Hey and Associates, Inc.

EVALUATION OF ALTERNATIVES FOR RUBICON RIVER PHOSPHORUS INPUT DIVERSION

Pike Lake, Washington County, Wisconsin

Prepared for:
Pike Lake Inland Lake Protection and Rehabilitation District

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INTRODUCTION

Pike Lake in Washington County is 522 acre glacial lake that receives drainage from an 11.5 square mile watershed (Figure 1). The Rubicon River, which drains 7.85 square miles, is the largest inlet tributary and contributes 56 percent of the annual water flow to the lake and 80 percent of the annual phosphorus inputs based on monitoring by the U. S. Geological Survey in 1999 and 2000. Of the phosphorus inputs 43 percent is delivered from the Village of Slinger Wastewater Treatment Plant and 37 percent is from nonpoint source pollution. In 1995 the Pike Lake Management District installed a diversion project in the Rubicon River to minimize nutrient mixing of the Rubicon River with the lake during low flow conditions when the treatment plant makes up much of the stream base flow. Between 1998 and 2000 during high flows the diversion plug washed out. The purpose of the following report is to evaluate alternatives to reducing phosphorus inputs from the Rubicon River into Pike Lake. Funding for this project was provided by the Wisconsin Department of Natural Resources through a Lake Planning Grant and from the Pike Lake Inland Lake Protection and Rehabilitation District.

PHYSICAL DESCRIPTION OF LAKE

Pike Lake (Figure 2) is a natural drainage lake formed about 10,000 years ago during the Wisconsinan glaciation. A low-head dam at the lake's outlet raises the lake surface about two feet higher than if there was no dam. The lake has a surface area of 522 acres; however, if the marsh along the north side of the lake is excluded from the lake area, the remaining open-water area is 459 acres. The maximum depth of the lake is 45 ft, its volume is 6,171 acre-ft, and its mean depth is 13.5 ft (Wisconsin Department of Natural Resources, 2001). Table 1 summarizes the physical characteristics of the lake.

Table 1

Physical Characteristics of Pike Lake (Source: SEWRPC)

Parameter	Measurement
Area of Lake	470 acres
Area of Total Drainage Area	7,966 acres
Lake Volume	6,942 acre-feet
Residence Time	1.1 years
Depth Area of Lake Less than Five Feet	39 percent
Area of Lake 10 to 30 Feet	34 percent
Area of Lake More than 30 Feet	27 percent
Mean Depth	14 feet
Maximum Depth	45 feet

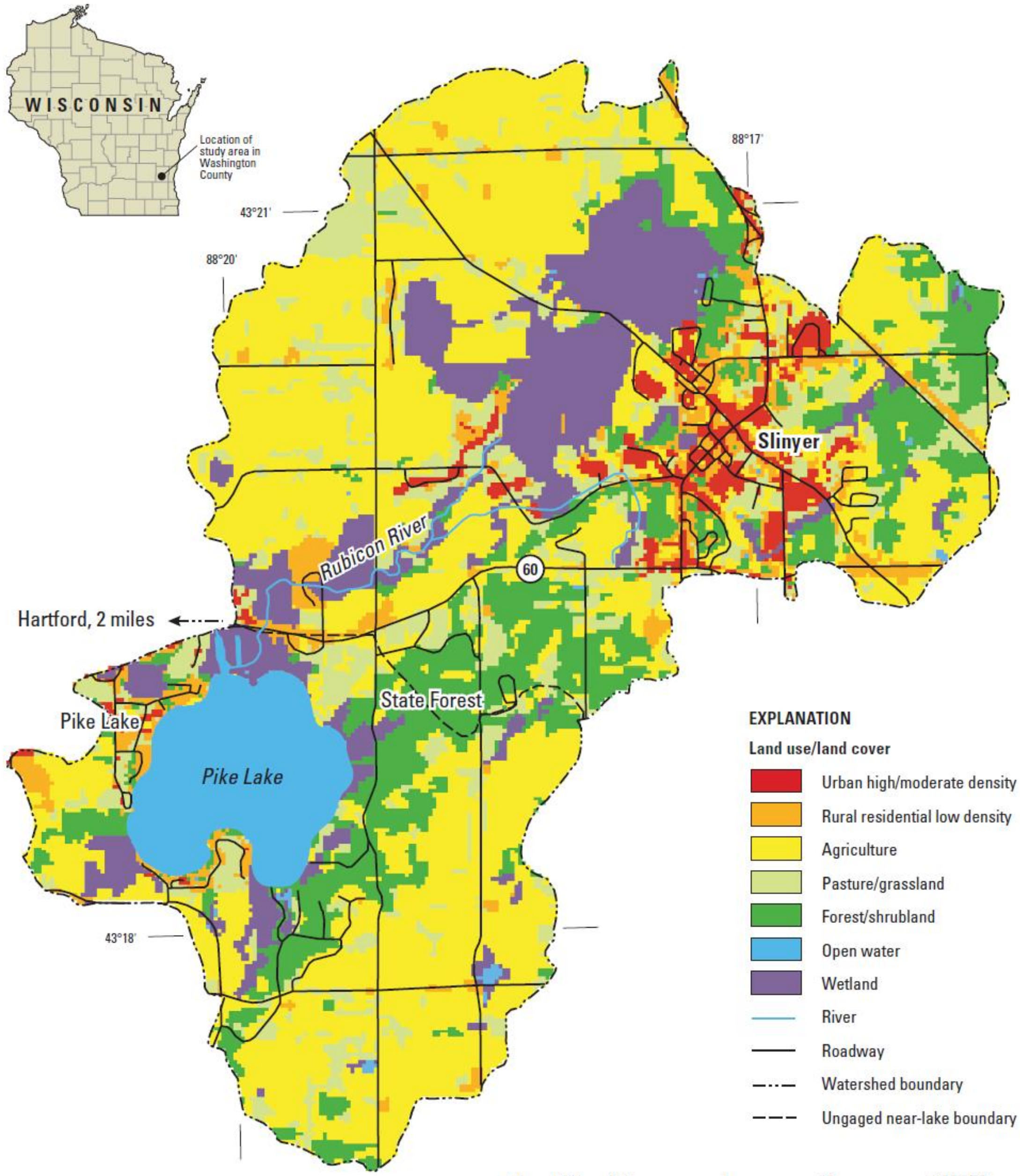

Figure 1.
Drainage basin of Pike Lake, Wis. Land use/land cover from WISCLAND geographic information coverage (Lillesand and others, 1998)(Source USGS).

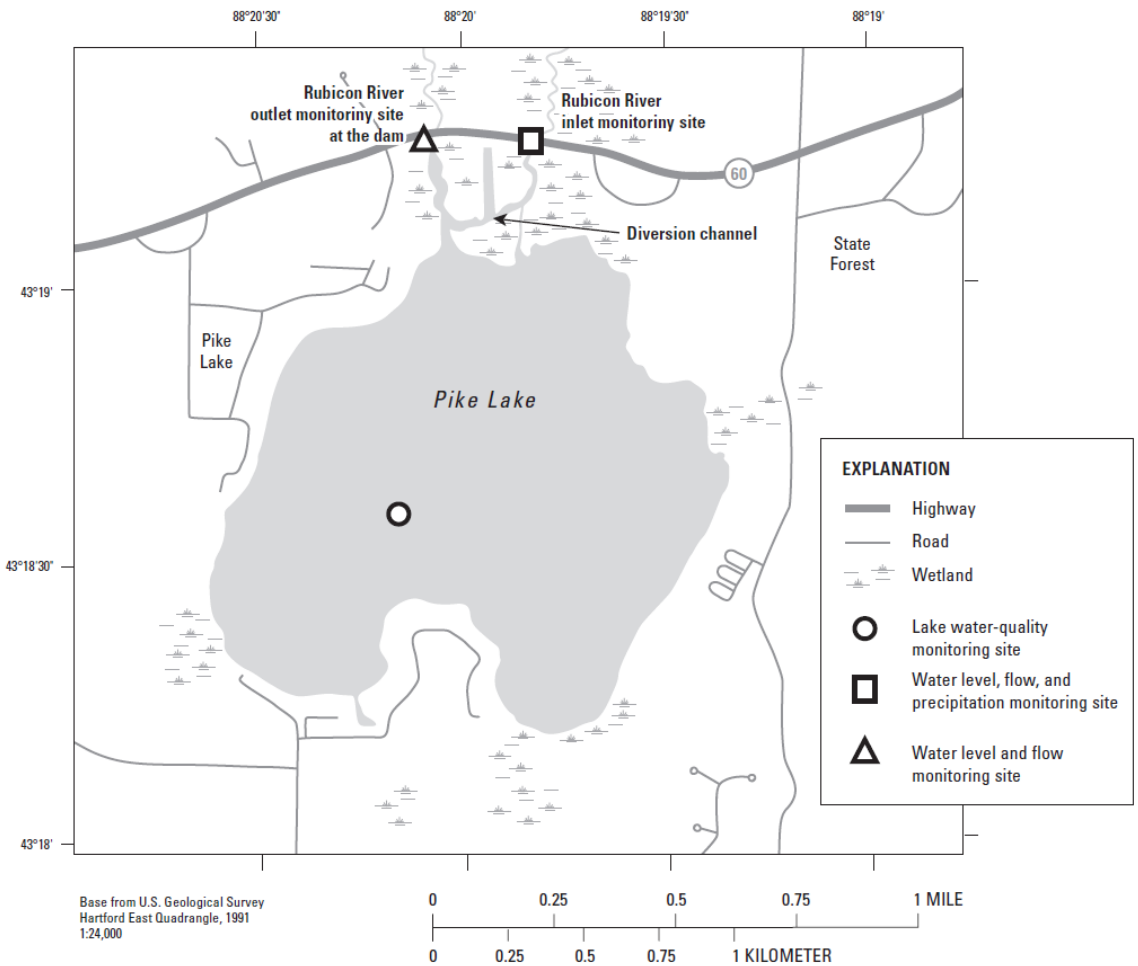

Figure 2.
Locations and types of data-collection sites at or near Pike Lake, Wis. (Source USGS)

DESCRIPTION OF WATERSHED

Pike Lake has one primary inlet and outlet formed by the Rubicon River, as shown on Figure 1. The River enters the Lake from the north through a natural channel which flows in a southerly direction, through a wetland complex, into the main lake basin. The Rubicon River leaves Pike Lake through a natural channel located approximately 400 feet west of the inlet, flowing northerly and westerly through the City of Hartford. The area of the watershed upstream of the State Highway 60 crossing of the Rubicon River is 7.95 square miles. The headwaters of the Rubicon River drain about a 1-square mile marsh just northwest of Slinger. The river flows in a generally southwesterly direction toward Pike Lake and receives effluent from the Slinger Wastewater Treatment Plant (WWTP).

Two intermittent, unnamed tributary streams also enter the Lake from the southeast and southwest, respectively; the southeastern-most tributary is locally known as Glasgow Creek. In addition, a number of springs and small streams enter the Lake from the east. The

Rubicon River eventually drains to the Rock River about 35 miles downstream, within Dodge County.

Land use in the Pike Lake watershed is a mix of agriculture, urban, forest, and wetland. Land use/land cover for the lake's watershed is summarized in Table 2.

Table 2
Land Use Pike Lake Watershed 2000 (Source: SEWRPC)

Land Use	Area (acres)	Percent of Total
Residential	945	11.9
Commercial	68	0.9
Industrial	62	0.8
Governmental and Institutional	98	1.2
Transportation, Communication, and Utilities	585	7.3
Recreational	127	1.6
Agricultural and Other Open Lands	3,739	46.9
Wetlands	1,030	12.9
Woodlands	773	9.7
Surface Water	514	6.5
Quarry	25	0.3
Total	**7,966**	**100.0**

HISTORIC LAKE WATER QUALITY

Based on the water quality parameters of total phosphorus, chlorophyll a, and water clarity (secchi disk transparency) Pike Lake can be considered to have good to fair water quality. The lake is classified as mesotrophic, or moderately nutrient rich. A detailed discussion of the water quality of the lake can be found in *A Lake Management Plan for Pike Lake Washington County Wisconsin*, prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in 2005. As part of the lake management plan SEWRPC identified that phosphorus was the limiting nutrient that controlled algae growth in Pike Lake.

Pike Lake has been monitored intermittently for water quality from 1973 through the present. Figures 3 through 5 illustrate the trends in available data for total phosphorus, chlorophyll a, and Secchi disk transparency. The data represents surface conditions at the deepest spot in the lake. The location of the sampling site is illustrated in Figure 2.

Total phosphorus concentrations for the 35-year record average 23 ug/l, slightly higher than the level of 20 ug/l recommended by SEWRPC in the Commissions adopted regional water quality management plan to prevent nuisance algae blooms. The data shows unusually high phosphorus concentration in 1993 and 1994 which are unexplained. With the exception of the peaks in the early 1990's, generally phosphorus concentrations in the lake do not show any dramatic increases over time.

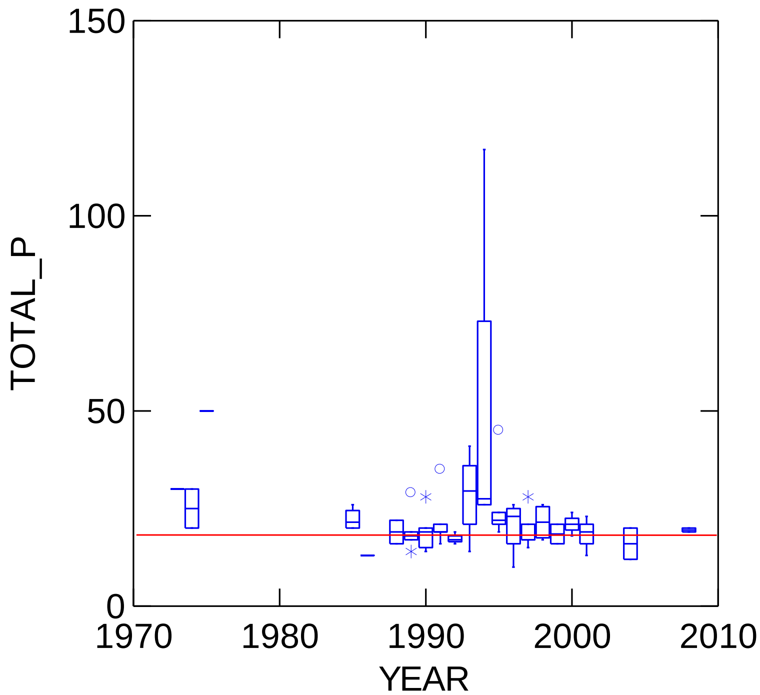

Figure 3
Annual Ranges of Total Phosphorus Concentration in ug/l
(Source: WDNR, USEPA STORET)

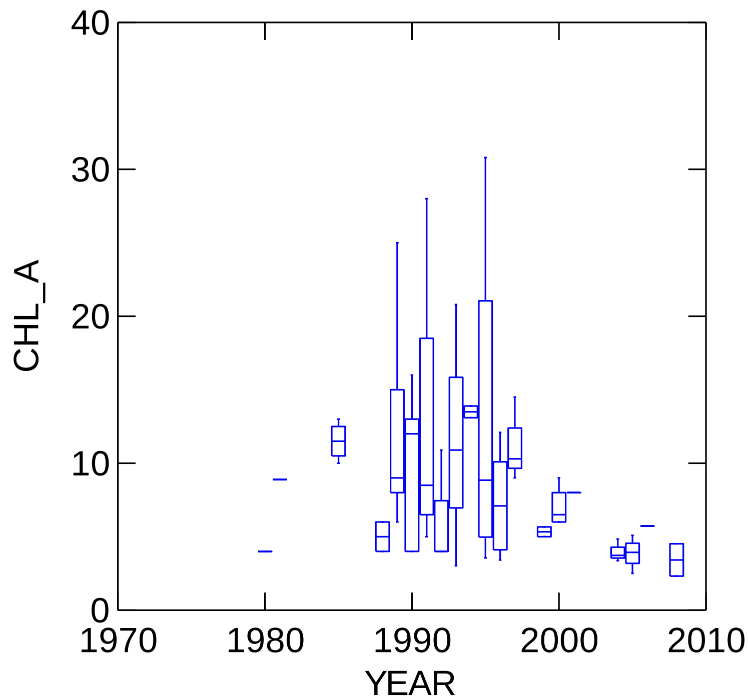

Figure 4
Annual Ranges of Chlorophyll a Concentration in ug/l
(Source: WDNR, USEPA STORET)

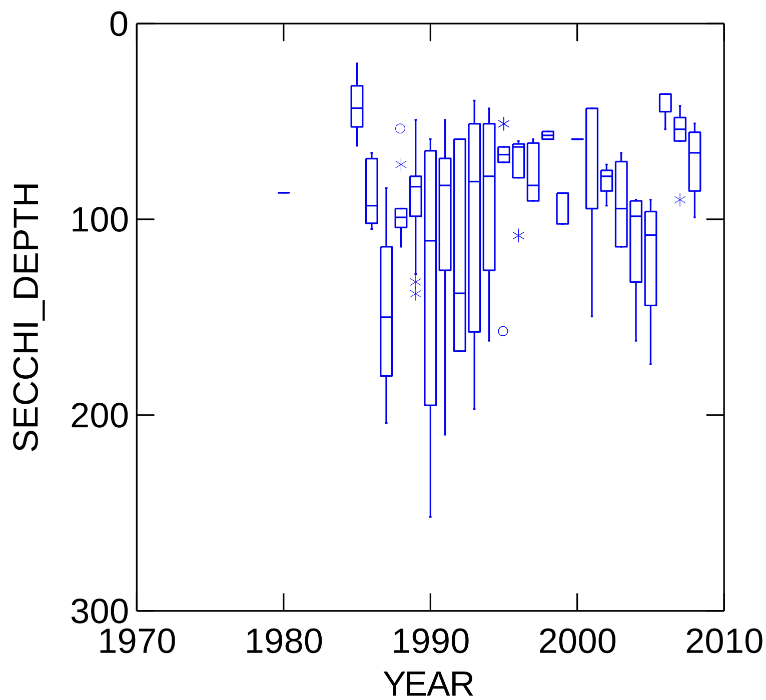

Figure 5
Annual Ranges of Secchi Transparency Depth in Inches
(Source: WDNR, USEPA STORET)

Chlorophyll a concentrations in Pike Lake, for the 28-year period of record, average 8.83 ug/l, indicating relatively low levels of planktonic algal growth in the center of the lake. Ranges in chlorophyll a concentrations decline after 1995 possible due the installation of the diversion project (Figure 4). Calendar years 2004 through 2008 illustrate the lowest range of chlorophyll a concentrations for the period of record.

