents the buildup of damming debris. Stream crossings are constructed to minimize impacts on flow characteristics.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Fair to good, prevents acceleration of bank and channel erosion.**
	b) Nitrogen (N)	**Unknown, contribution would be from decaying debris.**
	c) Phosphorus (P)	**Unknown, contribution would be from decaying debris.**
	d) Runoff	**Fair to good, prevents deflections or constrictions of stream water flow which may accelerate bank and channel erosion.**
2.	**Capital Costs**	**Low, supervision required to ensure proper disposal of debris.**
3.	**Operation and Maintenance**	**Low, if proper supervision during logging is maintained, otherwise $160-$800 per 100 ft stream.**
4.	**Longevity**	**Good.**
5.	**Confidence**	**Good.**
6.	**Adaptability**	**Excellent.**
7.	**Potential Treatment Side Effects**	**None identified.**
8.	**Concurrent Land Management Practices**	**Proper design and location of haul and skid trails; Streamside management zones.**

Haul Roads and Skid Trails: This practice is implemented prior to logging operations. It involves the appropriate site selection and design of haul road and skid trails. Haul roads and skid trails should be located away from streams and lakes. Recommended guidelines for gradient, drainage, soil stabilization, and filter strips should be followed. Routes should be situated across slopes rather than up or down slopes. If the natural drainage is disrupted, then artificial drainage should be provided. Logging operations should be restricted during adverse weather periods. Other goods practices include ground covers (rock or grass) closing roads when not in use, closing roadways during wet periods, and returning main haul roads to prelogging conditions when logging ceases.

CRITERIA		**REMARKS**
1.	**Effectiveness**	
	a) Sediment	**Good if grass cover is used on haul roads (45 percent reduction); Excellent if crushed rock is used as ground cover (92 percent reduction).**
	b) Nitrogen (N)	**Unknown.**
	c) Phosphorus (P)	**Unknown.**
	d) Runoff	**Unknown.**
2.	**Capital Costs**	**High, grass cover plus fertilizer $5.37/100 ft roadbed, crushed rock (6 in) $179.01/100ft roadbed.**
3.	**Operation and Maintenance**	**High, particularly with grass which may have to be replenished routinely and may not be effective on highly traveled roads.**
4.	**Longevity**	**Unknown.**
5.	**Confidence**	**Good for ground cover, poor for nutrients.**
6.	**Adaptability**	**Good.**
7.	**Potential Treatment Side Effects**	**Potential increase in nutrients to water course if excess fertilizers are applied.**
8.	**Concurrent Land Management Practices**	**Maintain natural waterways.**

APPENDIX III
SOURCES OF INFORMATION AND ASSISTANCE
Keller Lake, Waupaca County, WI

Department of Natural Resources:

Waupaca Area Office
N2490 Hartman Creek Road
Waupaca, WI 54981
715-258-2372 or

Lake Michigan District Office
Tim Rasman
1125 N. Military Road, Box 10448
Green Bay, WI 54307-0448
414-497-6034

Can answer questions on lake management, groundwater, water quality, fisheries, regulations, zoning and wildlife or direct you to someone that can be of help.

East Central Wisconsin Planning Commission:

Ken Theine
RP, ECWRPC
132 N. Main Street
Menasha, WI 54952
414-729-4770

Has information regarding zoning and building planning information as well as information on land use.

Environmental Task Force:

Environmental Task Force
College of Natural Resources
UW-Stevens Point
Stevens Point, WI 54481

Will test soils, lake water or well water.

IPS Environmental and Analytical Services

IPS Environmental and Analytical Services
ATTN: Lake Management Program
P.O. Box 446
Appleton, WI 54912-0446
(414) 749-3040 (Business Phone)
(414) 749-3046 (FAX)

Has specific information on the Keller Lake management plan and development of other management plans in the area.

APPENDIX III
(continued)

Town of DuPont

Dennis Desens, Chairman
N10557 Desen Rd
Clintonville, WI 54929
(715) 823-2989

Can provide information on specific town ordinances or plans.

Town of Wyoming

Gordon Zietlow, Chairman
E2752 County Rd C
Iola, WI 54945
(715) 445-3148

Can provide information on specific town ordinances or plans.

Shawano County Land Conservation Department:

Ronald Ostrowski
Courthouse
311 N. Main Street
Shawano, WI 54166

State Laboratory of Hygiene:

University of Wisconsin
Center for Health Sciences
465 Henry Mall
Madison, WI 53706
608-262-3458

Can give information on costs or testing of water and soils.

