Environmental Consequences

Physical

Erosion

Due to the combined effects of ever-increasing water levels and the loss of aquatic plants, erosion of the wetlands and some adjacent uplands has been a problem for at least the last 50 years. RKLD and other citizens have recognized this problem and have attempted to deal with this by "armoring" part of the shoreline. The majority of these projects have included riprap armor (Figures 43 and 44) of wetland shoreland areas that have been eroded and lost over time.

Figure 43. 6/13/03; USGS Gage - 776.31 msl; top of riprap protection at Carcajou Shallow Marsh at outside corner of riprap lakeward from opening behind Carcajou Shallow Marsh. Elevation near top of rock is 777.48 msl.

Figure 44. Carcajou Shallow Marsh Date: 5/13/2003 Water Elevation: 777.30 msl.

During 2002 and 2003, the RKLD worked cooperatively with wetland owners to protect approximately 38% or 4.7 miles of the 12.5 miles of wetland shoreline. In 2001 Act 16, the Legislature granted authorization to the District for a Lake Koshkonong Comprehensive Project (Table 2). Act 16 recognized the placement of breakwater structures was another suitable management approach to prevent wetland losses resulting from wind and seasonal flood conditions.

RKLD is also currently involved with the U.S. Army Corps of Engineers (ACOE) in an Ecosystem Restoration Program (under Section 206 of the Water Resources Act) to further restore and protect wetlands and near-shore shallow water areas. The ACOE has identified several places in Lake Koshkonong where off shore breakwaters could provide protected habitat for plants and aquatic life. This project has a focus of not only arresting waves but also excluding carp from shallow near shore areas. On the Lake Winnebago pool this concept has been effective in reestablishment of submergent vegetation, but not emergent vegetation. The status of this program is tenuous at this point. In Federal FY 04 a $112,000 congressional addition was placed within the Water Resources Development Act specifically allotting money to the ACOE to work on the Lake Koshkonong 206 project for planning and design of the Lake Koshkonong breakwater project. There is currently $160,000 of congressional additions within the House vision of the Water Resources Development Act for FY 05, which if enacted would allow for continued funding of the Lake Koshkonong 206 project at the Feasibility level. ACOE officials have estimated that the report is approximately 40% to 50 % complete. However, the project manager has expressed great concern about moving forward with a project design until they are certain of the water level regime that will be established and further that the new water level regime will yield the same environmental benefits from off shore breakwaters. Accordingly, the ACOE project management team has decided to suspend all work on this project until the District's petition to raise water level is resolved.

RKLD concludes in the EIR that one of the negative impacts of raising the summer water level to a target of 776.8 would be:

> "Reduced diversity of emergent macrophyte community, potentially an increase in wave erosion on unprotected wetland shorelines, potentially more access to shallow marshes by roughfish, higher water levels may cause shallow marshes to proceed to lake phase resulting in reduced emergent macrophytes and aquatic insect populations."

They propose to counteract wetland losses by installing additional rock rip rap similar to what has been placed in front of the Carajou marsh (Figures 43 and 44). While this rock may be effective in the short term, based upon similar low elevation installations in the Upper Winnebago pool lakes (UWPL) riprap alone is unlikely to prevent long term erosion of these wetlands. In the UWPL rock and even old cars were placed in front of a cattail marsh over a number of years to prevent erosion. In all cases, erosion continued (R. Kahl, WI Dept of Natural Resources, personal communication). The rock material that has been placed in Lake Koshkonong is smaller than that used in UWPL and would be expected to be less effective over time. Figure 44 shows that this material will largely be flooded at water levels only slightly higher than the maximum proposed target level of 777.0 msl. With the higher level, even minor flood events will overtop these structures and may result in the deterioration of this armoring. While high water levels and waves during storm events are partially responsible for the failure of these structures, even more detrimental to the riprap structures in UWPL was ice jacking. If winter drawdown is eliminated as proposed, the rock riprap would degrade more quickly. The destructive capability of ice shoves is evident during the current water levels with past problems with some boat landings on Lake Koshkonong.

In order for the armoring to have any chance of long term success it must be much larger than shown in Figure 43. In the UWPL (Terrell Island) much larger material was used. The large rocks used extend roughly 4 feet above the water and this type of structure seems to be effective and long lasting in the UWPL but is very expensive to build. In Lake Koshkonong it is important that large rocks to be used and they must extend above the OHWM. If these large rocks are not used, the armoring will be short-lived as the rock dikes will quickly deteriorate during flood events and as a consequence of ice jacking.

If the winter drawdown is eliminated, there will be an increase in erosion as the result of ice jacking. The larger surface area of ice will increase the potential damage from ice. In addition, the higher water levels will enable ice jacking to more readily damage shoreland structures such as armoring, boat ramps and piers. Ice-jacking and the formation of ice ridges is most dramatic during winters with extreme temperature fluctuations and little snow cover. A dense layer of snow on top of the ice not only reduces the freezing rate, but also forms an insulation blanket that reduces temperature changes in the ice, and subsequent frequency of ice-jacking events. In conclusion, it appears that the effects of the "jacking" action of ice are most severe during those periods when there is little or no snow-cover, and temperatures fluctuate greatly. One intent of winter drawdown is to purposely move the zone of ice-jacking offshore; in the interest of minimizing shoreline alterations and the formation of ices ridges at the bank.

Figure 45

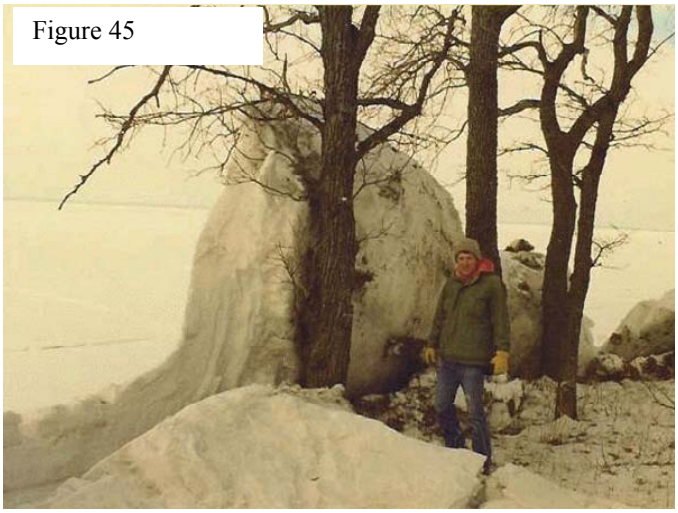
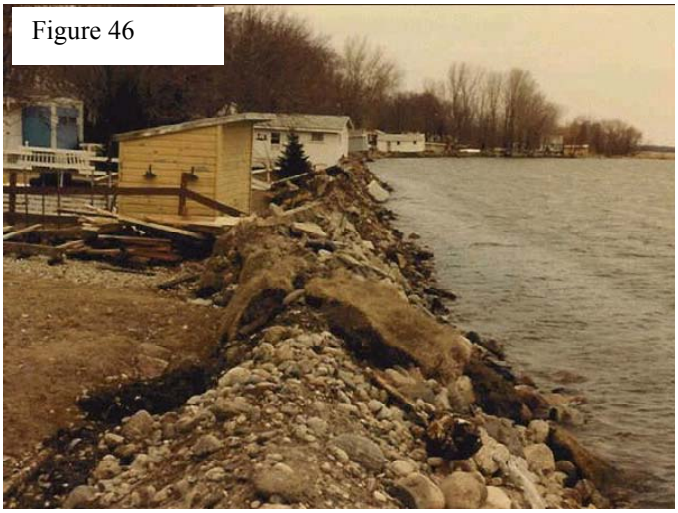


Figure 46



Floods

A change in normal operating pools will not have an effect on flood levels. There have been two studies to address this issue. ***Evaluation of Alternative Reservoir Management Practices In The Rock River Basin, Wisconsin*** *by* USGS and ***Hydraulic Analysis of Indianford Dam and Lake Koshkonong*** *by* Montgomery Association Resource Solutions, LLC**.** Both studies came to similar conclusions, that normal pool elevations or changes in normal pool level had little to no affect on flood level elevations.