Water clarity in Pike Lake, for the 28-year period of record, ranged from 20.4 to 252 inches, with a mean of 92.9 inches (7.75-feet). The data provides some interesting trends. While the ranges of lowest annual values have not generally declined, the frequency of clearer days has declined from the late 1980's/ early 1990's to the present. Trends in changes in water clarity do not follow the same trends as chlorophyll a and total phosphorus concentrations. The general theory is that higher total phosphorus concentrations result in higher populations of algae as indicated by the presence of chlorophyll a, resulting in poorer water clarity. The trends in Pike Lake raise the question, is the decline in water clarity due to other causes than algae growth and could it be due to increased suspended sediment levels. Data on suspended sediment is not available to answer this question.

SUMMARY OF USGS 1999-2000 RUBICON RIVER DIVERSION STUDY

In 1998 to 2000 the U.S. Geological Survey conducted a detailed water quality monitoring program to describe the water quality and hydrology of Pike Lake, quantify sources of phosphorus including the effects of short-circuiting of inflows as the result of the 1995 diversion project, and determine how changes in phosphorus loading should affect the water quality of the lake (Rose, et al., 2004). Measuring all significant water and phosphorus sources and estimating lesser sources was the method used to construct detailed water and phosphorus budgets. Table 3 summarizes the average annual water budget by percent of annual flow for the inflow and outflow for the lake. As we majority of inflow and outflow at Pike Lake is through the Rubicon River.

Table 3
Pike Lake Annual Water Budget by Percent Annual Flow for 1999 and 2000
(Source: USGS)

Inflows		**Outflows**	
Source	**Percent of Annual Flow**	**Source**	**Percent of Annual Flow**
Rubicon River	55	Rubicon River outlet	87
Ungaged near-lake surface inflow	20	Evaporation	13
Precipitation	17	-	-
Ground water	7	-	-

Total input of phosphorus to the lake was about 3,500 pounds in 1999 and 2,400 pounds in 2000. About 80 percent of the phosphorus was from the Rubicon River, about half of which came from the watershed and half from a waste-water treatment plant in Slinger, Wisconsin. Inlet-to-outlet short-circuiting of phosphorus is facilitated by a meandering segment of the Rubicon River channel through a marsh at the north end of the lake. It is estimated that 77 percent of phosphorus from the Rubicon River in monitoring year 1999 and 65 percent in monitoring year 2000 was short-circuited to the outlet without entering the main body of the lake.

Simulations using water-quality models within the Wisconsin Lake Model Suite (WiLMS) indicated Pike Lake’s response to 13 different phosphorus-loading scenarios. These scenarios included a base “normal” year (2000) for which lake water quality and loading were known, six different percentage increases or decreases in phosphorus loading from controllable sources, and six different loading scenarios corresponding to specific management actions. Model simulations indicate that a 50-percent reduction in controllable loading sources would be needed to achieve a mesotrophic classification with respect to phosphorus, chlorophyll a, and Secchi depth (an index of water clarity). Model simulations indicated that short-circuiting of phosphorus from the inlet to the outlet was the main reason the water quality of the lake is good relative to the amount of loading from the Rubicon River and that changes in the percentage of inlet-to-outlet short-circuiting have a significant influence on the water quality of the lake.

DESCRIPTION OF SLINGER WASTEWATER TREATMENT PLAN

The Village of Slinger in 1950 installed a wastewater treatment plant on the Rubicon River upstream of Pike Lake. In 1981 the plant was expanded and today the sewage treatment facility has a hydraulic design capacity of 0.76 million gallons per day (MGD) on an average annual flow basis. The plant is an oxidation ditch design with clarification and chlorination. The current the flow rate is approximately 0.60 MGD on an average annual basis.

In 2001, the Village of Slinger completed preparation of a wastewater facilities plan to determine the best means of upgrading and expanding the Village's sewage treatment plant. In 2002, a sewage treatment plant facility plan amendment and sewage treatment plant capacity re-rating analysis was prepared for the Village of Slinger. The analysis indicated that the plant capacity could be increased to about 1.5 MGD with mechanical equipment modifications. Improvements to the plant which are currently underway will cost approximately $9 million. Part of the improvements - new influent pumps, fine bar screening, new grit remover, washer and compactor and SCADA system - were completed in 2004. Under construction are a new three ring oxidation ditch, two new clarifiers, ultraviolet disinfection system, and an additional sludge storage tank, increasing the sludge storage capacity to 1.76 million gallons.

On October 1, 2008 the Wisconsin Department of Natural Resource issued a renewed permit for the treatment plant which expires on September 30, 2013. The permit, located in Appendix A of this report, establishes standards for the effluent discharge. For biological oxygen demand (BOD), total suspended solids (TSS), and total phosphorus the effluent standards as follows:

- Biological oxygen demand (BOD) 30 mg/l (daily max), 15 mg/l (Monthly average)
- total suspended solids (TSS) 30 mg/l (daily max), 15 mg/l (Monthly average)
- total phosphorus 1 mg/l (Monthly average)

In 1999/2000 the USGS estimated that the Village of Slinger treatment plant discharged approximately 1,161 pounds per year of total phosphorus, or 39.3 percent of Pike Lake's annual phosphorus input (Rose, et al, 2004).. In the Rubicon River the treatment plant makes up approximately 8% of the annual flow and 49.9% of the annual total phosphorus load. The USGS estimated that elimination of the treatment plant discharge would reduce in-lake phosphorus concentrations by 21.6% and a 100% increase in discharge would increase in-lake phosphorus concentrations by 26.4%.

NEED FOR ABATEMENT OF PHOSPHORUS INPUTS

Pike Lake today has in-lake phosphorus concentrations above the level of 20 ug/l recommended by SEWRPC in the Commissions adopted regional water quality management plan to prevent nuisance algae blooms. The USGS in their report titled *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) identified that proposed doubling of the size of the Village of Slinger wastewater treatment plant could increase in lake phosphorus concentrations by 26.4% to as high as 35 ug/l, resulting in a 15.1% increase in chlorophyll a and 5.3% reduction in water clarity. Figure 6 illustrates the total phosphorus concentrations at the Rubicon River inlet to

Pike Lake at STH 60 for 1999 and 2000. Inflow total phosphorus concentrations at Highway 60 were measured to range from 58 to 756 ug/l, with a mean of 202 ug/l. During the two year study period an average of 2,325 pounds of phosphorus per year entered Pike Lake from the Rubicon River and 2091 pounds exited the lake through the outlet. Figure 7 illustrated the net inflow and outflow of phosphorus on individual days of the study year. To reduce in-lake total phosphorus concentrations to below the SEWRPC recommended level of 20 ug/l, assuming no inlet short-circuiting, existing inputs levels need to be reduced by 72% and future levels with the expansion of the treatment plant in Slinger by as much as 85%. Figure 8 illustrates the predicted trophic status of Pike Lake if no action is taken to control inputs of phosphorus (SEWRPC, 2005). Without mitigation measure SEWRPC predicts that Pike Lake will fall further into the impaired classification. The alternatives section of this report will evaluate alternatives available to reduce phosphorus inputs to Pike Lake from the Rubicon River.

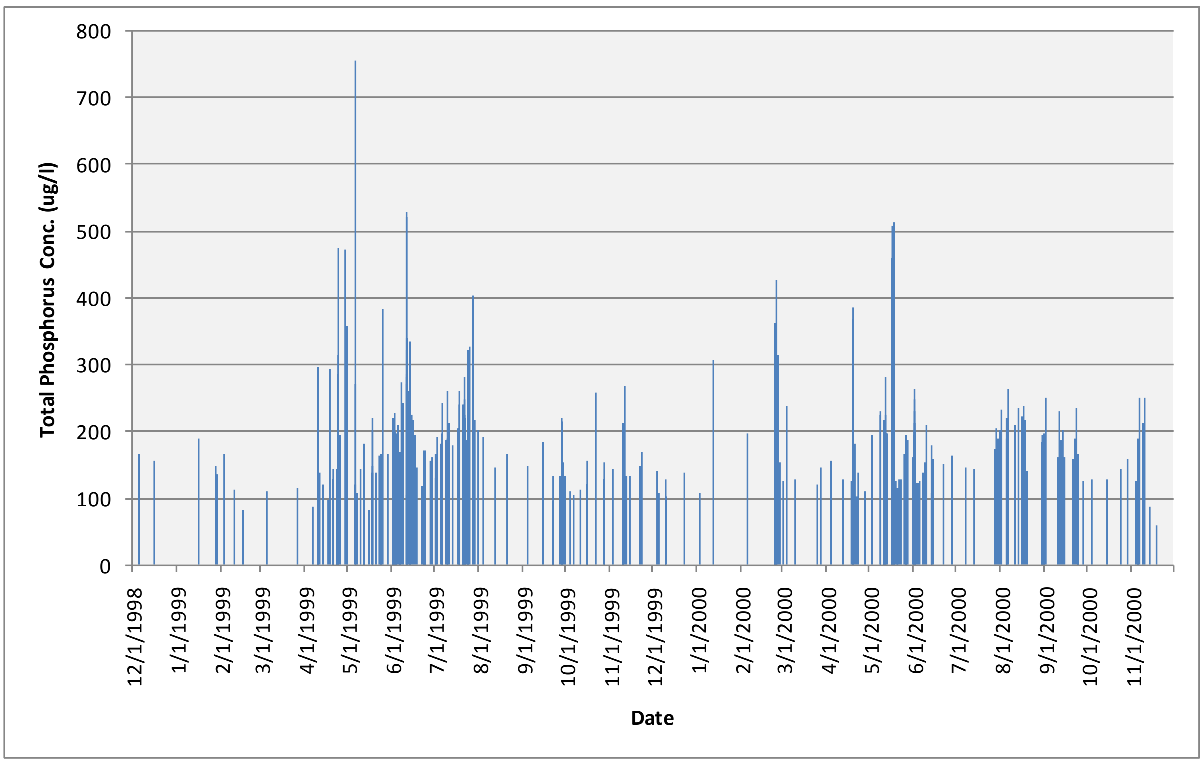

Figure 6

Total Phosphorus Concentrations Rubicon River Inlet to Pike Lake 1999 to 2000 (Source: USGS)

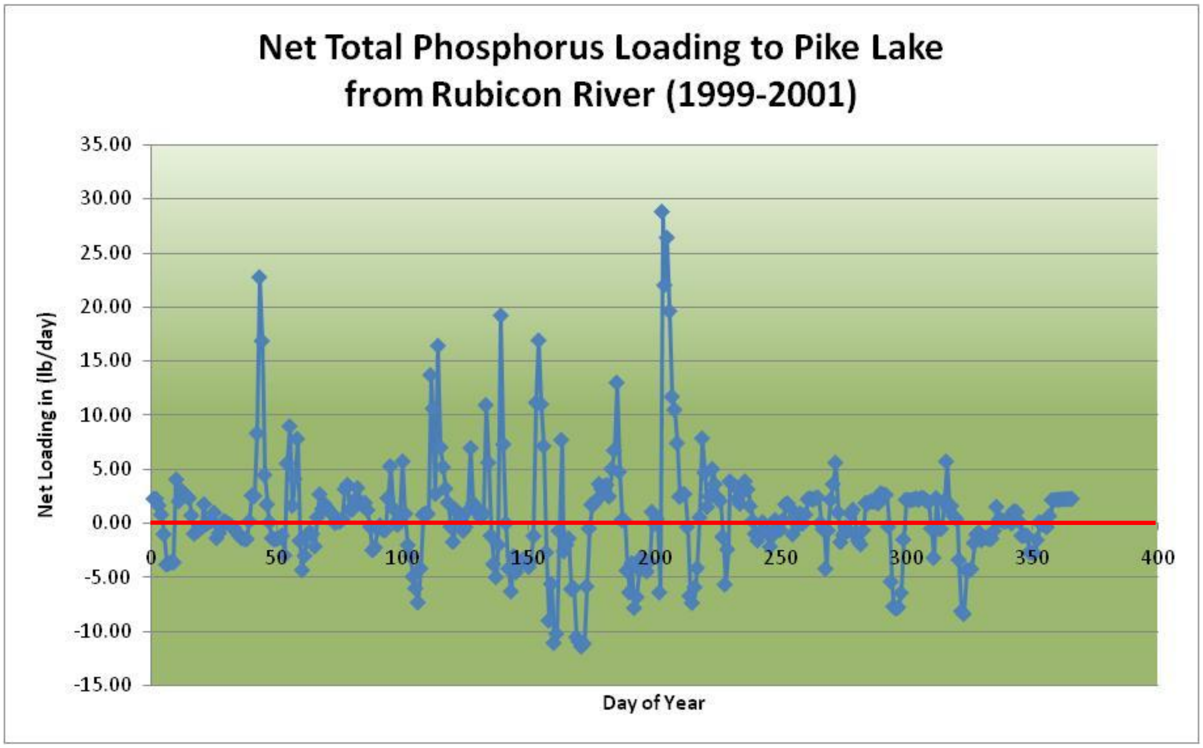

Figure 7
Daily Net Total Phosphorus Inputs and Outputs at Rubicon River 1999-2001

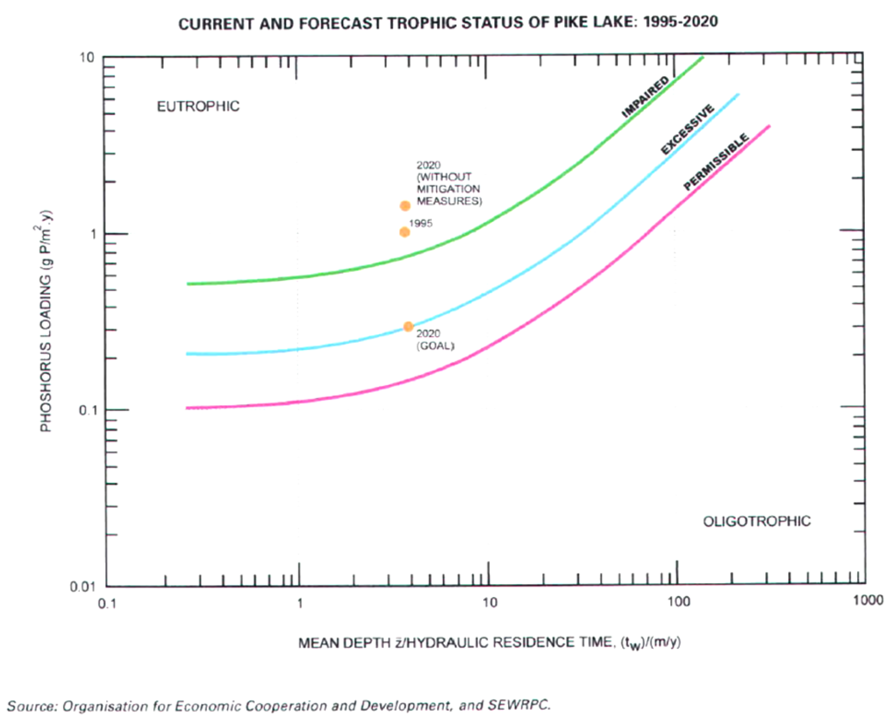

Figure 8
Current and Forecasted Trophic Status of Pike Lake
(Source: SEWRPC)

HISTORY OF 1995 DIVERSION PROJECT

The major tributary to Pike Lake is the Rubicon River, which flows under State Highway 60 into the marsh at the north of the lake about 0.2 miles east of the lake's outlet (Figure 7). The area of the watershed upstream of the State Highway 60 crossing of the Rubicon River is 7.95 square miles. The River enters the Lake from the north through a natural channel which flows in a southerly direction, through a wetland complex, into the main lake basin. The Rubicon River leaves Pike Lake through a natural channel located approximately 400 feet west of the inlet, flowing northerly and westerly through the City of Hartford.