Waupaca County Land Conservation Department:

Bruce Bushweiler
LCC, Courthouse
811 Harding Street
Waupaca, WI 54981
715-258-6245

Can provide soil erosion prevention measures and water quality problems related to your area.

APPENDIX III
(continued)

Waupaca County Soil Conservation Service (USDA):

Gary Elmer
SCS, Courthouse
811 Harding Street
Waupaca, WI 54981
715-258-6245

Can provide information on soil types and limitations, depths to groundwater and bedrock and related information.

Waupaca County University of Wisconsin Extension:

Tom Wilson
UWEX, Courthouse
811 Harding Street
Waupaca, WI 54981
715-258-6230

Has information of agricultural practices, waste disposal and conservation practices.

Waupaca County Zoning Administration:

Dave Rosenfeldt
ZA, Courthouse
811 Harding Street
Waupaca, WI 54981
715-258-6255

May have information on development, land uses, floodplain and regulations regarding land parcels in your area.

Wisconsin Geological and Natural History Survey:

Ron Hennings
3817 Mineral Point Road
Madison, WI 53705
608-263-7384

Can give information on groundwater and mineral exploration.

APPENDIX IV
SUMMARY OF PERTINENT WAUPACA COUNTY ORDINANCES AND PLANS

Waupaca County Zoning Ordinance

Included in this ordinance are regulations for floodplain zoning, general shoreland provisions, and land subdivisions.

- Floodplain Zoning: Section 87.30 Wis. Stats. requires all counties to adopt floodplain zoning as part of their local zoning ordinance. This type of zoning is used to minimize flood damage in areas subject to flooding.

  Waupaca County's floodplain ordinance regulates all lands that would be inundated by a "regional flood" or a flood the magnitude that could be expected on the average of once per hundred years. Floodplain districts include a floodway and flood fringe area. The floodway is the channel of a stream and that portion of the floodplain adjoining the channel that would carry and discharge the floodwaters of the stream. Only open space uses that have a low flood damage potential and will not obstruct flood flows are permitted within the floodway.

  The flood fringe is that portion of the floodplain between the outer limits of the general floodplain and the floodway that would be covered by flood waters during a regional flood. The flood fringe is generally associated with standing water rather than rapidly flowing water. A number of structural land uses are permitted in the flood fringe, provided they meet certain floodproofing standards.

  Shoreland Provisions: As required under Section 59.971 Wis. Stats., Waupaca County was required to adopt shoreland zoning. This type of zoning provides the means to protect valuable natural resources that are common along lakes and rivers. The ordinance can prevent development of land and certain land use activities from adversely affecting the waterbody.

Soil Erosion Control Plan

In 1988, Waupaca County adopted a Soil Erosion Control Plan based on guidelines contained in Chapter AG 160 of the Wisconsin Administrative Code. The purpose of the plan is to "...

APPENDIX IV
(continued)

determine where the most serious erosion is occurring and to establish a strategy to address the problem." (Waupaca County, 1988). Specifically, the plan provides educational programs, technical assistance, and seeks cost sharing funds to reduce soil erosion to acceptable limits and reduce the amount of sediment being carried to surface waters. Based on maintaining a tolerable soil loss level (expressed as "T"), the plan delineates areas in the county that should receive priority assistance in reducing soil loss. Although the plan looks at soil loss in relation to maintaining agricultural productivity, it can also have a significant impact in reducing nutrient loadings to rivers and lakes.

Animal Waste Water Pollution Control Plan

In 1986, Waupaca County adopted an Animal Waste Management Plan. The purpose of this plan is to "...identify those areas within the county that have the greatest potential for water pollution caused by animal waste." As with the Soil Erosion Control Plan, these priority areas will be eligible to receive technical and cost share assistance, as available.

APPENDIX V

POTENTIAL FUNDING SOURCES FOR PLAN IMPLEMENTATION

Potential sources of funds to assist plan implementation include:

County:

- Conservation funds from the state to be used for natural resources projects (old predator fund). Erosion control cost share funds through Land Conservation Committee.

- Waupaca County Water Quality Maintenance Program. Over $20,000 is available annually for the upkeep and protection of Waupaca County surface waters in the areas of lake management planning, Adopt-a-waterway, soil erosion abatement and watershed enhancement (i.e. rock rip-rapping).