Affects on the OHWM

Due to the limitations and lack of data, the Montgomery analysis is not a sufficient prediction tool to assure that the OHWM will not change do to the increase in water levels. There is no known relationship between recurrence interval (the presence and action of water) and the OHWM. While we do not know how often water has to be present to influence the OHWM we do know the presence of water on the shoreline is a function of three elements: 1) still water level, 2) wave action generated from wind or boats, and 3) shoreline configuration. In taking into account wind set-up and wave run-up under conservative conditions (20 and 24 mph winds) it appears that the presence and action of water will be changed to the point that the OHWM could be affected by the proposal.

Water Level Affects Beyond Lake Koshkonong

The full extent of the area that will be affected by the RKLD's proposal to raise the water levels held by the Indianford Dam is not fully known. The extent of the impact was requested of RKLD but was not provided. Evidence shows that the effects go well beyond Lake Koshkonong. Raising water levels in a waterway can affect the water levels on tributaries to that waterway as well as groundwater, wetlands and other low-lying areas. The OHWM study and portions of the Montgomery report only address Lake Koshkonong and do not speak to OHWMs in the upstream and downstream river channels affected by the dam.

The Jefferson County Flood Insurance Study (FIS) and the City of Jefferson FIS are dated 1984. These FISs contain floodplain studies for the Rock River, the Crawfish River and the Bark River. The five floodplain study panels showing the channel elevations are in Attachment 8. The floodplain studies contain channel bed survey information taken on these waterways. The Rock River channel profile is on Panels 01P and 02P of the county FIS and panel 01P of the City FIS. The elevation profiles show that raising water levels at the Indianford Dam affect water levels as far upstream as the Jefferson Dam in the City of Jefferson.

The Bark River study's survey (shown on Panel 13P) extends from the mouth of the Bark River at the Rock River to County Highway D, a total of 12.3 miles. RKLD's proposed increase will affect the entire 12.3 miles within the study but the full extent of the water level effect can't be determined since the survey ends before the increased water level effect ends.

The Crawfish River study's survey (shown on Panel 14P) starts at the mouth of the Crawfish River at the Rock River extending upstream. The survey shows that RKLD's proposed increase would affect 5 miles upstream of the mouth including a small tributary to the Crawfish River at 4.1 miles upstream of the mouth.

Other tributaries to the Lake Koshkonong and the Rock River will be affected but the full extent is not known. Again, raising water levels in a waterway can affect the water levels on tributaries to that waterway as well as groundwater, wetlands and other low-lying areas. These tributaries can be found on the US Geological Survey quadrangle maps and include:

Rock County

- Saunders Creek which outlets 1.7 miles upstream of the Indianford Dam in section 15, T4N, R12E
- an unnamed tributary which outlets 3.3 miles upstream of the dam in section 14, T4N, R12E

Dane County

- A small tributary enters Lake Koshkonong in section 36, T5N, R12E.

Jefferson County

Several tributaries enter Lake Koshkonong in T5N, R13E, Jefferson County. They include:

- an unnamed tributary in section 10
- an unnamed tributary in section 15
- Koshkonong Creek in section 20
- an unnamed tributary in section 24
- an unnamed tributary in section 33
- Otter Creek
- 2 unnamed tributaries in section 34

Rock River Upstream of the Lake

- an unnamed tributary in section 5, T5N, R14E
- an unnamed tributary in section 8, T5N, R14E
- Allen Creek in section 17, T5N, R14E
- Deer Creek in section 35, T6N, R14E
- three unnamed tributaries in section 23, T6N, R14 E
- an unnamed tributary in section 14, T6N, R14E
- an unnamed tributary in section 11, T6N, R14E

Crawfish River

- two unnamed tributaries in section 4, T6N, R14E
- an unnamed tributary in section 33, T7N, R14 E

Bark River

- an unnamed tributary in section 12, T5N, R14E
- an unnamed tributary in section 7, T5N, R15E
- Whitewater Creek in section 7, T5N, R15E
- two unnamed tributaries in section 9, T5N, R15E
- an unnamed tributary in section 10, T5N, R15E

Drainage Board

A common agricultural practice to drain wetlands and other large tracts of land that were too wet to cultivate was to dig ditches or deepen and widen adjacent streams to improve the surface and subsurface drainage. The ditching would dry out the associated fields and allow the fields to be put into crop production. To assure that a downstream ditch wouldn't adversely affect the drainage of an upstream area, and to share the cost of the planning, design, ditch construction and maintenance, drainage districts were formed. Drainage Districts' authority is under ch. 88, Wis. Stats., and numerous earlier state laws.

The Jefferson County Farm Drainage Board is granted powers under ch. 88.90 and 88.91, Wis. Stats., to contest actions that would adversely affect water flow in the drainage districts in Jefferson County. The Board has provided survey evidence that raising the water level of Lake Koshkonong will adversely affect Drain 39. Raising water levels in an agricultural drainage ditch will lessen the drainage of the associated cultivated land and can reduce crop production. In a letter dated May 5, 2004, the attorney for the Jefferson Board registered objection to increasing Lake Koshkonong water levels.

Drain 39 outlets into the Bark River, tributary to the Rock River, in the NW1/4 of Section 9, T5 N, R15 E. Survey provided by the Board shows that the downstream 1850 feet of the main ditch and outlet of lateral 4 will be affected by the RKLD's proposed water levels and dam operation.

Low flow

RKLD's petition does not propose a change in low flows release from the dam. The current low flow release requirement of 64 cubic feet per second (CFS) is similar to the drought level flow conditions within the Rock River. The requirement to release a minimum low flow is intended to protect downstream aquatic life. A change in water levels is not expected to have any significant effect on the occurrence of low flow conditions. While it has been the routine practice of the Department and the state to require a minimum release, it would be far more protective for

downstream resource to tie the dam release to the amount of flow that is in the system, commonly referred to as run of river (ROR) flow. The Department has requested ROR restrictions on power dams regulated by the Federal Energy Regulator Commission routinely. Revising the order to require ROR releases from the dam would be more protective of downstream resources but would come at the expense of more lake fluctuations.

Groundwater
The Indianford Dam and Lake Koshkonong water levels impact the groundwater levels in the SE corner of Dane County, the SW corner of Jefferson County and north central Rock County. Lake Koshkonong is an area of groundwater discharge, meaning that the precipitation that infiltrates into the soil in the area move through the soil towards the lake. Groundwater can be exposed at the land's surface in the form of wetlands, springs, ponds and stream flow. Historical accounts of Lake Koshkonong often refer to the area as replete with springs. Lake Koshkonong's lake level and associated groundwater level affect these water features and the soil moisture which can ultimately affect vegetation and land use. The effects are not only adjacent to the lake but can be a considerable distance away from the lake. The lateral effect to groundwater depends on a number of factors including topography, groundwater recharge, other water features such as streams, and soil characteristics.

The soils in nearshore area the impoundment that includes the lake are saturated to the same level as the Lake Koshkonong water level. Additionally, there are extensive wetlands, numerous ponds, springs and drained agricultural land in the general area of the lake that extends long distances from lakeshore.

The RKLD proposes to increase the normal lake elevation from a normal of 776.2 msl and a maximum of 776.33 msl at which all gates must be opened on the dam, to a normal of 776.8 and a maximum of 777.0 msl. Raising the water levels by 0.6 feet (7.2 inches) will result in the nearshore groundwater raising 7.2 inches. The nearshore saturation zone will extend landward but the distance is not known. It can be reasonably expected that the long term effects will be to expand areas of soil saturation around the lake, raise water levels in some ponds and soil moisture in some areas. It is possible that some marginal septic fields could be negatively affected in the near shore area. The extent of exact horizontal and vertical increase has not been determined.

Biological

Riparian emergent and forested wetlands
Lake Koshkonong possesses riverine/lake fringe wetlands associated with the Rock River and its tributaries. Wetland plant communities present include southern lowland forest (floodplain forest), emergent marsh, wet meadow and aquatic bed types. Stresses on wetlands include impacts from raised water level, decreased water quality, human uses and disturbance from carp and non-native plant introductions. High water levels were noted by the lack of herbaceous layers in much of the lakeside wetlands, the presence of adventitious roots, shallow roots, (Figures 47 and 48) dead and dying trees and the absence of groundwater-dependent plants and plant communities. High water levels have increased erosion and loss of wetlands. Water quality conditions are poor as a result of

Figure 47 Location: Carcajou Floodplain Forest Date: 5/28/02 WL: 776.81 msl. Evidence of erosional sediment loss in root systems along shore.