The Rubicon River channel, in the wetland complex, has undergone several changes in the last 60 years. Figure 7 illustrates the configuration of the inlet channel from 1941 through the present. As can be seen in the 1941 and 1950 aerials, the Rubicon River entered from the northeast and quickly curved to the west and exited the lake to the northwest. During these early years the base flow of the river had limited direct contact with the lake and needed to flow through approximately 150 feet of wetland to reach the lake. In the early 1960's a project to create lake access from the north was undertaken. This project illustrated in the 1963 aerial cut a wide deep channel through the marsh into the lake creating a diversion of flow of the Rubicon River more directly into the lake. In the 1980 aerial we see that the channel to west is beginning to become plugged with emergent wetland vegetation and most of the Rubicon River flow is going through the new man-made breach. By 1990 the western channel is completely blocked with vegetation and in 1995 all of the Rubicon River flow is directly into the lake.

In the fall of 1995, the new inflow channel to the lake was plugged and a diversion channel was constructed through the marsh at the north end of the lake connecting the inflow channel with the outflow channel to enhance the natural short-circuiting of high nutrient inflow to the outlet that existed prior to the 1960's (Figure 8). During flooding of 1997 and 1998 the plug began to wash away and in the 2000 and 2005 aerials we can see the start of an opening in the marsh fringe to the lake.

In July 2007 a survey by Hey and Associates of the Rubicon River channel identified that all of the flow of the river was flowing through the breach into the lake and no flow was going to the west towards the outlet. The westerly channel from the breach to the outlet was blocked by a beaver dam and the channel was filled with organic sediment (Figure 9). The survey found little evidence of the 1995 plug. All of the core clay material was gone and only a few pieces of the rip-rap were found. The channel bottom in the breach was solid and made up of clay. There was no evidence that the plug settled into the sediment and it appeared that plug was washed into the lake, likely by the large floods in June 1997 and August 1998, which both exceed 100-year frequency flows.

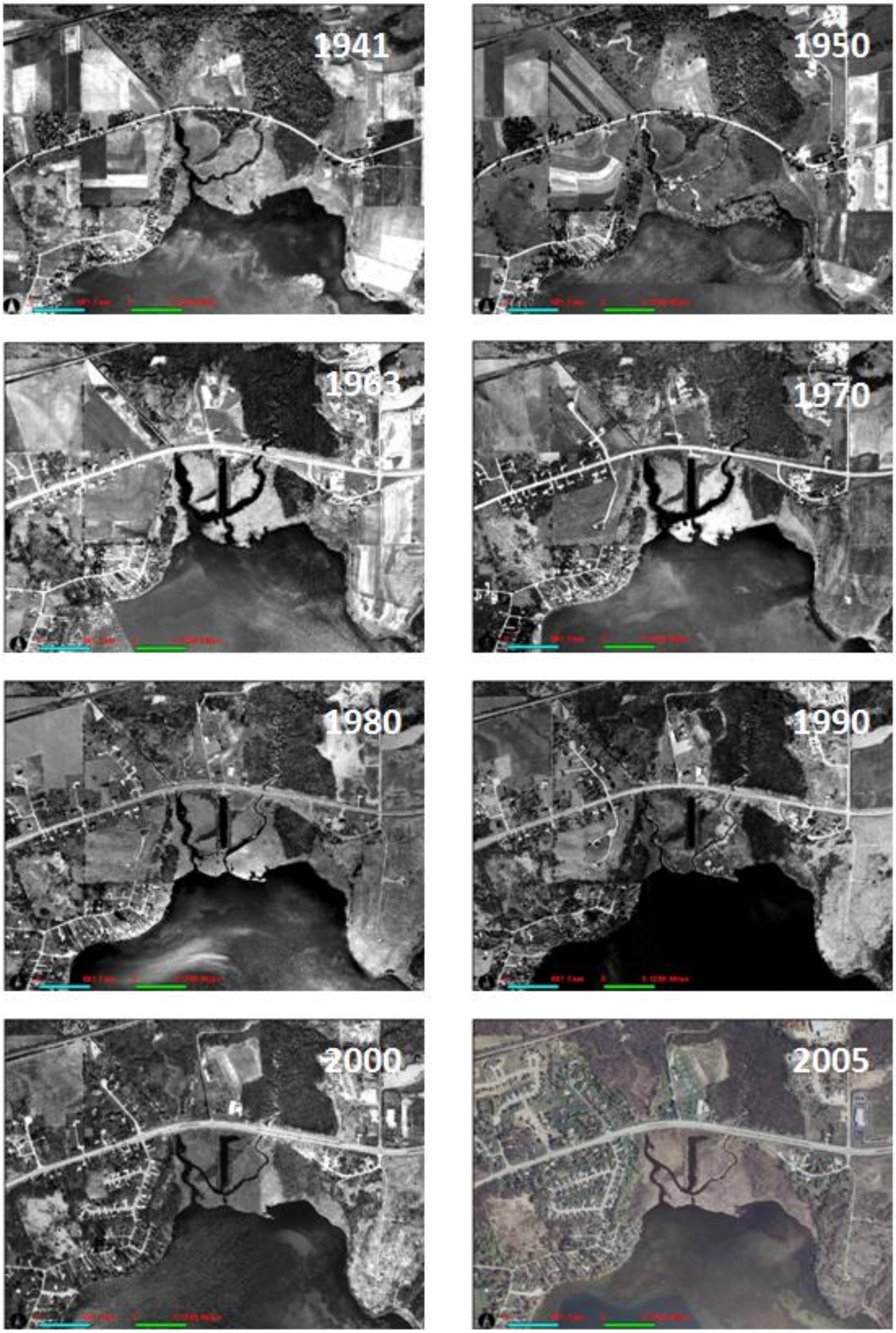

Figure 7
Pike Lake Inlet Aerial Photographs 1941 through 2005
(Source: Washington County)

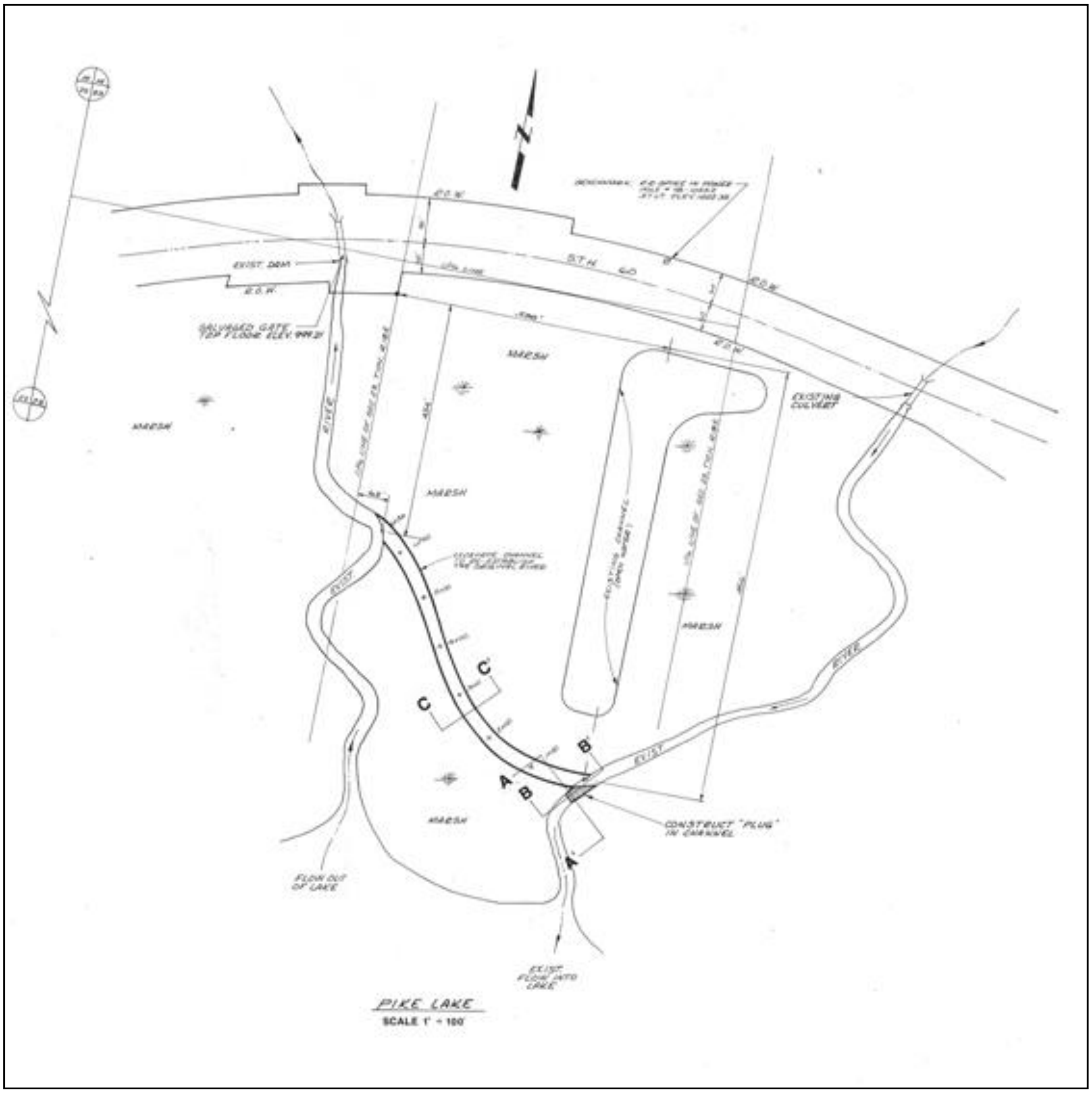

Figure 8
1995 Rubicon River Re-Diversion Project Plans
(Source: R. A. Smith National)

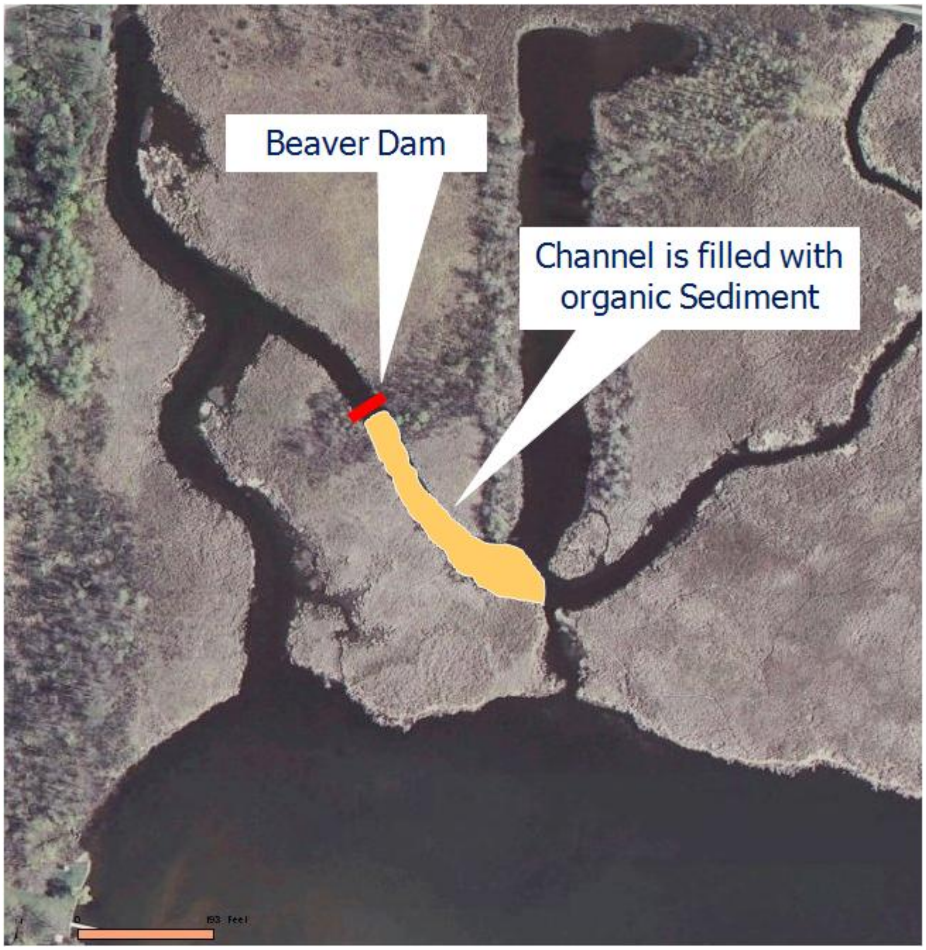

Figure 9

Location of Channel Blockage September 2007

EVALUATION OF ALTERNATIVES TO REDUCE PHOSPHORUS INPUTS FROM RUBICON RIVER

Alternatives to reduce total phosphorus inputs to Pike Lake from the Rubicon River fall into three broad categories:

- Source controls, to prevent pollutants from entering the stream
- Trapping of pollutants already in the river upstream of the lake
- Diversion options, to reduce the opportunity of pollutants from mixing with the main body of the lake

Source Controls

Source controls are pollution treatment practices that prevent contaminants from entering the Rubicon River and eventually Pike Lake.

Watershed Nonpoint Source Controls

Concept – Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants (point sources), comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. These pollutants include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;
- Oil, grease, and toxic chemicals from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks;
- Salt from irrigation practices and acid drainage from abandoned mines;
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems;

In the 2000 USGS study (Rose, et al., 2004) it was estimated that 2,441 pounds of phosphorus enter Pike Lake on an annual basis. Of this total amount 1,410.5 pounds, or 57.6%, is the result of nonpoint source pollution. Within the Rubicon River watershed 897 pounds per year, or 46.3%, of the total phosphorus input is from nonpoint sources. Table 4 summarizes the distribution of phosphorous inputs by land use (assuming no inlet short-circuiting). We see that the major source of phosphorus inputs (40.3% total and 35.0% to the Rubicon River) is from agriculture.

Table 4
Distribution of Phosphorous Inputs to Pike Lake by Land Use –2000[1]
(Source: USGS)

Land Use	Rubicon River		Total Lake Watershed	
	Pounds per Year	Percent of total	Pounds per Year	Percent of total
Urban	34.2	1.8	49.8	2.0
Agriculture	677.3	35.0	986.5	40.3
Pasture/grassland	95.7	4.9	139.4	5.7
Forest/wetland/open water	89.8	4.6	130.8	5.3
Precipitation on lake	-	-	60.0	2.4
Groundwater	-	-	44.0	1.8
Total NPS Sources	**897**	**46.3**	**1,410.5**	**57.6**
Slinger Wastewater Treatment Plant	1,039	53.7	1,039	42.4
Total all sources	**1,936**	**100.0**	**2,449.5**	**100.0**

[1] The above number does not include the estimated 65% inlet short-circuiting experienced in 2000. Slight difference in total loading is due to rounding of numbers.

SEWRPC in *A Lake Management Plan for Pike Lake Washington County Wisconsin* outlines a number of recommended nonpoint source controls for the Pike Lake watershed. In the management plan SEWRPC recommends a reduction of 25% in urban and rural nonpoint-sourced pollutants plus streambank erosion control, construction site erosion control, and onsite sewage disposal system management be achieved. A 25% reduction in existing nonpoint source pollution would result in a 353 pound per year reduction in phosphorus inputs from the entire watershed and 224 pound per year reduction from the Rubicon River watershed. This action would reduce the total phosphorus input to the lake from 2,450 pounds per year to 2,097 pounds per year or a total reduction of 14.4%.

Advantages – Implementation of nonpoint source pollution controls would achieve a large percentage of the needed 20% reduction in existing phosphorus source to the lake. Implementing these practices watershed wide would help reduce the nutrient inputs not only from the Rubicon River but also the watershed area south of STH 60.

Disadvantages – Agricultural runoff makes up 53% of the total phosphorus inputs to Pike Lake (Rose, et al., 2004). Nonpoint source pollution is generally exempt from the enforcement actions of the state and federal Clean Water Act, and therefore implementation of controls is predominantly voluntary. While cost share incentives from state and federal agencies have been available for over forty years to implement agricultural nonpoint source practices, many agricultural land owners have been reluctant to implement nonpoint source control practices such as manure storage or conservation tillage. There are no guarantees that implementation of the agricultural nonpoint source recommendations in lake management plan will ever be implemented.

Costs - Cost will vary depending on the individual practices implemented by each landowner.

Diversion of Slinger Wastewater to Hartford Treatment Plant

Concept – If the discharge of the Village of Slinger wastewater treatment plant was completely eliminated existing total phosphorus inputs to Pike Lake could be reduced by 1,039 pounds per year, a 42.4% reduction in total phosphorus input (Rose, et al., 2004). To eliminate the Slinger discharge the wastewater from the Village could be diverted to the City of Hartford treatment plant. The diversion would take place through the installation of a force main sewer from the existing Slinger plant to the Hartford plant. One potential route for the force main is illustrated in Figure 10.