State:

- WDNR Priority Watershed Program. This program has been modified to include priority lakes. The program provides 50-80% cost share for installing "best management practices" to combat nonpoint source water pollutants. Projects are selected by the WDNR and administered by the County Land Conservation Committee.

- WDNR Lake Management Grants. Funding is available to local governments and lake management organizations for the collection and analysis of information needed to manage lakes. The state may pay for 75% of the cost and up to $10,000 for any one project. The remaining 25% must be provided by the local organization or cash contributions from other sources. Projects may include: gathering and analysis of physical, chemical and biological information, describing present and potential land uses within lake watersheds, reviewing jurisdictional boundaries and evaluating ordinances that relate to zoning, sanitation or pollution control, gathering and analyzing information from lake property owners, community residents and lake users, developing alternative courses of action and recommendations.

- WDNR Lake Protection Grants. Another 75% cost share program which allows lake management organizations to obtain funds to protect or restore lakes and their ecosystems. Activities eligible for funding include: the purchase of property which will contribute to the protection

APPENDIX V
(Continued)

or improvement of the natural ecosystem and water quality of a lake, the restoration of wetlands, the development of regulations and ordinances, and any lake improvement projects recommended in a DNR approved plan including lake restoration, watershed management, pollution prevention and control projects.

- WDNR's Recreational Boating Facilities Program (NR 7). Program has been expanded to include qualified lake associations as applicants. This program is administered by the WDNR and supervised by the Wisconsin Waterways Commission. Forty percent of funds are allocated to the Great Lakes,
40% to inland lakes and 20% is discretionary. Financial assistance is available for safe recreational boating projects including: "...dredging of channels of waterways for recreational boating purposes, acquisition of capital equipment necessary to cut and remove aquatic plants, and acquisition of aids to navigate and regulatory markers." A 50% cost share is provided.

- Dam Repairs. Counties, cities, villages, towns and public inland lake protection and rehabilitation districts are eligible for 50% cost sharing of dam maintenance, repair, modification or abandonment. Three million dollars is allocated annually and dams must be inspected by the WDNR and be under directives to be repaired.

- DATCP Farmers' Fund (AG 165). Assists farmers with construction of animal waste management installations (county sets design standards). Soil Erosion Control (AG 160) funds targeted to areas that counties have identified as priorities in the County Erosion Control Plan (the watershed including Keller Lake is not currently identified as a priority soil erosion area).

- Stewardship Program. Ten year $250,000 to protect environmentally sensitive areas and acquire or maintain recreational areas. The funds are raised by state sale of bonds. Potential lake applications include:

APPENDIX V
(Continued)

Habitat Restoration Areas - $1.5M annually to encourage private landowners and non-profit organizations to adopt management practices favorable to wildlife.

Urban Green Space - $750,000 annually for 50% grants to municipalities to protect scenic or ecological sites from development.

Streambank Protection - $1M annually to WDNR to purchase streambank easements of at least 66 feet and to provide fencing.

Federal:

- EPA Clean Lakes Program (appropriations pending). Limited amount of cost share funding for planning and implementing public lake protection and restoration projects. WDNR must apply for the funds on behalf of lake organization. Requires EPA feasibility study.

- US Army Corps of Engineers. Can provide limited cost share funds to states to support selected aquatic plant management projects. Must be identified by WDNR as high priority and have an in-depth aquatic plant management plan.

- USDA (1985 Federal Farm Bill). Program to take land out of agricultural production. While these funds go to individual farmers, lake leaders may want to encourage farmers to use these programs. Conservation Reserve Program is purchasing the right to keep some Wisconsin farmland out of cultivation for 10 years. County office administers the program.

- FmHA Loan program to farmers in exchange for Conservation Easements. Long-term easements take land adjacent to wetlands, lakes and streams out of production. Annual multi-year set-aside programs.

- SCS. Beginning in 1983, SCS has provided large grants to selected areas to enhance water quality.

APPENDIX V
(Continued)

Miscellaneous:

Programs that might be useful in certain situations include: Trout Stamp land purchase program (WDNR), Water Bank Program (ASCS), water safety patrol aids (WDNR), Land and Water Conservation Fund (US Dept. of Interior and WDNR), Forest Incentive Program (ASCS), Mining Investment and Local Impact Fund (Wis. Dept. of Revenue) and Septic Tank Replacement Program (WDNR).

PHASE I
LAKE MANAGEMENT PLAN
KELLER LAKE
WAUPACA COUNTY, WISCONSIN

Prepared for

Waupaca County Parks and Recreation Committee

by

August, 1996