Figure 48. Carajou floodplain forest Jan 02

nutrient and sediment-laden surface water coming into the wetlands from upstream agricultural and urban areas. Wetland filling has occurred along the shoreline and urban uses within the watershed contribute additional pollutants. Recreational boating activity stirs up sediments in the shallow basin, likely increasing turbidity levels.

Lake Koshkonong has experienced significant riparian wetland loss since the lake was dammed. Originally the lake was described as a deep-water marsh with most of the surface covered with emergent vegetation, e.g. wild rice, cattails, reeds, bulrushes (Kumlien, 1877; Main, 1945). Much of the current lake area became an open water environment after the water level was increased with the construction of the original dam soon after 1851, which raised the lake level, by 6 feet. Although it is very likely the area of riparian emergent wetlands declined during the period from dam construction until the first available aerial photographs in 1937, there were considerable acreage of these wetlands. The next available aerial photographs in 1966 indicated that a large amount of these wetlands had been destroyed. It is highly likely this was the consequence of increasing lake levels that occurred during the time period as documented in the Affected Environment Section. Mean summer water levels increased on average 0.5 feet from 1937-1966. Perhaps more important than the increase in the average water level was abnormally high water levels as a result of floods. Such an event occurred during the spring of 1959. Interestingly, a similar event occurred in 1929, yet there were large areas of wetlands remaining after this event. It is likely that the lower water levels in the 1930s allowed the wetlands to recover. While it is possible that the 1959 flood resulted in the loss of wetlands, it is also possible the loss was the result of abnormally high water levels during the period 1956-59. Mean summer water levels during this period were about 776.2 msl, which is the current summer target value.

The EIR indicated that there was a loss of 57 acres of shallow water wetlands between 1950 and 1969. There was a further loss of 76 acres between the 1969 and 2000. During the first time period, the mean summer water level increased 0.4 feet and there was a further increase in water level of 0.5 ft during the second time period.

Additional aerial photographs from 1979, 1986, and 1992 document the continued loss of the riparian wetlands. Since 1966, the lake levels have continued to increase and there has continued to be a loss of riparian emergent wetlands. The history of wetland loss in conjunction with rising water levels indicates that if the summer target water level is raised to the requested level of 776.80 msl there will be a further loss of riparian emergent wetlands.

Numerous other studies support the loss of wetlands as the result of high water levels. Large shallow lakes in Wisconsin, such as Puckaway, Upper Winnebago pool lakes (Butte des Morts, Winneconne, Poygan) have historically lost significant amounts of emergent vegetation as the result of elevated water levels, usually as a consequence of dam construction (Kahl, 1991). A small lake in northwestern Wisconsin, Rice Lake, was converted from a clear water, wild rice dominated system to a turbid algal dominated system as a result of high water (Engel and Nichols, 1994).

In lakes, wetland plants have been reestablished as a result of lowering water levels, usually as a consequence of drought. One example, Delta Marsh on the shore of Lake Manitoba, experienced a large increase in the growth of *Scirpus* as a result of lower water levels in response to a drought (Goldsborough and Wrubleski, 2004). In Lake Saint-Pierre near the St. Lawrence River, low water levels result in a large marshland, while during high water levels the lake shifts to an open-water body (Hudon, 1997). In a study conducted in Pool 8 of the Upper Mississippi River, manually lowering the water level by 18 inches resulted in a large increase in emergent vegetation. As a result of the increased vegetation, there was a large increase in the presence of shorebirds and the usage of this area by migratory waterfowl (Benjamin and Kenow, 2004).

Increased water levels will result in continued loss of emergent and forested wetlands along the shoreline due to erosion and increase areas of open water. Groundwater dominated wetlands such as sedge meadows will be converted to marshes. Based on observations of permanently flooded black willow (tolerant to flooding) on Horicon Marsh Wildlife Area by DNR staff, all trees in areas flooded (to the surface of the soil or above) by the permanent increase in water level will die. Most trees in the areas that will now have continuously saturated soil will be overthrown by the wind or die as a result of the combined stresses of growing in permanently saturated soil. Because areas which are currently not forested that remain dry enough to support floodplain forest are currently in other uses, the losses from the increased water level will not be offset by floodplain forest restoration.

A water level increase will adversely affect the functional values of wetlands associated with Lake Koshkonong. The wetland complex has already been affected by high sustained water levels since the dam was installed.

Increasing the level and duration of water will add to those impacts. Because of higher precipitation during the spring and summer of 2004, water levels were higher in the wetlands and the Department was able to observe how the proposed increased water levels may affect these wetlands. In terms of floral diversity, there was a loss of much of the herbaceous vegetation in forested wetlands. Established plant survey points showed a significant reduction in diversity due to species loss from high water levels. It is well documented in the literature that marshes have cyclical drought and flood cycles and are often manipulated to simulate the drought cycles. This management regime has historically been used to increase wetland emergent growth and provide enhanced habitat for waterfowl and other species of wildlife. Sustained high water levels reduce the ability of the marsh species to regenerate and revegetate. This is evident in the recent past and the continuing loss of emergent and forested wetlands.

Another adverse impact to floral diversity resulting from increased water levels is the drowning of groundwater dominated wetland communities. Groundwater dominated wetlands are generally more diverse floristically. Increased surface water, especially if carrying nutrients and sediments, can adversely impact these wetlands. Wetlands such as sedge meadows, low prairies and lowland hardwood swamps are highly susceptible to surface water inundation. Marshes are considered moderately susceptible and floodplain forests are slightly susceptible. Even for wetlands in the "slightly susceptible" category, regular inundation for longer than an additional two days may result in significant adverse impacts to the wetland.

Water Quality

If the lake level is raised to the summer proposed target of 776.8 MSL there will be no change in water clarity or turbidity. There will also be no change in dissolved oxygen (DO) or temperature during the summer. If winter drawdown is eliminated as proposed, there may be a nominal increase in DO during winters with heavy snowcover since there will be more water volume above the sediment. There will not be a change in winter temperatures.

It was estimated in the EIR that increasing the summer water levels would improve water clarity. A graph showing Secchi depths at various water levels was used to support this argument (Figure 49). In fact, when summer (June-mid September) Secchi depth is regressed against water levels within the range of the proposed target (maximum of 777.0), there is no significant relationship (Figure 50). This is not surprising since a model run using WILMS (Panuksa and Kreider, 2002) was performed (Attachment 9), which indicated there would not be a significant reduction in total phosphorus with the increased water level. The model run used the period from October through September 1999 as the baseline data since the U.S. Geological Survey had collected relevant data during this time. The surface area and volume used in the analysis were calculated at a point located half way between the proposed target level of 776.8 MSL and the maximum level of 777.0 MSL. The modeling effort indicated that the greater water volume that would result from higher water levels would only increase the water residence time by 1.9 days. This increased residence time would reduce the total phosphorus concentration from 312 µg L^{-1} to 310 µg L^{-1} which would have no effect upon water clarity or the frequency of algal blooms.

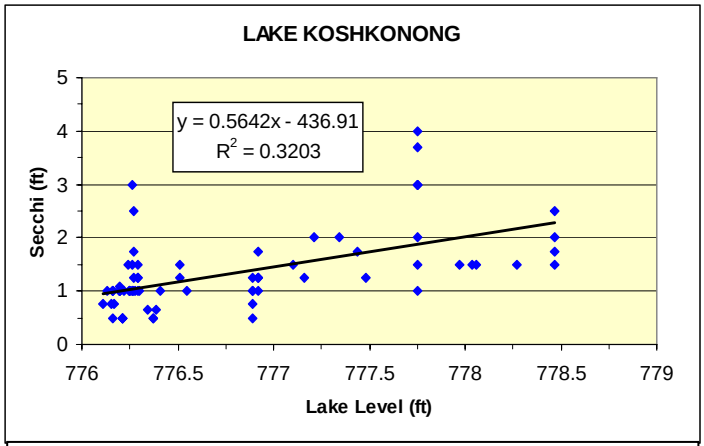


Figure 49 Regression of water level vs summer Secchi depth for years 2001-2003.