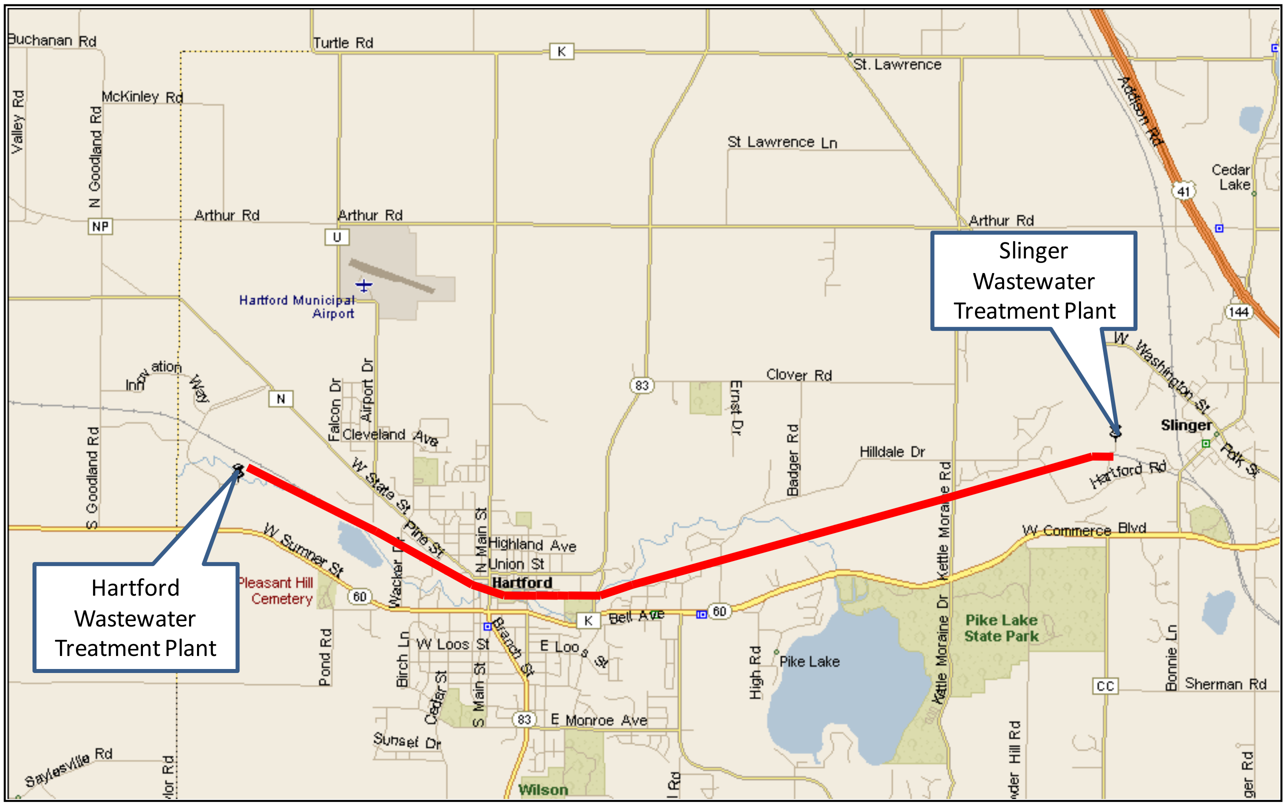

Figure 10
Potential Route for Force Main to Connect Slinger Wastewater Treatment Plant to Hartford
(5.94 miles of Force Main)

Advantages – Elimination of the Village of Slinger treatment plant discharge would reduce total phosphorus inputs to Pike Lake by 42.4%.

Disadvantages – The predominant disadvantage of this alternative would be cost. Cost would include construction of 5.9 mile force main to move the waste from Slinger to Hartford and loss of the capital investment in the Slinger treatment plant. The diversion would cause the Hartford treatment plant, which currently has a design capacity of 3.6 MGD and 2003 average flows of 2.2 MGD, to have to be increased it size. The Village of Slinger is in the process of implementing over $10.3 million in improvements to expand the capacity of their plant from 0.76 MGD to 1.5 MGD. Slinger has recently been issued a discharge permit from the State of Wisconsin that allows operation of the new plant through 2013. It is politically unlikely that the Village of Slinger would indorse this alternative at this time.

Costs – Cost of a new force main could exceed $3 million. Loss of capital investment in the existing Slinger treatment plant is unknown but could exceed $25 million. Cost to expand the Hartford treatment plant is unknown.

Extension of Slinger Wastewater Treatment Plant Discharge Downstream of Pike Lake

Concept – Extending the discharge of the Village of Slinger wastewater treatment plant from its existing location to location downstream of Pike Lake would eliminate 1,039 pounds per year of phosphorus from entering the lake. This action would reduce annual phosphorus inputs by approximately 42.4%. Figure 11 illustrates a potential route for the new discharge pipe. This proposed route is located along the railroad right-a-way owned the Wisconsin Department of Transportation. The elevation at the current outfall is approximately 1.022 feet above sea level. The potential new outfall is a an elevation of 990 feet above sea level allowing a 32-foot drop potentially allowing a gravity feed pipe. The length of pipe needed is 12,360 feet (3.35 miles).

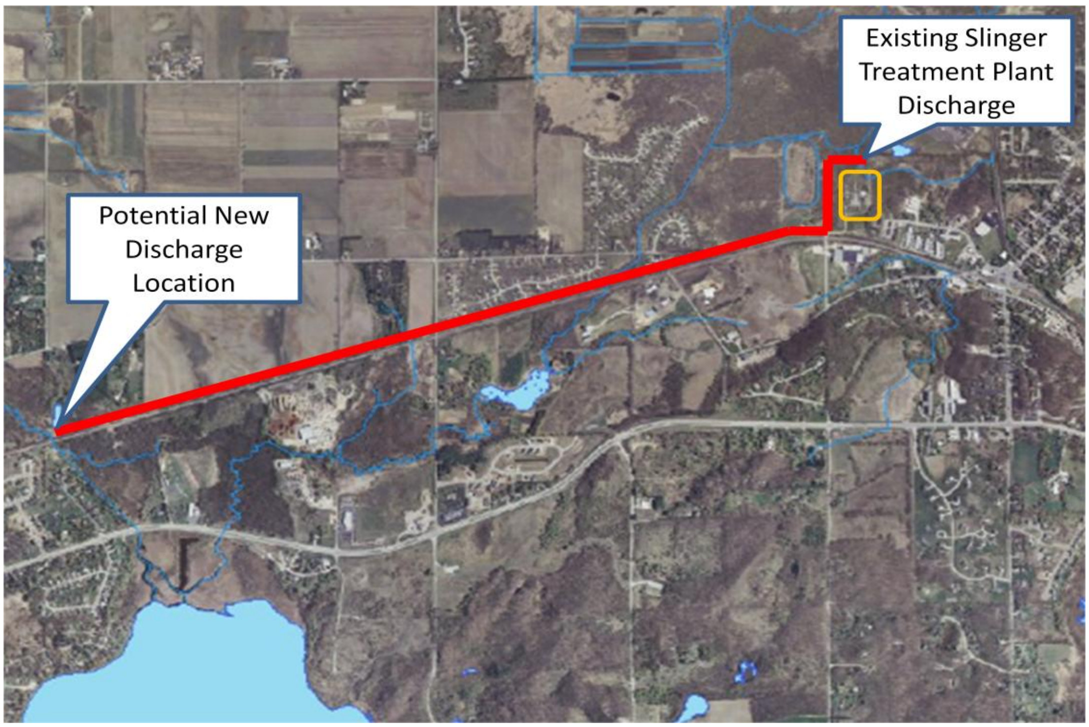

Figure 11
Potential Route for Extension of Village of Slinger Treatment Plant Outfall

Advantages – This alternative would completely eliminate the discharge of the Village of Slinger treatment plant, resulting in the elimination of 1,039 pounds per year of phosphorus from entering the lake under existing conditions and potentially 2,740 pounds per year when the new treatment plant reaches its full capacity.

Disadvantages – The main disadvantage would be cost for extending the existing discharge point 3.35 miles to the west.

Costs – Approximately $1.9 million (12,360 of pipe and 62 manholes).

Advanced Phosphorus Removal at Slinger Treatment Plant

Concept – Typical wastewater influent phosphorus concentration is 6.0 mg/l. In conventional wastewater treatment; only about 20 to 30% of the phosphorus is removed from the waste stream (Henze et al, 1995). Additional phosphorus can be removed through the implementation of advanced biological phosphorus removal and/or chemical phosphorus removal.

In the biological phosphorus removal, the main actors are bacteria known as polyphosphate accumulating organisms (PAOs) whose ability to take up large amounts of phosphorus from phosphates by exposing them to alternating anaerobic and anoxic/aerobic conditions is exploited.

In chemical phosphorus removal, a metal salt (usually aluminium and iron salts) is used to convert the dissolved inorganic phosphorus compounds in the wastewater into a low solubility metal phosphate which can be removed in the subsequent sedimentation stage of an activated sludge process.

Additional phosphorus removal can be achieved when the above methods are combined with tertiary filtration such as sand filtration or other tertiary removal processes. The following are typical total phosphorus effluent limits that can be reached with advanced phosphorus removal (Lancaster, 2008):

Achievable NPDES TP Permit Limits with Advanced Phosphorus Removal:

- Secondary systems w/o filtration
  - Biological removal 0.75 mg/L
  - Chemical removal 0.50 mg/L
- Secondary systems with sand filtration 0.20 mg/L
- Tertiary chemical processes
  - Ballasted flocculation 0.10 mg/L
  - Tertiary filtration 0.10 mg/L
  - Dissolved air floatation 0.20 mg/L
  - Solids contact 0.10 mg/L
  - Membranes 0.05 mg/L

The advantages of the different advanced phosphorus removal methods include:

- Biological phosphorus removal
  - Lower operating cost
  - Less sludge production
  - Easier to operate
  - Safer
- Chemical phosphorus removal
  - More reliable
  - Lower concentrations possible
  - Smaller footprint
- Tertiary chemical phosphorus removal
  - Even lower concentrations possible

The disadvantages of the different advanced phosphorus removal methods include:

- Biological phosphorus removal
  - Potential for phosphorus release from sludge
  - Larger footprint
  - Less reliable
  - Dependent on certain carbon sources (VFAs)
- Chemical phosphorus removal
  - High sludge production
  - High operating costs (chemical use)
- Tertiary chemical processes
  - High capital costs
  - High operating cost (chemical use, power consumption)

Today the current Slinger wastewater treatment plant receives influent with total phosphorus concentrations typically between 1.2 and 5.2 mg/l/. Effluent concentrations achieved form treatment typically range from 0.1 to 1.1 mg/l, averaging about 0.6 mg/l (Village of Slinger). If the average phosphorus concentration in the effluent was reduced from 0.6 to 0.2 mg/l through the use of biological or chemical phosphorus removal combined with sand filtration the annual phosphorus loading from the plant under current conditions (1,039 pounds per year) could be reduced to 343 pounds per year a 67% reduction. Through this action, total in-lake phosphorus inputs would be reduced by 28.4% under current conditions.

Under future condition as the Slinger treatment plant expands to double its average daily flow capacity, from 0.76 MGD to 1.5MGD, the reductions by using advanced phosphorus removal becomes even more important. Table 5 summarizes the potential changes in total phosphorus inputs to Pike Lake assuming the treatment plant is operating at full capacity, nonpoint source inputs do not change, and the average effluent total phosphorus concentration is either 0.6 mg/l total phosphorus or 0.2 mg/l. Without implementation of advanced phosphorus removal the total phosphorus inputs to Pike Lake as the plant discharge doubles could increase by 48%. With advanced phosphorus removal the total phosphorus inputs to Pike Lake would decrease by 33% under current conditions and by 17% when the new wastewater treatment plant reaches its full design capacity.

Table 5

Effects of Different Effluent Total Phosphorus Concentrations on Pike Lake Inputs Under Existing and Proposed Village of Slinger Treatment Plant Flow Capacities

Treatment Plant Average Daily Flow (MGD)	Effluent Conc. Total P (mg/l)	Effluent Annual P Loading (lb/yr)	NPS Loading (2000)(lb/yr)	Total Loading to Lake (lb/yr)	Percent change from Existing
0.76	0.6	1388.1	1410.5	2798.6	-
1.50	0.6	2739.7	1410.5	4150.2	+48.3
0.76	0.2	462.7	1410.5	1873.2	-33.3
1.50	0.2	913.2	1410.5	2323.7	-17.0

The new Village of Slinger wastewater treatment plan has been designed to allow integration of advanced phosphorus removal in the future.

Advantages – Advanced phosphorus removal could reduce existing total phosphorus inputs to Pike Lake by 33% and prevent phosphorus inputs from increasing in the future as the volume of effluent increases as the new plant goes on line. Under this alternative, even as the treatment plant reaches full capacity in the future the phosphorus loadings to the lake will be less than they are today by as much as 17%.

Disadvantages – Disadvantages include the following:

- Increased capital cost to add biological or chemical phosphorus removal and sand filters.
- Increased cost of annual plant operation and maintenance
- Increase volume of sludge to be disposed of annually

Costs – (unknown at this time until consultant meets with Village of Slinger Public Works staff)

Trapping Pollutants Upstream

The following section will discuss alternatives that are designed to trap pollutants that are already in the Rubicon River before they have an opportunity to enter Pike Lake.

Alum Injection Upstream of Lake

Concept – The process of adding aluminum sulfate salt, otherwise known as alum, to stormwater is called alum injection. Alum causes fine particles to coalesce (or flocculate) into larger particles (USEPA, 2009). Alum injection can help meet downstream pollutant load reductions by reducing concentrations of fine particles and soluble phosphorus.

Alum treatment systems generally consist of three parts, a flow-weighted dosing system, storage tanks that provide alum to the doser, and a downstream pond that allows the alum, pollutants and sediments to settle out (Kurz, 1998). When injected into stormwater or stream flow, alum forms the harmless precipitates aluminum phosphate and aluminum hydroxide. These precipitates combine with heavy metals and phosphorus and sink into the sediment in a stable, inactive state (WEF, 1992). The collected mass of alum precipitates, pollutants and sediments is commonly referred to as floc. Dosage rates, which range from 5 to 10 mg of Al per liter, are determined on a flow-weighted basis (Harper, 1996).

It's important to dispose of the floc that settles in downstream basins because it contains high concentrations of dissolved chemicals, as well as viable bacteria and viruses (Kurz, 1998). In addition to the settling pond, a separate floc collection pump-out facility should be installed to reduce the chance of re-suspension and transport of floc to receiving waterbodies. The facility's pumps dispose of the floc into a sanitary sewer system, a nearby upland area, or a sludge drying bed. Pumping into a sanitary sewer system requires a permit, however. The quantity of sludge produced at a site can be as much as 0.5 percent of the volume of water treated (Gibb et al., 1991).

Operation and maintenance for alum treatment is critical. Some typical items include:

- Routine inspection and repair of equipment, including the doser and pump-out facility.
- A trained operator should be on-site to adjust the dosage of alum and other chemicals, and possibly to regulate flows through the basin.
- Floc stored on-site in drying beds will need to be disposed of regularly.
- The settling basin must be dredged periodically to dispose of accumulated floc.

Limited performance data of alum injection is available in Table 1. One study (Harper and Herr, 1996) found high removal rates for total suspended solids (TSS), total phosphorus (TP) and fecal coliform bacteria. Another study (Carr, 1998) showed mixed results on total phosphorus and ortho-phosphorus.

Table 6
Literature Values of Alum Injection Removal Rates

Study	TSS	TP	Dis.-P	TN	Fecal Coliform Bacteria	Heavy Metals	Zinc	NH3
Harper and Herr, 1996	95-99	85-95	90-95	60-70	99	50-90	-	-
Carr, 1998	-	37	42	52.2	-	-	41	24.5

If we assume a total phosphorus removal rate of 80%, an upstream alum injection system could reduce the existing phosphorus inputs from the Rubicon River by 1,549 pounds per year to 387 pounds per year, and total lake inputs from 2,449 pounds per year to 900.7 pounds per year, a 63% reduction.

Advantages – This alternative if properly designed could reduce total phosphorus inputs from both point and nonpoint sources of pollution.

Disadvantages – Disadvantages include:

- Capital cost to install alum injection system
- Need to construct a settling pond to collect the floc
- Need to dispose of floc
- Need for a professional operator for the system

Costs – Construction costs for alum treatment systems range from $135,000 to $400,000, depending on the watershed size. Operation and maintenance costs, including routine and chemical inspections, range from $6,500 to $25,000 per year (Harper and Herr, 1996).

Wetland Treatment Systems

Concept –Constructed wetlands are water quality treatment practices that incorporate wetland plants in a shallow pool. As stormwater runoff flows through the wetland, pollutant removal is achieved by settling and biological uptake. While natural wetlands can sometimes be used to treat stormwater runoff that has been properly pretreated, stormwater wetlands are fundamentally different from natural wetland systems. Stormwater wetlands are designed specifically for the purpose of treating stormwater runoff, are designed to encourage sheet flow through the system, and typically have less biodiversity than natural wetlands both in terms of plant and animal life. There are several design variations of the stormwater wetland, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland. Typical pollutant removal efficiencies for constructed wetlands is shown in Table 7.