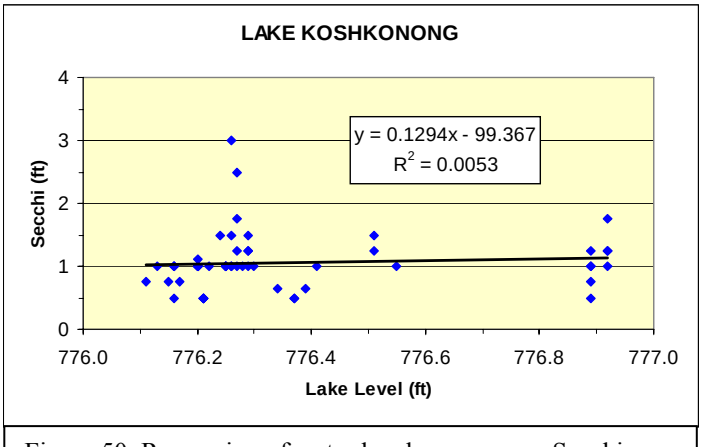


Figure 50 Regression of water levels vs summer Secchi depth for years 2001-2003 at levels below the proposed summer maximum (777.0 msl).

The suggested improvement in water clarity with higher water levels presented in the EIR is the result of flooding events when the water levels exceeded the proposed maximum target level (777.0 msl). A plethora of studies conducted worldwide clearly show that algal levels are strongly correlated with phosphorus loading /concentration (Sakamoto 1966, Dillon and Rigler 1974, Jones and Bachman 1976, Vollenweider 1976. Shindler 1978, Oglesby and Schaffner 1978, Rast and Lee 1978, Canfield and Bachman 1981). The regression between phosphorus loading and average annual chlorophyll (algal) concentrations is approximated by (Wetzel 2001):

$$[\text{chl. a}] = 0.55\{[P]_i/(1+\sqrt{t_w})\}^{0.76}$$

where:

chl a = mean summer chlorophyll concentration
P = total phosphorus loading
t_w = average residence time of water

The improvement in water clarity during the higher water levels is the result of additional runoff from precipitation and does not accurately reflect typical water clarity with higher water levels. During these events the higher water volume from overland runoff diluted the density of the algal community and did not reflect conditions that would occur under normal operating conditions with the proposed order.

Numerous studies in North America and Europe have shown that to improve water clarity it is necessary to REDUCE water levels, not increase them (Wallsten and Forsgren 1989, Bengtsson and Hellström 1992, Beklioglu 2002a, Beklioglu and Tan 2002b, Coops and Hosper 2002, Steinman et al. 2002). These studies have shown that reducing water levels increases the amount of light that reaches the upper plant canopy, which facilitates their growth. Timms and Moss (1984) report that the establishment of plants improved water clarity. This is further supported by regional studies in the Netherlands (Scheffer 1998), Danish lakes (Jeppesen et al. (1990) and Florida lakes (Canfield et al. (1984). From these studies it is clear that increasing the water levels will not increase water clarity. Instead, reducing the water levels may enhance growth of submerged aquatic plants which could improve water clarity.

Oxygen Depletion Rates-Winter

A general assumption is that lower water levels cause an oxygen deficit leading to a greater possibility for winterkill. In order to evaluate the potential for winterkill, the following analysis was made.

Mathias and Barica (1980) found that the winter oxygen depletion rate of Canadian lakes was predictable according to two parameters. Namely, the ratio of surface area of sediments to lake volume, and secondly whether the lake was eutrophic or oligotrophic. Water depth in itself was not significant as the water of both oligotrophic and eutrophic lakes had an oxygen consumption rate of 0.01 $(g)(m^{-3})(d^{-1})$. Thus it would take 100 days to reduce the water by 1 ppm if dependent upon the water volume alone.

Sediments were found to be responsible for most of the oxygen consumption, and fell into two rates depending upon primary productivity. Oligotrophic lakes had a mean oxygen depletion rate of 0.075 $(g)(m^{-2})(d^{-1})$, and the value for eutrophic lakes was about three times higher at 0.23 $(g)(m^{-2})(d^{-1})$. Therefore, a formula incorporating the ratio of sediment area to lake volume and trophic status will predict the winter oxygen depletion rate of the lake. This is described as follows:

$A/V\ (D) = R$

Where A = Area of sediment m2
V = Water Volume m3
D = $0.23(g)(m^{-2})(d^{-1})$ for eutrophic lakes or
$0.75\ (g)(m^{-2})(d^{-1})$ for oligotrophic lakes
R = the oxygen depletion rate in $(g)(m^{-3})(d^{-1})$
Or the loss of Oxygen in ppm/day

In order to estimate the amount of time that oxygen would be available to prevent winterkill, it was assumed those oxygen levels would be at least 12.0 ppm at the time that oxygen production ceased. It was also assumed that winterkill would not begin until oxygen levels had fallen to 2.0 ppm. Therefore, the formula was used to predict the number of days necessary to consume 10 ppm of oxygen, or simply 10/R.

In computing the probability of winterkill at various winter water levels, area and volume ratios were computed for various levels from 776.2msl, to 772.6msl which represents an 18-inch drawdown with 18 inches of ice (Table 11).

Since flushing rates increase at the volume of the lake decreases, the flushing rates at various levels were also computed.

Table 11. Model of winter oxygen depletion rates based on various water levels for Lake Koshkonong.

MSL	776.2	774.7	773.2
Flushing time @ 1223 cfs	23 days	21.4 days	15.7 days
Area (acres0/Volume (acre feet)	10460/55793	10042/52000	9522/3800
A (m^2)/V(m^3)	42,363,000/68,775,784	40,670,100/64,100,400	38,454,100/46,842,600
Area (m^2)/Volume(m^3)	.6160	.6344	.8201
Sed. Depl. Constantg/m_2d	0.23	0.23	0.23
O_2 Depletion Rate(R) AD/V = g/m^3d or ppm/d	.1417	.1459	.1886
Time to consume 10 ppm (days to fish kill)	70.57	68.54	53.02
Number of times lake flushes within Oxygen supply	3.07	3.20	303

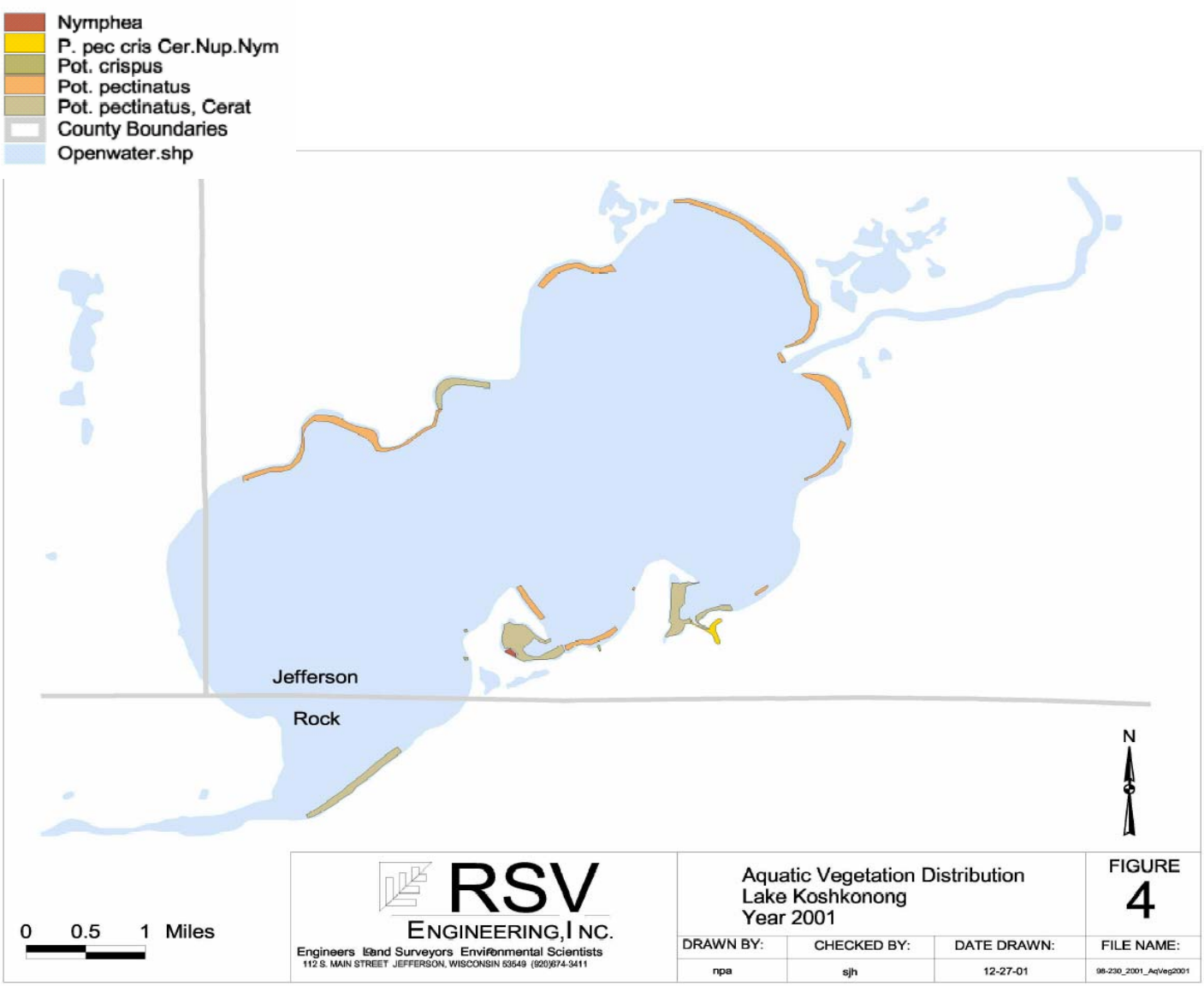
Summary--In the extreme example of an 18-inch over winter drawdown coupled with 18 inches of ice, the oxygen supply will drop from 70.57 days to 53.02 days. This loss of seventeen days of oxygen would become a problem if flushing rates were not an issue. At such a low level, the volume decreases and the flushing rate or turnover rate for the lake speeds up to once every 15.7 days over once every 23 days. At any water level, at normal flows, the lake will change its water three times within the predicted oxygen supply time.