Table 7.
Typical Pollutant Removal Rates of Wetlands (%) (Winer, 2000)

Pollutant	Stormwater Treatment Practice Design Variation			
	Shallow Marsh	ED Wetland[1]	Pond/Wetland System	Submerged Gravel Wetland[1]
Total Suspended Solids	83±51	69	71±35	83
Total Phosphorus	43±40	39	56±35	64
Total Nitrogen	26±49	56	19±29	19
Nitrite/nitrate	73±49	35	40±68	81
Metals	36 - 85	(-80) - 63	0 - 57	21 - 83
Bacteria	761	NA	NA	78

[1] Data based on fewer than five data points

To work effectively constructed wetlands need to consume about 3% to 5% of the land that drains to them. The Rubicon River watershed above Pike Lake is 7.85 square miles (5,088 acres) in size. To meet this design criteria a constructed wetland for treatment of the Rubicon River above Pike Lake would need to be between 153 and 254 acres in size.

Advantages – Constructed wetland act in a passive manner and require little annual maintenance. The wetland areas provide other benefits such as open space, wildlife habitat and aesthetics.

Disadvantages – The treatment practice consumes large geographic areas of land. Typically need to be built in low topographical areas to allow water to drain into and out of them by gravity. These areas are typically natural wetlands that need to be disturbed in the construction process. Permitting of constructed wetlands in Wisconsin is very difficult.

Costs – Cost of constructed wetlands can be $ 57,100 for a 1 acre-foot facility, $ 289,000 for a 10 acre-foot facility, and $ 1,470,000 for a 100 acre-foot facility (Brown and Schueler, 1997). Using these costs a constructed wetland to treat the entire Rubicon Rive system would be between $2,250,000 and $3,700,000.

Diversion Options

Diversion alternatives are practices that are designed to take pollutants that are already in the Rubicon River and diverting them around Pike Lake.

New channel along STH 60

Concept – The USGS study *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) documented that short-circuiting of the inflow of the Rubicon River to the outlet can provide reductions in the percent of phosphorus that enters Pike Lake. During the two year study the USGS estimated that the short-circuiting project implemented in 1995 provided a 65% reduction in phosphorus loading to Pike Lake. Unfortunately recent blockages of the diversion channel and erosion of new channel in the location of the old wetland breach are not allowing all of the flow of the Rubicon River to discharge directly into the lake. Reestablishing of a diversion of the Rubicon River could reduce phosphorus inputs to Pike Lake.

Figure 12 illustrates a plot of the percent of total phosphorus inputs to Pike Lake from the Rubicon River by average daily flow in cubic feet per second (cfs). From this graph we see for example, to reduce annual loading of total phosphorus by 70% we would need to bypass all flow events below 60 cfs. To bypass these flows into the bypass channel a diversion weir would need to be installed to force low-flows into the bypass and allow higher flows to enter the lake.

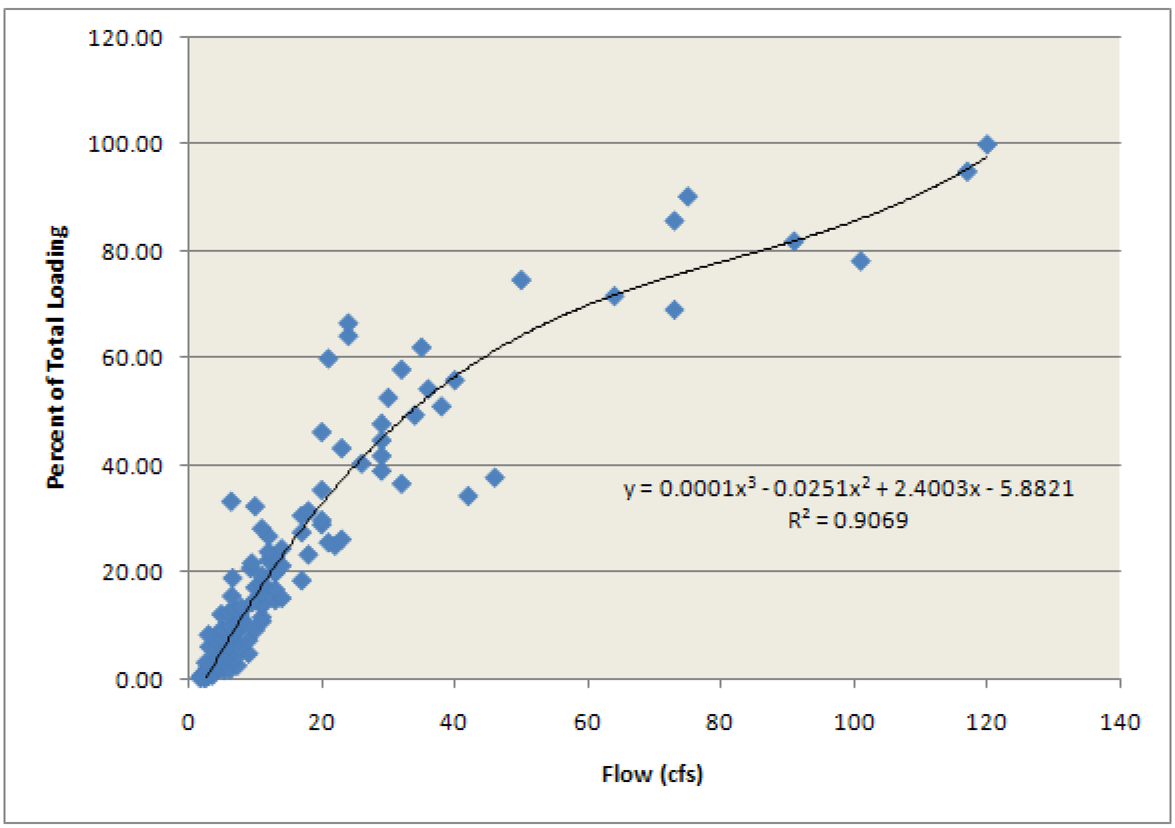

Figure 12
Plot of the Percent of Total Phosphorus Inputs to Pike Lake from the Rubicon River by Average Daily Flow

Construction of a new bypass channel along STH 60 would need to be located either north or south of the highway. Figure 13 illustrates two potential routes for the channel. A channel to the north of the highway would need to cross 4 private properties, cut through a hill 10-12 feet high, have a top with at its widest point of 77-feet, and have a length of approximately 1,250 feet. A channel south of the highway would be located in mapped wetland owned by the Town of Hartford. The channel would need to be 4 feet deep and have a length of approximately 1,100 feet.

Figure 13
Potential Routes for Diversion Channel along STH 60

Advantages – A properly designed diversion channel could restore the short-circuiting of the Rubicon River that took place prior to the 1960's. A channel designed to bypass the first 60 cfs of flow could reduce the total phosphorus inputs from the Rubicon River by 70% and total loading to the lake under existing conditions by 55.3%.

Disadvantages – A channel located north of STH 60 would require a channel that would be cut through four private properties, have a maximum cut depth of 10- to 12-feet, a channel width at its widest point of 77-feet, and disturb 0.4 acres of wetland. The channel would consume much of the front area of each developed lot and would completely eliminate the parking lot on the Timlin's property.

A channel south of STH 60 would disturb 0.9 acres of wetland.

Figure 14 illustrates the percent of annual flow into Pike Lake from the Rubicon River attributed by each range of flow in cfs. We see from this graph that if we bypass the first 60 cfs of flow, we would reduce the annual input of water from the river by approximately 70%, and total flow to the lake by 38.3%

Costs – Assuming a cost of $75/foot for channel construction, a channel north of STH 60 with a diversion weir would cost approximately $119,000 and south of the highway approximately $107,500.   These costs do not include design, permitting or acquisition of easements.

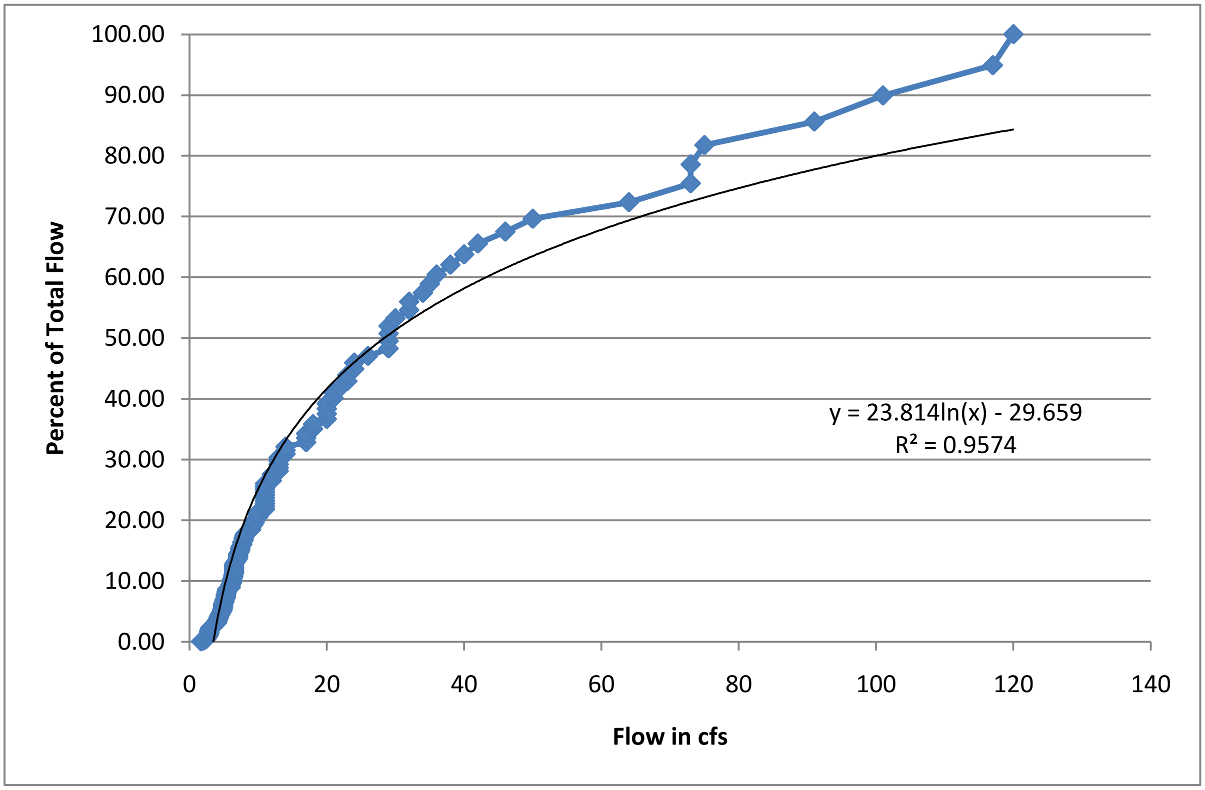

Figure 14
Percent of Annual Flow into Pike Lake from the Rubicon River Attributed by Each Range of Flow in Cubic Feet per Second (cfs)

Replacement of the Channel Plug in the Marsh on North End of Lake

Concept - The USGS study *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) documented that short-circuiting of the inflow of the Rubicon River to the outlet can provide reductions in the percent of phosphorus that enters Pike Lake. During the two year study the USGS estimated that the short-circuiting project implemented in 1995 provided a 65% reduction in phosphorus loading to Pike Lake. Unfortunately recent blockages of the diversion channel and erosion of new channel in the location of the old wetland breach are not allowing all of the flow of the Rubicon River to discharge directly into the lake. Reestablishing of a diversion of the Rubicon River could reduce phosphorus inputs to Pike Lake.

Under this alternative the original plug placed in 1995 would be replaced. The beaver dam in the diversion channel, which is causing sediment to accumulate in the channel, would be removed and the existing sediment in the channel would be allowed to scour downstream.

The 1995 plug was constructed with a compacted clay plug and 12-inch rip-rap on the lake side of the structure. Assuming that structure was constructed to specification, we see that even an engineered earthen structure is prone to damage during flood events that exceed the 100-year frequency.

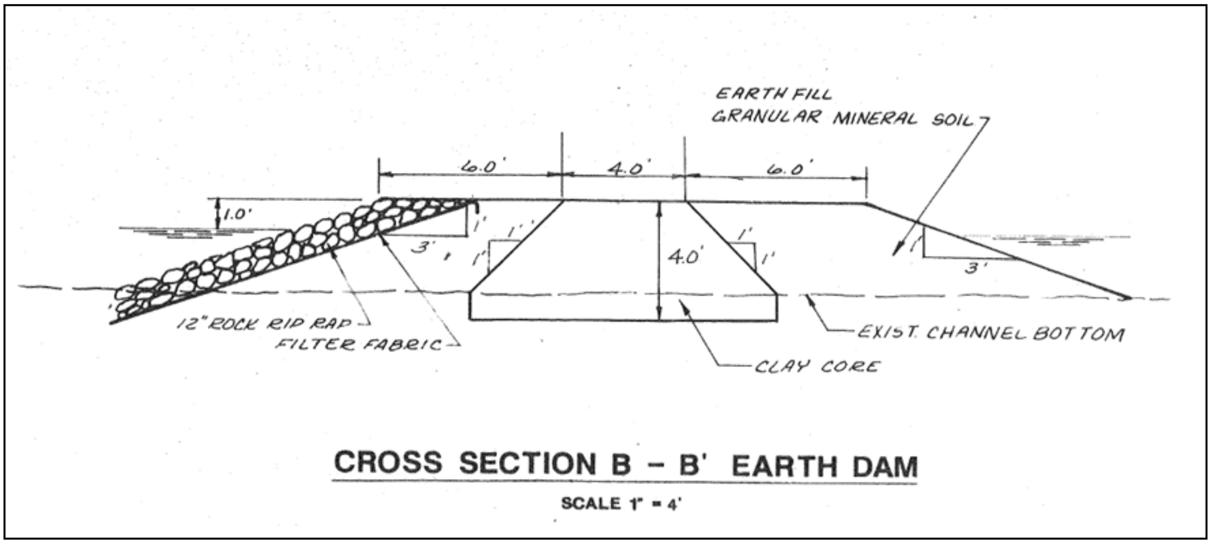

Figure 15
Cross Section of Wetland Plug Installed in 1995
(Source: R. A. Smith National)

To replace the plug there are several options:

- Replace the 1995 earthen structure, understanding that it may be damaged during another major flood event.
- Replace the plug with a structure that could withstand major floods such as a sheet-pile wall.
- Replace the structure with a low cost structure that likely fail in large flood events but would be easily replaced. Figure 16 illustrates a low cost alternative structure made out of steel cable and wire mesh fencing, called a “Cable Dam”.

Cable dams have been described as man-made beaver dams. They are designed to trap debris and over time become very compact with material creating a structure that inhibits water flow and resembles a beaver dam. They are low cost to construct and can be assembled without heavy construction equipment.

Advantages – the advantage of replacing the plug is it could utilize the existing diversion channel that was constructed in 1995. The previous study by USGS illustrated that the diversion channel combined with the plug could short-circuit 65% of the Rubicon River phosphorus loadings.

Disadvantages – Disadvantages of replacing the plug include:

- Potential disturbance to the marsh areas near the plug during construction.

- Aesthetics would be a concern if a sheet-pile or other man-made material was used to construct the structure.
- Installation of this practice may provide disincentive to implementing other upstream source controls, as public may perceive this is all that is need to protect the lake.