Complicating factors are that some of the lake may not be cycling its water with the river flows, the river flows may fall to levels below 200 c.f.s., and photosynthesis will likely be adding oxygen to the system. The bottom line is that the winter water quality of the lake is extremely dependent upon the water quality and quantity of the incoming Rock River. There are times when oxygen levels in the river are low. If combined with low flows and a lack of flow, a fish kill may occur regardless of what level the lake is a

Submerged Aquatic Vegetation (SAV)

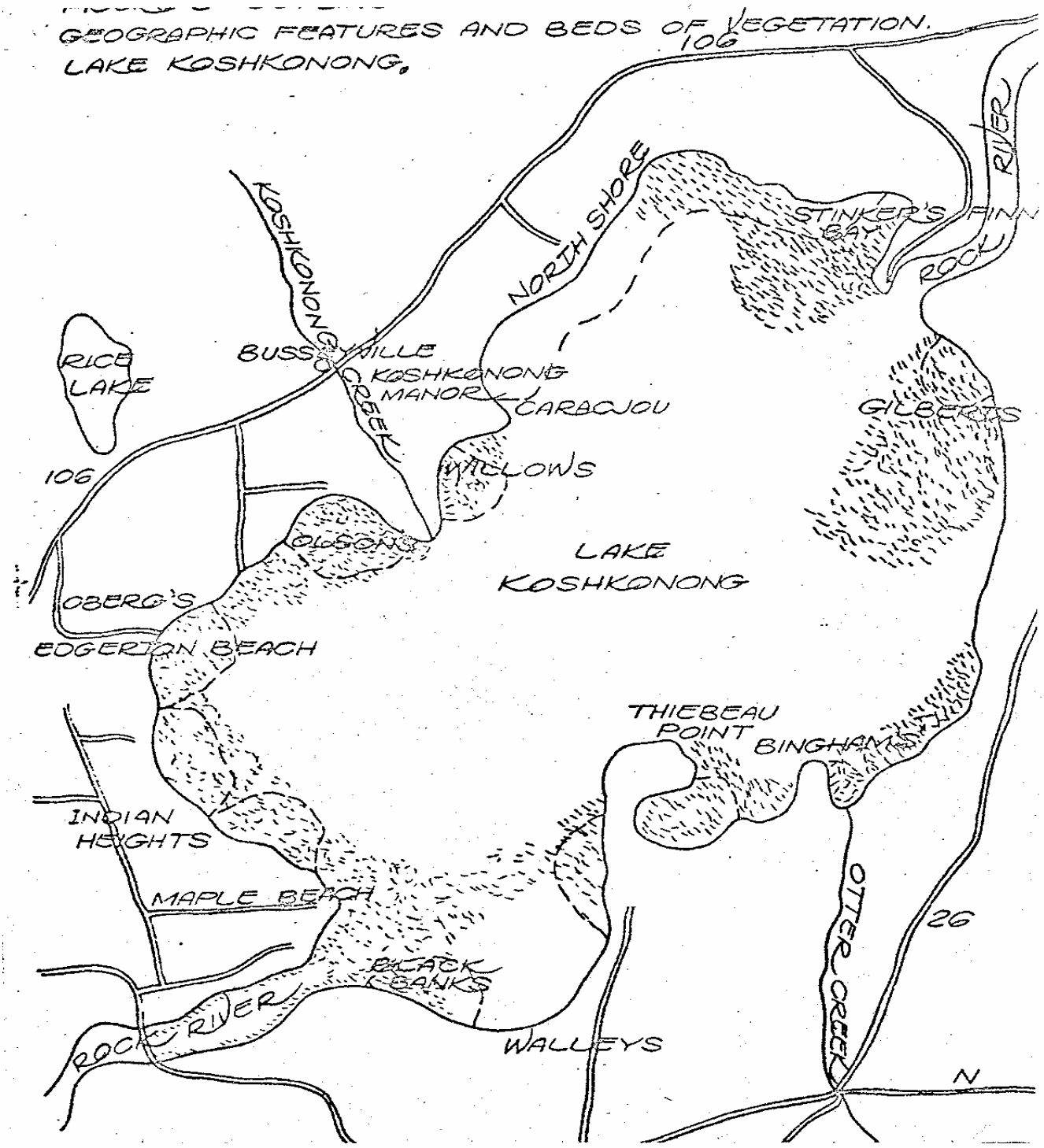
At the current time the area of the Lake Koshkonong that contains SAV is relatively small (Figure 51). It is much reduced from coverage reported by Threinen (1952) (Figure 52). The community is also relatively simple, being dominated by sago pondweed (*Potomageton pectinatus*). The loss of plant cover is most likely the result of increased nutrients and sediment delivered from the watershed via the Rock River as well as rough fish (carp) activity. It was stated in the EIR that the amount of SAV would increase since water clarity would improve. Modeling using the WILMS model (water quality section above) indicates there would be no discernable decrease in total phosphorus concentrations with the higher water level, thus there would be no improvement in water clarity. Because there will not be an improvement in water clarity if the summer water level is raised to a target of 776.8 MSL, there will not be an expansion of the submergent plant beds. If the water level is raised, the maximum depth of growth will remain at about 4 feet as it is now. Increasing the water level will only displace the plant beds towards the present shoreline such that the SAV is found growing closer to the present shoreline and to a maximum depth of 4 feet.

Figure 51. Map of submerged aquatic vegetation in 2001.



Elimination of the winter drawdown would have no effect upon the SAV. Typically, the SAV does not grow in water depths less than 0.5-1.0 feet. The failure of plants to grow in this shallow depth is probably related more to erosion as a result of wave action during the ice free period than to winter drawdown. It is expected the minimum depth of plant growth will be unaffected whether the winter drawdown occurs or not.

Figure 52. Submergent Aquatic Vegetation map reported by Threinen (1952).



Amphibians and Reptiles

Of the 54 species of herptiles present in Wisconsin, 21 are found in and adjacent to Lake Koshkonong. Many of these inhabit riparian marshy habitats that support emergent, and in some cases, submergent vegetation. These species are dependent upon emergent and submergent vegetation for cover, food or egg deposition and will likely be negatively affected by higher summer water levels, as they have been as a result actual dam operations in the past. The history of emergent habitat loss in this lake is clear. Higher water means eventual loss of emergent shoreline habitat caused by the instability of inundated emergent vegetation. The process that has resulted in the historic loss of habitat caused by high water in the past will guarantee additional habitat loss if water levels are increased. As habitat is lost, the carrying capacity for herptiles and many other wildlife species dependent on this habitat within the Lake Koshkonong landscape will decrease.

Several amphibians are dependent on fishless habitats in order to sustain their populations over time. As water levels increase, and as additional shoreline habitat is lost, shallow habitats now isolated from fish will become available to fish and amphibian reproduction is likely to be reduced.