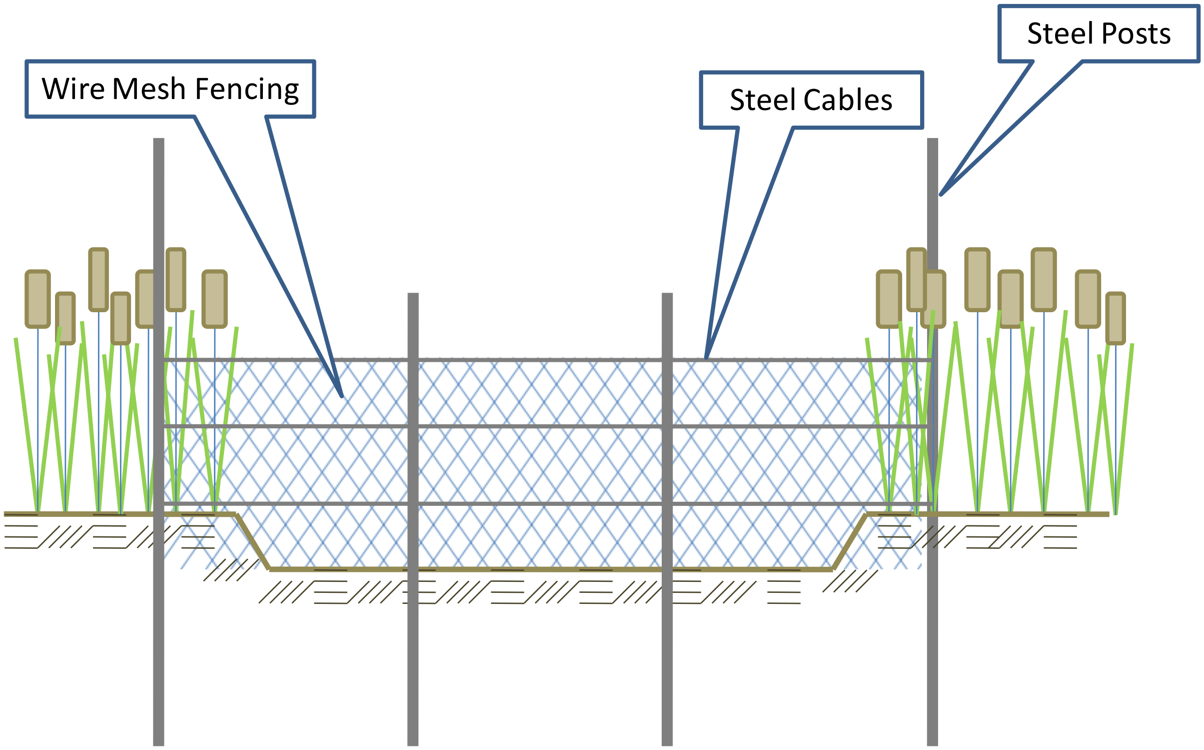

Figure 16
Cross-Section Cable Dam

Costs – Cost for the plug replacement will vary depending on the type of structure used. The following are cost estimates for three types of structures:

• 1995 style earthen plug	$50,000 to $75,000
• Steel sheet pile plug (60-feet)	$25,000 to $50,000
• Cable Dam	$ 2,500 to $7,500

RECOMMENDATIONS

Pike Lake today has in-lake phosphorus concentrations above the level of 20 ug/l recommended by SEWRPC in the Commissions adopted regional water quality management plan to prevent nuisance algae blooms. The USGS in their report titled *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) identified that proposed doubling of the size of the Village of Slinger wastewater treatment plant could increase in lake phosphorus concentrations by 26.4% to as high as 35 ug/l, resulting in a 15.1% increase in chlorophyll a and 5.3% reduction in water clarity. To reduce in-lake total phosphorus concentrations to below the SEWRPC recommended level of 20 ug/l, assuming no inlet short-circuiting, existing inputs levels need to be reduced by 72% and future levels with the expansion of the treatment plant in Slinger by as much as 85%. Without mitigation measure SEWRPC predicts that Pike Lake will fall further into the impaired classification.

Phosphorus is entering Pike Lake from a variety of sources with the most important being nonpoint source pollution (57.6%) and the Slinger Wastewater Treatment Plant (42.4%). A review of management alternatives shows that control of any one source alone will not achieve the needed reductions in phosphorus inputs to the lake. Therefore the following series of recommendations are made to achieve the proposed reduction goals. Implementation of all of the recommendations will be needed to protect Pike Lake. Implementation of only one will not achieve the needed in-lake phosphorus levels.

Recommendation 1: Nonpoint Source Controls in watershed

In the 2000 USGS study (Rose, et al., 2004) it was estimated that 2,441 pounds of phosphorus enter Pike Lake on an annual basis. Of this total amount 1,410.5 pounds, or 57.6%, is the result of nonpoint source pollution. Within the Rubicon River watershed 897 pounds per year, or 46.3%, of the total phosphorus input is from nonpoint sources. The major source of nonpoint source pollution phosphorus inputs (40.3% total and 35.0% to the Rubicon River) is from agriculture.

SEWRPC in *A Lake Management Plan for Pike Lake Washington County Wisconsin* outlines a number of recommended nonpoint source controls for the Pike Lake watershed. In the management plan SEWRPC recommends a reduction of 25% in urban and rural nonpoint-sourced pollutants plus streambank erosion control, construction site erosion control, and onsite sewage disposal system management be achieved. A 25% reduction in existing nonpoint source pollution would result in a 353 pound per year reduction in phosphorus inputs from the entire watershed and 224 pound per year reduction from the Rubicon River watershed. This action would reduce the total phosphorus input to the lake from 2,450 pounds per year to 2,097 pounds per year or a total reduction of 14.4%.

Implementation of nonpoint source pollution controls would achieve a percentage of the needed 72% reduction in existing phosphorus sources to the lake. Implementing these practices watershed wide would help reduce the nutrient inputs not only from the Rubicon River but also the watershed area south of STH 60. The Washington County Land Conservation Department should take the lead in working with agricultural land owners in implementing agricultural runoff controls. The Pike Lake Inland Lake Protection and Rehabilitation District should consider developing a cost share funding program to assist with the implementation of nonpoint sources control practices when state or federal assistance is not available.

Recommendation 2: Advanced Phosphorus Removal at Slinger Treatment Plant

Typical wastewater influent phosphorus concentration is 6.0 mg/l. In conventional wastewater treatment; only about 20 to 30% of the phosphorus is removed from the waste stream (Henze et al, 1995). Additional phosphorus can be removed through the implementation of advanced biological phosphorus removal and/or chemical phosphorus removal.

Today the current Slinger wastewater treatment plant receives influent with total phosphorus concentrations typically between 1.2 and 5.2 mg/l/. Effluent concentrations achieved form treatment typically range from 0.1 to 1.1 mg/l, averaging about 0.6 mg/l (Village of Slinger). If the average phosphorus concentration in the effluent was reduced from 0.6 to 0.2 mg/l through the use of biological or chemical phosphorus removal combined with sand filtration the annual phosphorus loading from the plant under current conditions (1,039 pounds per year) could be reduced to 343 pounds per year a 67% reduction. Through this action, total in-lake phosphorus inputs would be reduced by 28.4% under current conditions.

Under future condition as the Slinger treatment plant expands to double its average daily flow capacity, from 0.76 MGD to 1.5MGD, the reductions by using advanced phosphorus removal becomes even more important. Without implementation of advanced phosphorus removal the total phosphorus inputs to Pike Lake as the plant discharge doubles could increase by 48%. With advanced phosphorus removal the total phosphorus inputs to Pike Lake would decrease by 33% under current conditions and by 17% when the new wastewater treatment plant reaches its full design capacity. The current Wisconsin water quality regulations do not require treatment below 1 mg/l, the WDNR is considering new stream and lake water quality standards that could allow discharge requirements below the 1 mg/l level. Regardless of the actions by the state on new phosphorus standards, the Village of Slinger should install advanced phosphorus removal to protect Pike Lake.

Recommendation 3: Replacement of the Channel Plug with Cable Dam

The USGS study *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) documented that short-circuiting of the inflow of the Rubicon River to the outlet can provide reductions in the percent of phosphorus that enters Pike Lake. During the two year study the USGS estimated that the short-circuiting project implemented in 1995 provided a 65% reduction in phosphorus loading to Pike Lake. Unfortunately recent blockages of the diversion channel and erosion of a new channel in the location of the old wetland breach are not allowing all of the flow of the Rubicon River to discharge directly into the lake. Reestablishing of a diversion of the Rubicon River could reduce phosphorus inputs to Pike Lake. The use of an earthen plug or sheet piling could be effective, however would require access by heavy equipment and have high costs. At this time a cable dam is recommended for its low cost and minimal disturbance to the existing marsh area.

Recommendation 4: Continued Management of Beavers in the Rubicon River.

In July 2007 a survey by Hey and Associates of the Rubicon River channel identified that all of the flow of the river was flowing through the breach into the lake and no flow was going to the west towards the outlet. The westerly channel from the breach to the outlet was blocked by a beaver dam. In 2008 the beaver dam was removed by a local resident. Beaver are well established in the Rubicon River system and could return to the Inlet of Pike Lake, again causing a blockage of flow. Annually a survey of the Rubicon River at the north end of Pike Lake should be conducted to determine if beaver have returned and are constructing structures that are impeding flow. The beaver should be removed by trapping. Information on trapping regulations can be found at the Wisconsin DNR website at: www.dnr.wi.gov/org/land/wildlife/trap/.

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Appendix A
On October 1, 2008 the Wisconsin Department of Natural Resource Permit for Slinger Waste Water Treatment Plant

WPDES PERMIT

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

PERMIT TO DISCHARGE UNDER THE WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM

Slinger Wastewater Treatment Facility

is permitted, under the authority of Chapter 283, Wisconsin Statutes, to discharge from a facility located at
280 Hartford Road, Slinger WI 53086
to

a tributary to the Rubicon River in Washington County

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

The permittee shall not discharge after the date of expiration. If the permittee wishes to continue to discharge after this expiration date an application shall be filed for reissuance of this permit, according to Chapter NR 200, Wis. Adm. Code, at least 180 days prior to the expiration date given below.

State of Wisconsin Department of Natural Resources
For the Secretary

By ______________________________
Timothy Thompson
Basin Engineer

____
Date Permit Signed/Issued

PERMIT TERM: EFFECTIVE DATE - October 01, 2008 **EXPIRATION DATE - September 30, 2013**

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1 Influent Requirements

1.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
701	Influent 24 hour sampler intake located at a point prior to bar screening and before the addition of any side stream.

1.2 Monitoring Requirements

The permittee shall comply with the following monitoring requirements.

1.2.1 Sampling Point 701 - INFLUENT PLANT

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Continuous	Continuous	
BOD_5, Total		mg/L	3/Week	24-Hr Flow Prop Comp	
Suspended Solids, Total		mg/L	3/Week	24-Hr Flow Prop Comp	
Phosphorus, Total		mg/L	2/Month	24-Hr Flow Prop Comp	
Nickel, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The influent sample shall be taken on the day before the effluent sample. Also see the notes for effluent zinc and copper monitoring in Section 2.
Zinc, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The influent sample shall be taken on the day before the effluent sample. Also see the notes for effluent zinc and copper monitoring in Section 2.

2 Surface Water Requirements

2.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
001	Effluent 24 hour sampler intake located at a point after the UV system but before the Parshall flume. Grab samples shall be collected from the reaeration steps.

2.2 Monitoring Requirements and Effluent Limitations

The permittee shall comply with the following monitoring requirements and limitations.

2.2.1 Sampling Point (Outfall) 001 - EFFLUENT

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Continuous	Continuous	
BOD_5, Total	Daily Max	30 mg/L	3/Week	24-Hr Comp	
BOD_5, Total	Monthly Avg	15 mg/L	3/Week	24-Hr Comp	
Suspended Solids, Total	Daily Max	30 mg/L	3/Week	24-Hr Comp	
Suspended Solids, Total	Monthly Avg	20 mg/L	3/Week	24-Hr Comp	
Nitrogen, Ammonia (NH_3-N) Total	Daily Max	17 mg/L	2/Week	24-Hr Comp	Year round limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	6.4 mg/L	2/Week	24-Hr Comp	April limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	2.6 mg/L	2/Week	24-Hr Comp	May-September limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	9.1 mg/L	2/Week	24-Hr Comp	October limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	10 mg/L	2/Week	24-Hr Comp	November-March limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	2.6 mg/L	2/Week	24-Hr Comp	April limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	1.0 mg/L	2/Week	24-Hr Comp	May-September limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	3.6 mg/L	2/Week	24-Hr Comp	October limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	4.1 mg/L	2/Week	24-Hr Comp	November-March limit
pH Field	Daily Max	9.0 su	Daily	Grab	
pH Field	Daily Min	6.0 su	Daily	Grab	

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Dissolved Oxygen	Daily Min	4.0 mg/L	5/Week	Grab	
Fecal Coliform	Geometric Mean	400 #/100 ml	Weekly	Grab	May-September only
Phosphorus, Total	Monthly Avg	1.0 mg/L	3/Week	24-Hr Comp	
Nickel, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The effluent sample shall be taken on the day after the influent sample. If possible, the effluent sample should be on a day when a chronic WET sample is taken.
Zinc, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The effluent sample shall be taken on the day after the influent sample. If possible, the effluent sample should be on a day when a chronic WET sample is taken.
Chloride	Weekly Avg	605 mg/L	4/Month	24-Hr Flow Prop Comp	Monitoring shall be done on four consecutive days each month. Also see section 2.2.1.4
Acute WET		TU_a	Quarterly	24-Hr Flow Prop Comp	Twice during permit term. See section 2.2.1.3 for listed quarters
Chronic WET	Daily Max	1.0 rTU_c	Quarterly	24-Hr Flow Prop Comp	See section 2.2.1.3 for potential removal of limit.

2.2.1.1 Average Annual Design Flow

The average annual design flow of the permittee's wastewater treatment facility is 1.5 MGD.

2.2.1.2 Sample Analyses

Samples shall be analyzed using a method which provides adequate sensitivity so that results can be quantified, unless not possible using the most sensitive approved method.

2.2.1.3 Whole Effluent Toxicity (WET) Testing

Primary Control Water: Since the receiving water may be near or at zero flow upstream of the discharge during various times of the year, moderately hard laboratory water may be used for control water.

Instream Waste Concentration (IWC): 100%

Dilution series: At least five effluent concentrations and dual controls must be included in each test.

- **Acute:** 100, 50, 25, 12.5, 6.25% and any additional selected by the permittee.
- **Chronic:** 100, 30, 10, 3, 1% (if the IWC ≤30%) or 100, 75, 50, 25, 12.5% and any additional selected by the permittee.

WET Testing Frequency: Tests are required during the following quarters.

- **Acute:** July-September 2010; January-March 2012
- **Chronic:** The quarterly monitoring and limit of 1.0 rTUc shall continue beginning from the first quarter of 2009. The limit may be discontinued if there are no chronic toxicity failures within the first eight quarters of monitoring (ending at the fourth quarter of 2010) and subsequent monitoring frequency may be reduced to once per year.

Reporting: The permittee shall report test results on the Discharge Monitoring Report form, and also complete the "Whole Effluent Toxicity Test Report Form" (Section 6, "*State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition*"), for each test. The original, complete, signed version of the Whole Effluent Toxicity Test Report Form shall be sent to the Biomonitoring Coordinator, Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, WI 53707-7921, within 45 days of test completion. The original Discharge Monitoring Report (DMR) form and one copy shall be sent to the contact and location provided on the DMR by the required deadline.

Determination of Positive Results: An acute toxicity test shall be considered positive if the Toxic Unit - Acute (TU_a) is greater than 1.0 for either species. The TU_a shall be calculated as follows: If $LC_{50} \geq 100$, then $TU_a = 1.0$. If LC_{50} is < 100, then $TU_a = 100 \div LC_{50}$. A chronic toxicity test shall be considered positive if the Relative Toxic Unit - Chronic (rTU_c) is greater than 1.0 for either species. The rTU_c shall be calculated as follows: If $IC_{25} \geq IWC$, then $rTU_c = 1.0$. If $IC_{25} < IWC$, then $rTU_c = IWC \div IC_{25}$.

Additional Testing Requirements: Within 90 days of a test which showed positive results, the permittee shall submit the results of at least 2 retests to the Biomonitoring Coordinator on "Whole Effluent Toxicity Test Report Forms". The retests shall be completed using the same species and test methods specified for the original test (see the Standard Requirements section herein).

2.2.1.4 Chloride Variance – Implement Source Reduction Measures

This permit contains a variance to the water quality-based effluent limit (WQBEL) for chloride granted in accordance with s. NR 106.83(2), Wis. Adm. Code. As conditions of this variance the permittee shall (a) maintain effluent quality at or below the interim effluent limitation specified in the table above, (b) implement the chloride source reduction measures, including, but not limited to, the measures specified below, and (c) perform the actions listed in the compliance schedule. (See the Schedules of Compliance section herein.):

--Submit a plan to continue to identify and quantify sources of chloride to the sewer system. Specifically, the plan should define procedures for identification and sampling of chloride for industries, for Hillside Sanitary District, and for newer subdivisions – As part of the 6/30/09 annual report.

--Implement the plan above – during remainder of permit term.

--Continue to educate customers on the impacts of chloride from residential softeners, recommend periodic tune-ups for softeners, and emphasize the importance of increasing softener efficiency.

--Track daily acceptance of domestic septic tank and holding tank hauled waste – on discharge monitoring reports

--Conduct quarterly monitoring on hauled domestic waste for chloride. The sample shall be a composite of equal portions from each truckload of waste. Holding tank waste and septic tank waste may be commingled for the samples – on discharge monitoring reports, beginning in the first quarter of 2009.

-- In the event of a request for acceptance of hauled commercial or industrial waste, conduct an analysis for chloride of the proposed discharge prior to an agreement to accept the waste.

3 Land Application Requirements

3.1 Sampling Point(s)

The discharge(s) shall be limited to land application of the waste type(s) designated for the listed sampling point(s) on Department approved land spreading sites or by hauling to another facility.

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
002	Aerobically digested, gravity thickened, liquid sludge, sampled from the discharge end of the sludge mixing pump.

3.2 Monitoring Requirements and Limitations

The permittee shall comply with the following monitoring requirements and limitations.