The EIR states that elimination of the winter drawdown would be beneficial to hibernating herptiles. This statement is especially accurate for turtles, which are slow growing and take many years to reach maturity. Drawdowns conducted after aquatic herptile hibernation has started often results in mortality related to stranding and freezing. To avoid mortality, the department recommends that drawdowns be completed prior to October 1, although once completed, can be maintained for months or even years. Drawdowns can be very effective for restoring or enhancing emergent vegetation, for compacting bottom sediments, and for other purposes, most of which benefit herptiles associated with these habitats. As such, periodic drawdowns are recommended to enhance or restore habitats in Lake Koshkonong.

Macroinvertebrates

Many macroinvertebrate species are strongly dependent upon adequate substrate, e.g. submergent plants. As stated above, higher water levels are expected to cause additional losses of these habitat types. This will result in further impact to macroinvertebrates associated with the plants. Emergent vegetation also serves as habitat for numerous macroinvertebrate species. Since it is expected these marshes will be reduced in aerial coverage, there will be a decline in the amount of macroinvertebrates associated with these marshes. Some macroinvertebrates also inhabit sediments, e.g. chironomids. If the winter drawdown does not occur the numbers of these insect larvae may increase, as a larger amount of sediment will be flooded. However, it is important to note that none of the studies have documented the size of the macroinvertebrate community in the drawdown zone, so it is impossible to know how much of the community is affected. Unlike turtles, most lacustrine macroinvertebrates reproduce rather rapidly, allowing populations to rebound quickly following drawdowns.

Freshwater mussels are one macroinvertebrate group that would potentially benefit from the elimination of winter drawdowns since they mature much slower than most other invertebrates, and therefore do not have the same recovery potential. These organisms do not readily move, especially once water temperatures drop below 40^0F, and are readily stranded in late fall or winter drawdowns. The EIR reported stranded mussels on dry land following the winter drawdown. However, it is important to note that freshwater mussel diversity is typically low in flowage habitat, as is the case in Lake Koshkonong, because most mussel species require higher flows and more stable substrates. The species present in areas other than the main channel of the lake are species tolerant of poor water quality and slow flows. They seldom make up a significant portion of the macroinvertebrate community due to low densities. As a result, this group of organisms should receive less consideration when determining how and when to use drawdowns as a management tool in Lake Koshkonong. Because the freshwater mussels indicative of the lake occur in low densities, it s reasonable to conclude that, while increased water levels may benefit these mussels, their contribution to the system is expected to be negligible.

Fishery

As noted by Threinen, (1952), the fishery of Lake Koshkonong is noted for fluctuations of strong year classes of a wide variety of fish species. This is typical for all river systems. Periodic flooding and drought will enhance environmental conditions for the benefit of some species to the detriment of others. Adding to this potential for variability, the commercial removal of over one million pounds of carp from the system leaves a biological void to be filled by other species. In addition, the Department's aggressive gamefish stocking program has the opportunity to establish year classes which vary from minimal to enormous.

No water level manipulation (high or low) is capable of replacing or duplicating the natural conditions that enhance fish spawning during periodic flooding. Timing of flood events will benefit one species over another. During 1993 high waters caused one of the best hatches of walleyes on record. The same flood conditions on the Mississippi River washed many of the walleye fry downstream to unfavorable habitat. The flood events on the Rock River in 2004 were too late to enhance walleye spawning, but the high water enhanced forage fish populations which in turn resulted in exceptional growth and survival for young of the year walleyes and northern pike. It must be kept in mind that such flood events are not an occurrence on Lake Koshkonong by itself. The floods will cover fields and marshes throughout the Rock, Crawfish and Bark River systems. As the waters recede, the fry move downstream and eventually get down to Lake Koshkonong.

Flooded marshes are critical spawning habitat for northern pike, and can be used by walleye. The proposed raise in water levels will not be enough to cover marshes to enhance northern pike spawning in any way. Erosion from high water, wave and ice action has already destroyed most of the peripheral floating wetland habitat useful for pike spawning. If higher water levels result in the loss of more wetland vegetation, it equates to a reduction of pike spawning habitat.

Of the sixty or so species of fish found in the Rock River and Lake Koshkonong, many of them are river spawners, or are species that will utilize both lotic and lentic systems. River spawners such as sauger, white bass, suckers, redhorse and catfish will be unaffected, as they will still seek out the same habitats. Lake spawning fish may have some enhancements to spawning success during low river flows. The most abundant species such as carp and buffalo will still deposit millions of eggs along the shoreline. If water levels are stable and the eggs are deposited in vegetation, there may be a higher hatching rate. Nest building fish such as the Centrachidae or Sunfish will be largely unaffected. They may be able to move their nests somewhat inland, but it is doubtful that there will be any change in hatching success or numbers of nests.

The removal of the winter drawdown order may have consequences to the fishery. These observations are based upon the single season of 2002-2003 where the overwinter drawdown was successfully implemented. Under the current order, when water levels start dropping in marshes adjacent to the lake, the fish need to move out. Most of the fish in question are carp. With the marshes drying up and the lake being drawn down, the fish are concentrated and are therefore more susceptible to commercial seining. Moving carp out of marshes also allows for the operation of mechanical barriers to inhibit carp movements back into the marshes in the spring. Without a winter drawdown the carp barriers at the Thiebeau and Mud Lake marshes will be ineffective.

Dropping water levels will also concentrate gamefish. This may lead to higher angling success, but also can lead to heavy exploitation of the resource. To offset those issues, it is apparent that during low water conditions, many gamefish move upstream into the river where angling success is not as great. Fish appear to be skittish in very shallow water under ice. Ice angling is apparently less effective during low water conditions.

Under the current water level order, the drawdown persists until May 1st. This means that under normal or low flows, the bays around the marshes on the lake are dry during the spawning periods for northern pike and walleye. With the vegetation eroded back so far into the marshes, there is very little if any spawning habitat for northern pike in the lake. During the spring of 2003 northern pike which were marked in marshes in the spring of 2002 moved up the Rock River as the marshes were inaccessible. While higher water levels may seem like the quick fix to this situation, a more preferable alternative is to extend the wetland vegetation back to its former extent in the lake.

In summary, fish populations fluctuate in response to floods and droughts. These fluctuations are augmented by management efforts to remove rough fish, and stock gamefish. While it is tempting to draw a conclusion that more water in the lake will equate to more fishery habitat, the reality is that because of the extensive nature of the Rock River basin as a whole, there will be an insignificant gain in fish habitat from raising water levels. The potential loss of wetlands from higher water will result in a loss of northern pike spawning habitat. Elimination of the winter drawdown will make carp barriers ineffective, but will make current marshes somewhat more accessible to pike. Higher and more stable water levels may enhance spawning success for carp and buffalo.

Waterfowl
Presently, Lake Koshkonong and its associated wetlands still provide the same types of opportunities for waterfowl migration and production except to a far lesser degree. This loss in value is due to the long-term degradation of habitat that has occurred and is still in progress. The accelerated wetland loss due to the proposal will make the lake less attractive to waterfowl for staging and local production.

Furbearers
The lake and adjacent wetlands have a typical complement of furbearers, which include muskrat, mink, raccoon, river otter, some beaver, red fox, and coyote. These are the most "important" or valuable species from a trapping view point. All these species would be negatively impacted by artificially raised water levels due to the degradation and loss of wetland habitat types. Obviously, the species most injured would be the muskrat, beaver, mink, and river otter. The survival of these species is almost entirely tied to quality wetland habitat. The wetlands adjacent to the lake itself will see the largest vegetative change (negative) from higher water levels and consequently, this is where the furbearers would be most impacted. These species are present in significant numbers. Muskrats, the number one trapped fur in Wisconsin, will likely be the species sustaining the highest negative impact of all.

Endangered Resources
As discussed above, high water levels in riparian wetlands have been correlated with lack of herbaceous vegetation, tree mortality, drowning of groundwater-dependent wetland types, and adverse water quality impacts from sediment and nutrient deposition. Adverse impacts would be expected to the rare natural wetland communities and the rare species they support

The Koshkonong Creek Floodplain Forest is a high-quality natural community and habitat for a number of rare birds, and historically a number of rare plants. This area could suffer significant degradation due to tree mortality and loss of groundlayer plant species, impacting habitat for rare species such as Cerulean Warbler and Acadian Flycatcher. It is unknown whether the historical populations of several rare plants still exist in the area today; further surveys are needed. Likewise, the very high-quality floodplain forest documented at Koshkonong Lake Access could experience tree mortality, and negative impacts to the largely native ground flora. This site ranked among the top 9 for protection by Rock County in their Natural Area Inventory.