3.2.1 Sampling Point (Outfall) 002 - Sludge

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Arsenic Dry Wt	Ceiling	75 mg/kg	Annual	Grab	
Arsenic Dry Wt	High Quality	41 mg/kg	Annual	Grab	
Cadmium Dry Wt	Ceiling	85 mg/kg	Quarterly	Grab	
Cadmium Dry Wt	High Quality	39 mg/kg	Quarterly	Grab	
Copper Dry Wt	Ceiling	4,300 mg/kg	Quarterly	Grab	
Copper Dry Wt	High Quality	1,500 mg/kg	Quarterly	Grab	
Lead Dry Wt	Ceiling	840 mg/kg	Quarterly	Grab	
Lead Dry Wt	High Quality	300 mg/kg	Quarterly	Grab	
Mercury Dry Wt	Ceiling	57 mg/kg	Quarterly	Grab	
Mercury Dry Wt	High Quality	17 mg/kg	Quarterly	Grab	
Molybdenum Dry Wt	Ceiling	75 mg/kg	Quarterly	Grab	
Nickel Dry Wt	Ceiling	420 mg/kg	Quarterly	Grab	
Nickel Dry Wt	High Quality	420 mg/kg	Quarterly	Grab	
Nitrogen, Ammonium (NH_4-N) Total		Percent	Annual	Grab	
Nitrogen, Total Kjeldahl		Percent	Annual	Grab	
Phosphorus, Total		Percent	Annual	Grab	
Potassium, Total Recoverable		Percent	Annual	Grab	
Phosphorus, Water Extractable		Percent	Annual	Grab	
Selenium Dry Wt	Ceiling	100 mg/kg	Quarterly	Grab	
Selenium Dry Wt	High Quality	100 mg/kg	Quarterly	Grab	
Solids, Total		Percent	Quarterly	Grab	

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Zinc Dry Wt	Ceiling	7,500 mg/kg	Quarterly	Grab	
Zinc Dry Wt	High Quality	2,800 mg/kg	Quarterly	Grab	
PCB Total Dry Wt	Ceiling	50 mg/kg	Once	Grab	See section 3.2.1.5
PCB Total Dry Wt	High Quality	10 mg/kg	Once	Grab	"See section 3.2.1.5

Other Sludge Requirements	
Sludge Requirements	**Sample Frequency**
List 3 Requirements – Pathogen Control: The requirements in List 3 shall be met prior to land application of sludge.	**Annual**
List 4 Requirements – Vector Attraction Reduction: The vector attraction reduction shall be satisfied prior to, or at the time of land application as specified in List 4.	**Annual**

3.2.1.1 List 2 Analysis

If the monitoring frequency for List 2 parameters is more frequent than "Annual" then the sludge may be analyzed for the List 2 parameters just prior to each land application season rather than at the more frequent interval specified.

3.2.1.2 Changes in Feed Sludge Characteristics

If a change in feed sludge characteristics, treatment process, or operational procedures occurs which may result in a significant shift in sludge characteristics, the permittee shall reanalyze the sludge for List 1, 2, 3 and 4 parameters each time such change occurs.

3.2.1.3 Multiple Sludge Sample Points (Outfalls)

If there are multiple sludge sample points (outfalls), but the sludges are not subject to different sludge treatment processes, then a separate List 2 analysis shall be conducted for each sludge type which is land applied, just prior to land application, and the application rate shall be calculated for each sludge type. In this case, List 1, 3, and 4 and PCBs need only be analyzed on a single sludge type, at the specified frequency. If there are multiple sludge sample points (outfalls), due to multiple treatment processes, List 1, 2, 3 and 4 and PCBs shall be analyzed for each sludge type at the specified frequency.

3.2.1.4 Sludge Which Exceeds the High Quality Limit

Cumulative pollutant loading records shall be kept for all bulk land application of sludge which does not meet the high quality limit for any parameter. This requirement applies for the entire calendar year in which any exceedance of Table 3 of s. NR 204.07(5)(c), is experienced. Such loading records shall be kept for all List 1 parameters for each site land applied in that calendar year. The formula to be used for calculating cumulative loading is as follows:

[(Pollutant concentration (mg/kg) x dry tons applied/ac) ÷ 500] + previous loading (lbs/acre) = cumulative lbs pollutant per acre

When a site reaches 90% of the allowable cumulative loading for any metal established in Table 2 of s. NR 204.07(5)(b), the Department shall be so notified through letter or in the comment section of the annual land application report (3400-55).

3.2.1.5 Sludge Analysis for PCBs

The permittee shall analyze the sludge for Total PCBs one time during **2009**. The results shall be reported as "PCB Total Dry Wt". Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with Table EM in s. NR 219.04, Wis. Adm. Code and the conditions specified in Standard Requirements of this permit. PCB results shall be submitted by January 31, following the specified year of analysis.

3.2.1.6 Lists 1, 2, 3, and 4

List 1 **TOTAL SOLIDS AND METALS** See the Monitoring Requirements and Limitations table above for monitoring frequency and limitations for the List 1 parameters
Solids, Total (percent)
Arsenic, mg/kg (dry weight)
Cadmium, mg/kg (dry weight)
Copper, mg/kg (dry weight)
Lead, mg/kg (dry weight)
Mercury, mg/kg (dry weight)
Molybdenum, mg/kg (dry weight)
Nickel, mg/kg (dry weight)
Selenium, mg/kg (dry weight)
Zinc, mg/kg (dry weight)

List 2 **NUTRIENTS** See the Monitoring Requirements and Limitations table above for monitoring frequency for the List 2 parameters
Solids, Total (percent)
Nitrogen Total Kjeldahl (percent)
Nitrogen Ammonium (NH4-N) Total (percent)
Phosphorus Total as P (percent)
Phosphorus, Water Extractable (as percent of Total P)
Potassium Total Recoverable (percent)

List 3 **PATHOGEN CONTROL FOR CLASS B SLUDGE** The permittee shall implement pathogen control as listed in List 3. The Department shall be notified of the pathogen control utilized and shall be notified when the permittee decides to utilize alternative pathogen control. The following requirements shall be met prior to land application of sludge.		
Parameter	**Unit**	**Limit**
Fecal Coliform*	MPN/gTS or CFU/gTS	2,000,000
OR, ONE OF THE FOLLOWING PROCESS OPTIONS		
Aerobic Digestion	Air Drying	
Anaerobic Digestion	Composting	
Alkaline Stabilization	PSRP Equivalent Process	
* The Fecal Coliform limit shall be reported as the geometric mean of 7 discrete samples on a dry weight basis.		

List 4 **VECTOR ATTRACTION REDUCTION** The permittee shall implement any one of the vector attraction reduction options specified in List 4. The Department shall be notified of the option utilized and shall be notified when the permittee decides to utilize an alternative option. One of the following shall be satisfied prior to, or at the time of land application as specified in List 4.		
Option	**Limit**	**Where/When it Shall be Met**
Volatile Solids Reduction	≥38%	Across the process
Specific Oxygen Uptake Rate	≤1.5 mg O_2/hr/g TS	On aerobic stabilized sludge
Anaerobic bench-scale test	<17 % VS reduction	On anaerobic digested sludge
Aerobic bench-scale test	<15 % VS reduction	On aerobic digested sludge
Aerobic Process	>14 days, Temp >40°C and Avg. Temp > 45°C	On composted sludge
pH adjustment	>12 S.U. (for 2 hours) and >11.5 (for an additional 22 hours)	During the process
Drying without primary solids	>75 % TS	When applied or bagged
Drying with primary solids	>90 % TS	When applied or bagged
Equivalent Process	Approved by the Department	Varies with process
Injection	-	When applied
Incorporation	-	Within 6 hours of application

3.2.1.7 Daily Land Application Log

Daily Land Application Log		
Discharge Monitoring Requirements and Limitations The permittee shall maintain a daily land application log for biosolids land applied each day when land application occurs. The following minimum records must be kept, in addition to all analytical results for the biosolids land applied. The log book records shall form the basis for the annual land application report requirements**.**		
Parameters	**Units**	**Sample Frequency**
DNR Site Number(s)	Number	Daily as used
Outfall number applied	Number	Daily as used
Acres applied	Acres	Daily as used
Amount applied	As appropriate * /day	Daily as used
Application rate per acre	unit */acre	Daily as used
Nitrogen applied per acre	lb/acre	Daily as used
Method of Application	Injection, Incorporation, or surface applied	Daily as used

*gallons, cubic yards, dry US Tons or dry Metric Tons

4 Schedules of Compliance

4.1 Chloride Target Value

As a condition of the variance to the water quality based effluent limitation(s) for chloride granted in accordance with s. NR 106.83(2), Wis. Adm. Code, the permittee shall perform the following actions.

Required Action	Date Due
Annual Chloride Progress Report: Submit an annual progress report, that shall indicate the chloride source reduction measures have been implemented, with supporting documentation. This report shall also contain a plan to continue to identify and quantify sources of chloride to the sewer system, as noted in Section 2.2.1.4 of this permit. Note that the interim limitation of 605 mg/l, weekly average, remains enforceable until new enforceable limits are established in the next permit issuance. The first annual chloride progress report is to be submitted by the Date Due.	06/30/2009
Annual Chloride Progress Report #2: Submit a chloride progress report.	06/30/2010
Annual Chloride Progress Report #3: Submit a chloride progress report.	06/30/2011
Annual Chloride Progress Report #4: Submit a chloride progress report.	06/30/2012
Final Chloride Report: Submit a final report documenting the success in meeting the chloride target value of 450 mg/l, weekly average, as well as the anticipated future reduction in chloride sources and chloride effluent concentrations. This report shall also include proposed target values and source reduction measures for negotiations with the department if the permittee intends to seek a renewed chloride variance per s. NR 106.83, Wis. Adm. Code, for the reissued permit. Note that the target value is the benchmark for evaluating the effectiveness of the chloride source reduction measures, but is not an enforceable limitation under the terms of this permit.	06/30/2013

4.2 Development of Local Limits for Metal Pollutants

In order to protect the quality of effluent wastewater and sludge produced at the WWTP, the permittee shall amend its current sewer use ordinance (SUO) to include local limits for metal pollutants by implementing the following actions.

Required Action	Date Due
Develop local limits for metal pollutants : Develop and submit for Department review, local limits for metals - cadmium, chromium, copper, lead, nickel, and zinc. In developing the local limits, a procedure for allocation of maximum allowable headworks loadings shall be used.	12/31/2009
Sewer Use Ordinance Amendment: : Submit for the Department's review, a draft of an amendment proposal to the Village's Sewer Use Ordinance (SUO) to include the approved local limits for metal pollutants. The SUO amendment proposal shall include adequate legal authority language to ensure implementation of the approved local limits	06/30/2010
Complete action:: Complete all actions necessary for the development of the local limits and the SUO amendment. Implement amended SUO.	12/31/2010

5 Standard Requirements

NR 205, Wisconsin Administrative Code: The conditions in ss. NR 205.07(1) and NR 205.07(2), Wis. Adm. Code, are included by reference in this permit. The permittee shall comply with all of these requirements. Some of these requirements are outlined in the Standard Requirements section of this permit. Requirements not specifically outlined in the Standard Requirement section of this permit can be found in ss. NR 205.07(1) and NR 205.07(2).

5.1 Reporting and Monitoring Requirements

5.1.1 Monitoring Results

Monitoring results obtained during the previous month shall be summarized and reported on a Department Wastewater Discharge Monitoring Report. The report may require reporting of any or all of the information specified below under 'Recording of Results'. This report is to be returned to the Department no later than the date indicated on the form. When submitting a paper Discharge Monitoring Report form, the original and one copy of the Wastewater Discharge Monitoring Report Form shall be submitted to the return address printed on the form. A copy of the Wastewater Discharge Monitoring Report Form or an electronic file of the report shall be retained by the permittee.

All Wastewater Discharge Monitoring Reports submitted to the Department should be submitted using the electronic Discharge Monitoring Report system. Permittees who may be unable to submit Wastewater Discharge Monitoring Reports electronically may request approval to submit paper DMRs upon demonstration that electronic reporting is not feasible or practicable.

If the permittee monitors any pollutant more frequently than required by this permit, the results of such monitoring shall be included on the Wastewater Discharge Monitoring Report.

The permittee shall comply with all limits for each parameter regardless of monitoring frequency. For example, monthly, weekly, and/or daily limits shall be met even with monthly monitoring. The permittee may monitor more frequently than required for any parameter.

An Electronic Discharge Monitoring Report Certification sheet shall be signed and submitted with each electronic Discharge Monitoring Report submittal. This certification sheet, which is not part of the electronic report form, shall be signed by a principal executive officer, a ranking elected official or other duly authorized representative and shall be mailed to the Department at the time of submittal of the electronic Discharge Monitoring Report. The certification sheet certifies that the electronic report form is true, accurate and complete. Paper reports shall be signed by a principal executive officer, a ranking elected official, or other duly authorized representative.

5.1.2 Sampling and Testing Procedures

Sampling and laboratory testing procedures shall be performed in accordance with Chapters NR 218 and NR 219, Wis. Adm. Code and shall be performed by a laboratory certified or registered in accordance with the requirements of ch. NR 149, Wis. Adm. Code. Groundwater sample collection and analysis shall be performed in accordance with ch. NR 140, Wis. Adm. Code. The analytical methodologies used shall enable the laboratory to quantitate all substances for which monitoring is required at levels below the effluent limitation. If the required level cannot be met by any of the methods available in NR 219, Wis. Adm. Code, then the method with the lowest limit of detection shall be selected. Additional test procedures may be specified in this permit.

5.1.3 Recording of Results

The permittee shall maintain records which provide the following information for each effluent measurement or sample taken:

- the date, exact place, method and time of sampling or measurements;

- the individual who performed the sampling or measurements;
- the date the analysis was performed;
- the individual who performed the analysis;
- the analytical techniques or methods used; and
- the results of the analysis.

5.1.4 Reporting of Monitoring Results

The permittee shall use the following conventions when reporting effluent monitoring results:

- Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 0.1 mg/L, report the pollutant concentration as < 0.1 mg/L.

- Pollutant concentrations equal to or greater than the limit of detection, but less than the limit of quantitation, shall be reported and the limit of quantitation shall be specified.

- For the purposes of reporting a calculated result, average or a mass discharge value, the permittee may substitute a 0 (zero) for any pollutant concentration that is less than the limit of detection. However, if the effluent limitation is less than the limit of detection, the department may substitute a value other than zero for results less than the limit of detection, after considering the number of monitoring results that are greater than the limit of detection and if warranted when applying appropriate statistical techniques.

5.1.5 Compliance Maintenance Annual Reports

Compliance Maintenance Annual Reports (CMAR) shall be completed using information obtained over each calendar year regarding the wastewater conveyance and treatment system. The CMAR shall be submitted by the permittee in accordance with ch. NR 208, Wis. Adm. Code, by June 30, each year on an electronic report form provided by the Department.

In the case of a publicly owned treatment works, a resolution shall be passed by the governing body and submitted as part of the CMAR, verifying its review of the report and providing responses as required. Private owners of wastewater treatment works are not required to pass a resolution; but they must provide an Owner Statement and responses as required, as part of the CMAR submittal.

A separate CMAR certification document, that is not part of the electronic report form, shall be mailed to the Department at the time of electronic submittal of the CMAR. The CMAR certification shall be signed and submitted by an authorized representative of the permittee. The certification shall be submitted by mail. The certification shall verify the electronic report is complete, accurate and contains information from the owner’s treatment works.

5.1.6 Records Retention

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the application for the permit for a period of at least 3 years from the date of the sample, measurement, report or application. All pertinent sludge information, including permit application information and other documents specified in this permit or s. NR 204.06(9), Wis. Adm. Code shall be retained for a minimum of 5 years.

5.1.7 Other Information

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or correct information to the Department.

5.2 System Operating Requirements

5.2.1 Noncompliance Notification

- The permittee shall report the following types of noncompliance by a telephone call to the Department's regional office within 24 hours after becoming aware of the noncompliance:
  - any noncompliance which may endanger health or the environment;
  - any violation of an effluent limitation resulting from an unanticipated bypass;
  - any violation of an effluent limitation resulting from an upset; and
  - any violation of a maximum discharge limitation for any of the pollutants listed by the Department in the permit, either for effluent or sludge.

- A written report describing the noncompliance shall also be submitted to the Department's regional office within 5 days after the permittee becomes aware of the noncompliance. On a case-by-case basis, the Department may waive the requirement for submittal of a written report within 5 days and instruct the permittee to submit the written report with the next regularly scheduled monitoring report. In either case, the written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

NOTE: Section 292.11(2)(a), Wisconsin Statutes, requires any person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance to notify the Department of Natural Resources **immediately** of any discharge not authorized by the permit. The discharge of a hazardous substance that is not authorized by this permit or that violates this permit may be a hazardous substance spill. To report a hazardous substance spill, call DNR's 24-hour HOTLINE at **1-800-943-0003**

5.2.2 Flow Meters

Flow meters shall be calibrated annually, as per s. NR 218.06, Wis. Adm. Code.

5.2.3 Raw Grit and Screenings

All raw grit and screenings shall be disposed of at a properly licensed solid waste facility or picked up by a licensed waste hauler. If the facility or hauler are located in Wisconsin, then they shall be licensed under chs. NR 500-536, Wis. Adm. Code.

5.2.4 Sludge Management

All sludge management activities shall be conducted in compliance with ch. NR 204 "Domestic Sewage Sludge Management", Wis. Adm. Code.

5.2.5 Prohibited Wastes

Under no circumstances may the introduction of wastes prohibited by s. NR 211.10, Wis. Adm. Code, be allowed into the waste treatment system. Prohibited wastes include those:

- which create a fire or explosion hazard in the treatment work;
- which will cause corrosive structural damage to the treatment work;
- solid or viscous substances in amounts which cause obstructions to the flow in sewers or interference with the proper operation of the treatment work;
- wastewaters at a flow rate or pollutant loading which are excessive over relatively short time periods so as to cause a loss of treatment efficiency; and
- changes in discharge volume or composition from contributing industries which overload the treatment works or cause a loss of treatment efficiency.

5.2.6 Unscheduled Bypassing

Any unscheduled bypass or overflow of wastewater at the treatment works or from the collection system is prohibited, and the Department may take enforcement action against a permittee for such occurrences under s. 283.89, Wis. Stats., unless:

- The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
- There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
- The permittee notified the Department as required in this Section.

Whenever there is an unscheduled bypass or overflow occurrence at the treatment works or from the collection system, the permittee shall notify the Department <u>within 24 hours</u> of initiation of the bypass or overflow occurrence by telephoning the wastewater staff in the regional office as soon as reasonably possible (FAX, email or voice mail, if staff are unavailable).

In addition, the permittee shall <u>within 5 days</u> of conclusion of the bypass or overflow occurrence report the following information to the Department in writing:

- Reason the bypass or overflow occurred, or explanation of other contributing circumstances that resulted in the overflow event. If the overflow or bypass is associated with wet weather, provide data on the amount and duration of the rainfall or snow melt for each separate event.
- Date the bypass or overflow occurred.
- Location where the bypass or overflow occurred.
- Duration of the bypass or overflow and estimated wastewater volume discharged.
- Steps taken or the proposed corrective action planned to prevent similar future occurrences.
- Any other information the permittee believes is relevant.

5.2.7 Scheduled Bypassing

Any construction or normal maintenance which results in a bypass of wastewater from a treatment system is prohibited unless authorized by the Department in writing. If the Department determines that there is significant public interest in the proposed action, the Department may schedule a public hearing or notice a proposal to approve the bypass. Each request shall specify the following minimum information:

- proposed date of bypass;
- estimated duration of the bypass;

- estimated volume of the bypass;
- alternatives to bypassing; and
- measures to mitigate environmental harm caused by the bypass.

5.2.8 Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control which are installed or used by the permittee to achieve compliance with the conditions of this permit. The wastewater treatment facility shall be under the direct supervision of a state certified operator as required in s. NR 108.06(2), Wis. Adm. Code. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training as required in ch. NR 114, Wis. Adm. Code, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

5.3 Surface Water Requirements

5.3.1 Permittee-Determined Limit of Quantitation Incorporated into this Permit

For pollutants with water quality-based effluent limits below the Limit of Quantitation (LOQ) in this permit, the LOQ calculated by the permittee and reported on the Discharge Monitoring Reports (DMRs) is incorporated by reference into this permit. The LOQ shall be reported on the DMRs, shall be the lowest quantifiable level practicable, and shall be no greater than the minimum level (ML) specified in or approved under 40 CFR Part 136 for the pollutant at the time this permit was issued, unless this permit specifies a higher LOQ.

5.3.2 Appropriate Formulas for Effluent Calculations

The permittee shall use the following formulas for calculating effluent results to determine compliance with average limits and mass limits:

Weekly/Monthly average concentration = the sum of all daily results for that week/month, divided by the number of results during that time period.

Weekly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the week.

Monthly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the month.

5.3.3 Visible Foam or Floating Solids

There shall be no discharge of floating solids or visible foam in other than trace amounts.

5.3.4 Percent Removal

During any 30 consecutive days, the average effluent concentrations of BOD_5 and of total suspended solids shall not exceed 15% of the average influent concentrations, respectively. This requirement does not apply to removal of total suspended solids if the permittee operates a lagoon system and has received a variance for suspended solids granted under NR 210.07(2), Wis. Adm. Code.

5.3.5 Chloride Notification

The permittee shall notify the Department in writing of any proposed changes which may affect the characteristics of the wastewater, which results in an increase in the concentration of chloride, under the authority of sections 283.31(4)(b) and 283.59(1), Stats. This notification shall include a description of the proposed source of chlorides and the anticipated increase in concentration. Following receipt of the notification, the Department may propose a modification to the permit.

5.3.6 Fecal Coliforms

The limit for fecal coliforms shall be expressed as a monthly geometric mean.

5.3.7 Seasonal Disinfection

Disinfection shall be provided from May 1 through September 30 of each year. Monitoring requirements and the limitation for fecal coliforms apply only during the period in which disinfection is required. Whenever chlorine is used for disinfection or other uses, the limitations and monitoring requirements for residual chlorine shall apply. A dechlorination process shall be in operation whenever chlorine is used.

5.3.8 Whole Effluent Toxicity (WET) Monitoring Requirements

In order to determine the potential impact of the discharge on aquatic organisms, static-renewal toxicity tests shall be performed on the effluent in accordance with the procedures specified in the *"State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition" (PUB-WT-797*, November 2004) as required by NR 219.04, Table A, Wis. Adm. Code). All of the WET tests required in this permit, including any required retests, shall be conducted on the *Ceriodaphnia dubia* and fathead minnow species. Receiving water samples shall not be collected from any point in contact with the permittee's mixing zone and every attempt shall be made to avoid contact with any other discharge's mixing zone.

5.3.9 Whole Effluent Toxicity (WET) Identification and Reduction

Within 60 days of a retest which showed positive results, the permittee shall submit a written report to the Biomonitoring Coordinator, Bureau of Watershed Management, 101 S. Webster St., PO Box 7921, Madison, WI 53707-7921, which details the following:

- A description of actions the permittee has taken or will take to remove toxicity and to prevent the recurrence of toxicity;

- A description of toxicity reduction evaluation (TRE) investigations that have been or will be done to identify potential sources of toxicity, including some or all of the following actions:

  (a) Evaluate the performance of the treatment system to identify deficiencies contributing to effluent toxicity (e.g., operational problems, chemical additives, incomplete treatment)
  (b) Identify the compound(s) causing toxicity
  (c) Trace the compound(s) causing toxicity to their sources (e.g., industrial, commercial, domestic)
  (d) Evaluate, select, and implement methods or technologies to control effluent toxicity (e.g., in-plant or pretreatment controls, source reduction or removal)

- Where corrective actions including a TRE have not been completed, an expeditious schedule under which corrective actions will be implemented;

- If no actions have been taken, the reason for not taking action.

The permittee may also request approval from the Department to postpone additional retests in order to investigate the source(s) of toxicity. Postponed retests must be completed after toxicity is believed to have been removed.

5.3.10 Exceedance of a Whole Effluent Toxicity (WET) Limit

In the event of a WET limit exceedance, the permittee shall submit the following (within 30 days of test end):

- the findings of a toxicity reduction evaluation (TRE) or other investigation to identify the cause(s) of the toxicity;

- actions the permittee has taken or will take to mitigate the impact of the discharge, to correct the noncompliance, and to prevent the recurrence of toxicity;

- where corrective actions including a TRE have not been completed, an expeditious schedule under which corrective actions will be implemented; and

- if no actions have been taken, the reason for not taking action.

5.3.11 Whole Effluent Toxicity (WET) and Chloride Source Reduction Measures

Acute whole effluent toxicity testing requirements and acute whole effluent toxicity limitations may be held in abeyance by the department until chloride source reduction actions are completed, according to s. NR 106.89, Wis. Adm. Code, if either:

- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride exceeds 2,500 mg/L, or
- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride is less than 2,500 mg/L, but in excess of the calculated acute water quality-based effluent limitation, and additional data are submitted which demonstrate that chloride is the sole source of acute toxicity.

Chronic whole effluent toxicity testing requirements and chronic whole effluent toxicity limitations may be held in abeyance by the department until chloride source reduction actions are completed, according to s. NR 106.89, Wis. Adm. Code, if either:

- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride exceeds 2 times the calculated chronic water quality-based effluent limitation, or
- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride is less than 2 times the calculated chronic water quality-based effluent limitation, but in excess of the calculated chronic water quality-based effluent limitation, and additional data are submitted which demonstrate that chloride is the sole source of chronic toxicity.

Following the completion of chloride source reduction activities, the department shall evaluate the need for whole effluent toxicity monitoring and limitations.

5.4 Land Application Requirements

5.4.1 Sludge Management Program Standards And Requirements Based Upon Federally Promulgated Regulations

In the event that new federal sludge standards or regulations are promulgated, the permittee shall comply with the new sludge requirements by the dates established in the regulations, if required by federal law, even if the permit has not yet been modified to incorporate the new federal regulations.

5.4.2 General Sludge Management Information

The General Sludge Management Form 3400-48 shall be completed and submitted prior to any significant sludge management changes.

5.4.3 Sludge Samples

All sludge samples shall be collected at a point and in a manner which will yield sample results which are representative of the sludge being tested, and collected at the time which is appropriate for the specific test.

5.4.4 Land Application Characteristic Report

Each report shall consist of a Characteristic Form 3400-49 and Lab Report, unless approval for not submitting the lab reports has been given. Both reports shall be submitted by January 31 following each year of analysis.

The permittee shall use the following convention when reporting sludge monitoring results: Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 1.0 mg/kg, report the pollutant concentration as < 1.0 mg/kg .

All results shall be reported on a dry weight basis.

5.4.5 Monitoring and Calculating PCB Concentrations in Sludge

When sludge analysis for "PCB, Total Dry Wt" is required by this permit, the PCB concentration in the sludge shall be determined as follows.

Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with the following provisions and Table EM in s. NR 219.04, Wis. Adm. Code.

- EPA Method 1668 may be used to test for all PCB congeners. If this method is employed, all PCB congeners shall be delineated. Non-detects shall be treated as zero. The values that are between the limit of detection and the limit of quantitation shall be used when calculating the total value of all congeners. All results shall be added together and the total PCB concentration by dry weight reported. **Note**: It is recognized that a number of the congeners will co-elute with others, so there will not be 209 results to sum.
- EPA Method 8082A shall be used for PCB-Aroclor analysis and may be used for congener specific analysis as well. If congener specific analysis is performed using Method 8082A, the list of congeners tested shall include at least congener numbers 5, 18, 31, 44, 52, 66, 87, 101, 110, 138, 141, 151, 153, 170, 180, 183, 187, and 206 plus any other additional congeners which might be reasonably expected to occur in the particular sample. For either type of analysis, the sample shall be extracted using the Soxhlet extraction (EPA Method 3540C) (or the Soxhlet Dean-Stark modification) or the pressurized fluid extraction (EPA Method 3545A). If Aroclor analysis is performed using Method 8082A, clean up steps of the extract shall be performed as necessary to remove interference and to achieve as close to a limit of detection of 0.11 mg/kg as possible. Reporting protocol, consistent with s. NR 106.07(6)(e), should be as follows: If all Aroclors are less than the LOD, then the Total PCB Dry Wt result should be reported as less than the highest LOD. If a single Aroclor is detected then that is what should be reported for the Total PCB result. If multiple Aroclors are detected, they should be summed and reported as Total PCBs. If congener specific analysis is done using Method 8082A, clean up steps of the extract shall be performed as necessary to remove interference and to achieve as close to a limit of detection of 0.003 mg/kg as possible for each congener. If the aforementioned limits of detection cannot be achieved after using the appropriate clean up techniques, a reporting limit that is achievable for the Aroclors or each congener for the sample shall be determined. This reporting limit shall be reported and qualified

indicating the presence of an interference. The lab conducting the analysis shall perform as many of the following methods as necessary to remove interference:

3620C – Florisil	3611B - Alumina
3640A - Gel Permeation	3660B - Sulfur Clean Up (using copper shot instead of powder)
3630C - Silica Gel	3665A - Sulfuric Acid Clean Up

5.4.6 Land Application Report

Land Application Report Form 3400-55 shall be submitted by January 31, following each year non-exceptional quality sludge is land applied. Non-exceptional quality sludge is defined in s. NR 204.07(4), Wis. Adm. Code.

5.4.7 Other Methods of Disposal or Distribution Report

The permittee shall submit Report Form 3400-52 by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied.

5.4.8 Approval to Land Apply

Bulk non-exceptional quality sludge as defined in s. NR 204.07(4), Wis. Adm. Code, may not be applied to land without a written approval letter or Form 3400-122 from the Department unless the Permittee has obtained permission from the Department to self approve sites in accordance with s. NR 204.06 (6), Wis. Adm. Code. Analysis of sludge characteristics is required prior to land application. Application on frozen or snow covered ground is restricted to the extent specified in s. NR 204.07(3) (l), Wis. Adm. Code.

5.4.9 Soil Analysis Requirements

Each site requested for approval for land application must have the soil tested prior to use. Each approved site used for land application must subsequently be soil tested such that there is at least one valid soil test in the four years prior to land application. All soil sampling and submittal of information to the testing laboratory shall be done in accordance with UW Extension Bulletin A-2100. The testing shall be done by the UW Soils Lab in Madison or Marshfield, WI or at a lab approved by UW. The test results including the crop recommendations shall be submitted to the DNR contact listed for this permit, as they are available. Application rates shall be determined based on the crop nitrogen recommendations and with consideration for other sources of nitrogen applied to the site.

5.4.10 Land Application Site Evaluation

For non-exceptional quality sludge, as defined in s. NR 204.07(4), Wis. Adm. Code, a Land Application Site Request Form 3400-053 shall be submitted to the Department for the proposed land application site. The Department will evaluate the proposed site for acceptability and will either approve or deny use of the proposed site. The permittee may obtain permission to approve their own sites in accordance with s. NR 204.06(6), Wis. Adm. Code.

5.4.11 Class B Sludge: Fecal Coliform Limitation

Compliance with the fecal coliform limitation for Class B sludge shall be demonstrated by calculating the geometric mean of at least 7 separate samples. (Note that a Total Solids analysis must be done on each sample). The geometric mean shall be less than 2,000,000 MPN or CFU/g TS. Calculation of the geometric mean can be done using one of the following 2 methods.

Method 1:

Geometric Mean = $(X_1 \text{ x } X_2 \text{ x } X_3 \ldots \text{x } X_n)^{1/n}$

Where X = Coliform Density value of the sludge sample, and where n = number of samples (at least 7)

Method 2:

Geometric Mean = antilog[($X_1 + X_2 + X_3 \ldots + X_n$) ÷ n]
Where X = $\log_{10}$ of Coliform Density value of the sludge sample, and where n = number of samples (at least 7)
Example for Method 2

Sample Number	Coliform Density of Sludge Sample	$\log_{10}$
1	6.0×10^5	5.78
2	4.2×10^6	6.62
3	1.6×10^6	6.20
4	9.0×10^5	5.95
5	4.0×10^5	5.60
6	1.0×10^6	6.00
7	5.1×10^5	5.71

The geometric mean for the seven samples is determined by averaging the $\log_{10}$ values of the coliform density and taking the antilog of that value.
(5.78 + 6.62 + 6.20 + 5.95 + 5.60 + 6.00 + 5.71) ÷ 7 = 5.98
The antilog of 5.98 = 9.5×10^5

5.4.12 Class B Sludge - Vector Control: Injection

No significant amount of the sewage sludge shall be present on the land surface within one hour after the sludge is injected.

6 Summary of Reports Due

FOR INFORMATIONAL PURPOSES ONLY

Description	Date	Page
Chloride Target Value -Annual Chloride Progress Report	June 30, 2009	10
Chloride Target Value -Annual Chloride Progress Report #2	June 30, 2010	10
Chloride Target Value -Annual Chloride Progress Report #3	June 30, 2011	10
Chloride Target Value -Annual Chloride Progress Report #4	June 30, 2012	10
Chloride Target Value -Final Chloride Report	June 30, 2013	10
Development of Local Limits for Metal Pollutants -Develop local limits for metal pollutants	December 31, 2009	10
Development of Local Limits for Metal Pollutants -Sewer Use Ordinance Amendment	June 30, 2010	10
Development of Local Limits for Metal Pollutants -Complete action	December 31, 2010	10
Compliance Maintenance Annual Reports (CMAR)	by June 30, each year	12
General Sludge Management Form 3400-48	prior to any significant sludge management changes	18
Characteristic Form 3400-49 and Lab Report	by January 31 following each year of analysis	18
Land Application Report Form 3400-55	by January 31, following each year non-exceptional quality sludge is land applied	19
Report Form 3400-52	by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied	19
Wastewater Discharge Monitoring Report	no later than the date indicated on the form	11

Report forms shall be submitted to the address printed on the report form. Any facility plans or plans and specifications for municipal, industrial, industrial pretreatment and non industrial wastewater systems shall be submitted to the Bureau of Watershed Management, P.O. Box 7921, Madison, WI 53707-7921. All other submittals required by this permit shall be submitted to:

Southeast Region - Waukesha, 141 NW Barstow St., Room 180, Waukesha, WI 53188