Other wetlands and marshes around the lake that support numerous rare nesting and migratory birds such as North Lake Koshkonong Marshes, Koshkonong Marsh/Mud Lake, and Thiebeau Marsh would be affected. Rising water levels in these marshes and increased siltation would diminish vegetative nesting habitat for birds such as Black Tern, Forster's Tern, American and Least Bittern, Virginia Rail, and others.

Along the south side of the lake, there is substantial risk that the wet and wet-mesic prairies and sedge meadows found in Koshkonong Wetland, Fair Meadows Prairie and Thiebeau Marsh would be permanently altered by long-term surface water inundation and higher water tables.

Newville Carr, along the south shoreline of Lake Koshkonong, is characterized by the Rock County Natural Area Inventory report as a significant and uncommon wetland with an exceptional number of spring seepages running through the very old organic peat mounds. The report states that it has a high probability of supporting rare species, and features unusual mosses and lichens. More surveys are needed here. Increased water levels would be expected to impact the peat mound hydrology and morphology, the water quality, and plant composition.

The degree to which the rare plants found in the lake's riparian wetlands would be impacted by increased water levels cannot be determined with certainty without further studies and surveys. There is strong risk of impacting one of the best populations of a plant that is listed at both the state and federal levels. If inundated, these plants would perish. During the high water levels of May 2004, some of these plants were submerged and by July had disappeared. Inundation would affect seed germination and survival, cause siltation, and create competition due to the deposition and establishment of invasive species. Inundation could also affect the mycorrhizal fungi that these species rely on, and the moth species that pollinate them (including the moths' larval foodplants). Another population of this plant in Wisconsin that had apparently disappeared responded dramatically to a water level reduction of 1.5 feet along with burning and invasives management. After these activities, that population numbers over 500 plants. The 1999 federal recovery plan for this species states that if a site is disturbed by flooding, it should be left undisturbed for at least five years once flooding receded, so the seeds can germinate.

Other significant rare plant populations may exist in surrounding forested wetlands, as they did historically, but further surveys are needed.

Nesting habitat for Blanding's Turtle could also be affected.

Rare Fish: All of the nine rare and endangered fish species referenced in Chapter 7 of this analysis are rare in the Rock River. Their appearance in Lake Koshkonong is attributed to the diversity of habitat within the Rock River Basin. It is unclear if implementing the petitioner's proposal will benefit or detract from the abundance or continued successful spawning of these species.

Relevant Studies -- Three studies critical to a more quantitative assessment of impacts to these resources have been funded and are currently underway or to begin in 2005. Natural Resources Consulting, Inc., on behalf of the Lake Koshkonong Wetland Association, has received DNR River Protection Grant funding for three projects:

1. A Comprehensive Wetland Community Assessment: This project will include floristic quality assessment of five major wetland areas around the lake, classification and mapping of wetland communities, and development of a preliminary management strategy. Further rare plant species may be found in this study.
2. A Floodplain Forest Study: This project will describe correlations between lake water levels and growth rates of trees.
3. A Rare Plant Study: This project will study correlations between water elevations and populations of the federally listed plant found along the south shore. Five water-level monitoring wells were installed this year and monitoring will continue in 2005.

Cultural

Outdoor Recreation
An overall loss of recreational opportunity for wildlife observation, hunting, fishing, and trapping is anticipated; primarily due to accelerated wetland loss.

Angling--Ice fishing is an important cultural activity on Lake Koshkonong. Angler hours are measurable in the tens of thousands, and the catch and harvest of fish is in the thousands. During periods of good ice fishing, the local bait shops, sporting goods stores, restaurants and bars all profit from ice fishing.

Ice fishing activity on Lake Koshkonong is a function of safe ice and strong fish populations. In many years ice fishing is poor despite good fish populations because ice conditions are bad. Conversely, if ice conditions are good, and the fishery is not there, the fishing activity will not develop. It is apparent that during periods of low winter water levels many fish will leave the lake. Fish that do not leave the lake are often skittish and are not easily caught in the shallow water below the ice.

Biologically it makes no difference if the fish are harvested during the winter or the open water months. Open water anglers appreciate "saving" the fish until the warmer months, but to the angers that prefer to venture onto the ice, the sport is diminished.

Eliminating the winter drawdown would provide an overall enhancement to ice fishing. Improving the harvest rates of ice anglers will diminish the success rates of the open water anglers.

Recreational Boating and Navigation
RKLD's EIR estimates an increase of approximately 50 acres of boating surface area as a result of the proposed action. This increase in boating area is minimal as it represents less than 0.5% of the total surface area of Lake Koshkonong

However, one of the largest benefits to raising the pool 7 to 8 inches is thought to be improved access to the Lake both by riparians who need shorter piers and better access at boat landings. In order to better quantify this benefit DNR staff conducted a survey during the winter of 2004 using ice augers and hand held GPS units. The intend of this survey was not to address every access issue on the lake, but rather to try to better understand these issues at

some of the more extreme access areas along with the public boat landings. A total of 17 cross sections were taken. Figures 54 -60 are included as representative x-sections of that survey. Figure 53 shows the location of these cross sections.

A review of the Figures 58-60 (non-boat landing x-sections) gives one an idea of how access may be changed as a result of this proposal. In Wisconsin, a riparian may place a pier out to the line of navigation without a permit (generally 3 feet of water). However many piers are placed at more moderate depths especially when the piers have to be very long as they are on Lake Koshkonong. From a review of the North Shore X- Section 4-C, which is fairly typical of cross sections on the North Shore, it would appear that RKLD's proposal would reduce pier lengths 85 to 100 feet depending upon the desired depth at the end of the pier (2-3 feet). Piers would also be substantially shorter on the southeast shore of the lake. The Highwood at Cherokee Road cross would suggest that pier lengths could be reduced by 160 feet. However, the Mallwood cross section would predict much less of a reduced pier, perhaps 10 feet.

The cross sections at the boat landings are much more dubious. While RKLD's proposal would improve depths at all of the boat landings, the improved depth is probably not going to make these landings substantially more usable. The usability of these landings is probably much more effected by the type of equipment being used rather than a change in depth. Boater launching from tilt up boat trailers with boats on rollers will be much more affective than boaters launching from trailers using friction skid pads. Small maintenance dredging projects at these landings would make the landings much more dependable for a variety of boats/trailers.

Figure 53 Location of Navigation x-sections

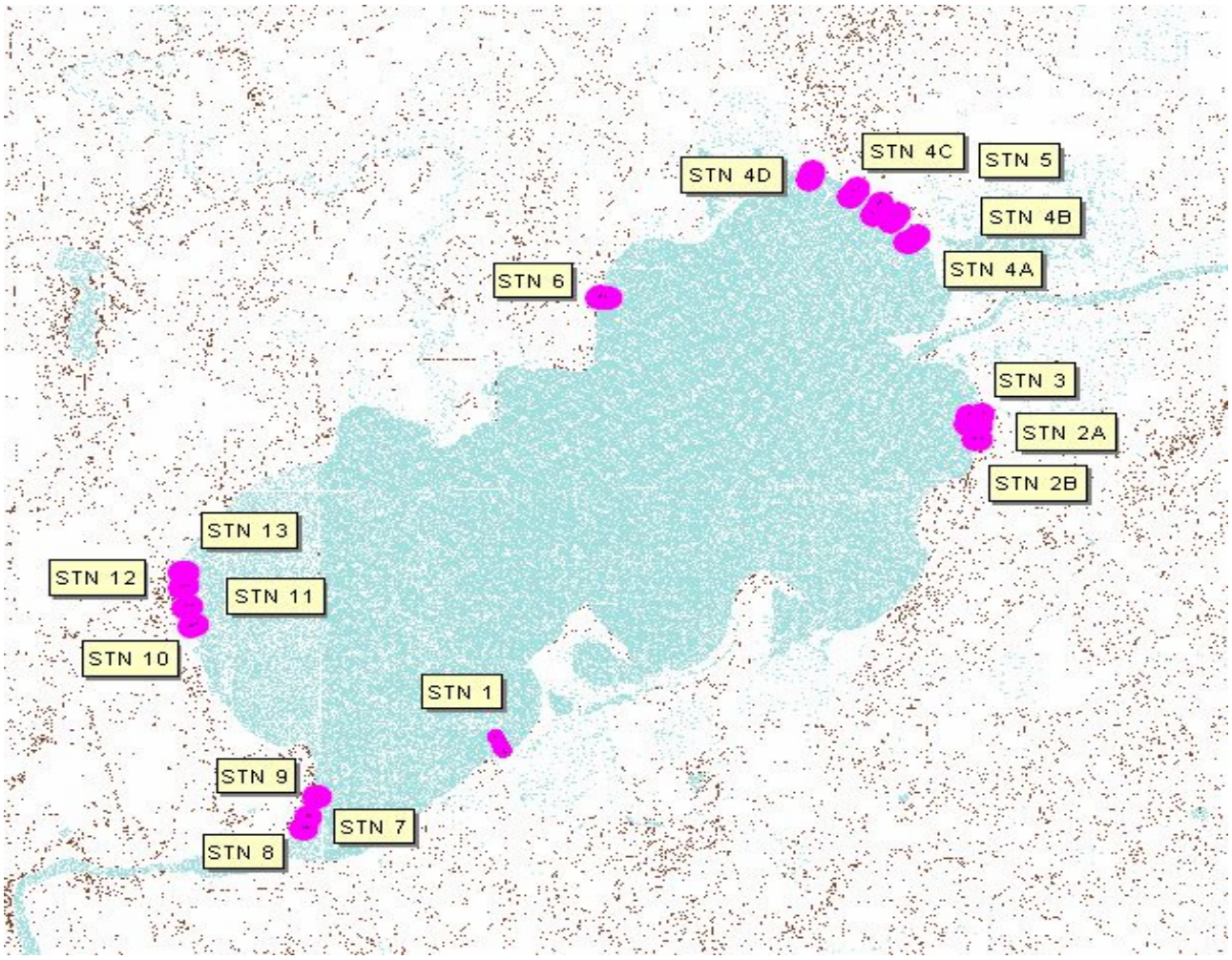


Figure 54. Keuhn Boat Landing is shown as STN 6 in Figure 53.

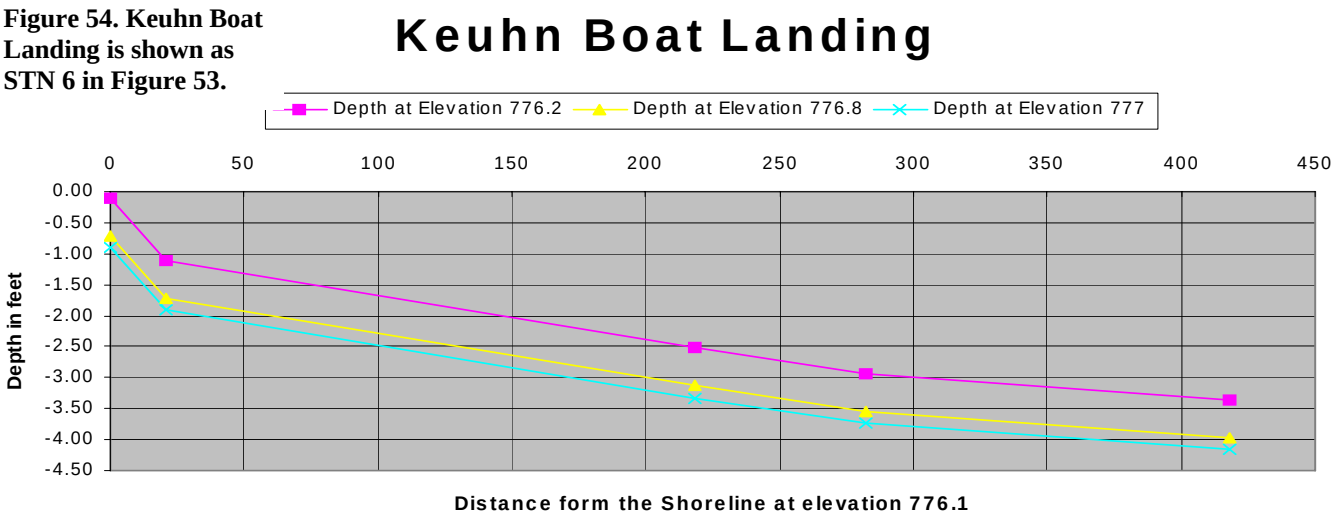


Figure 55. North Shore is shown as STN 5 in Figure 53.

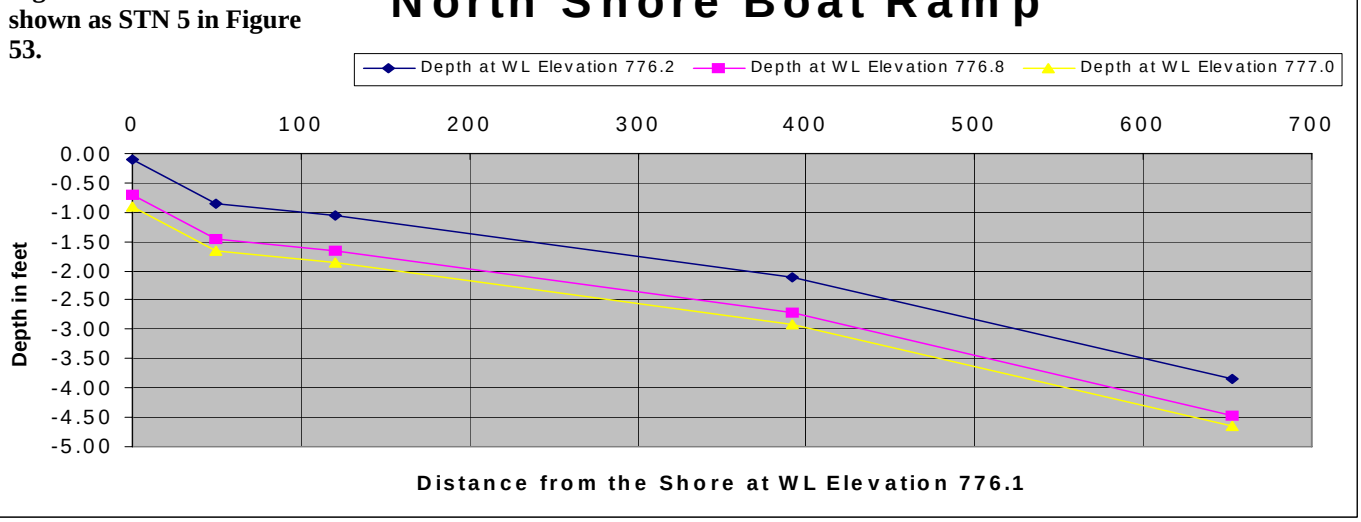


Figure 56. Dallmans is shown as STN 1 in Figure 53.

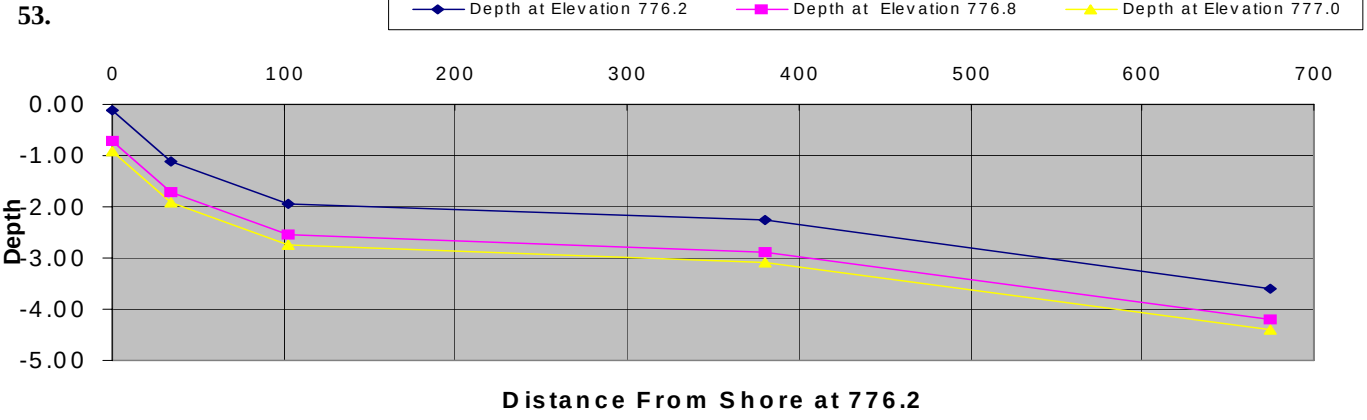


Figure 57. Vinnie Ha Ha is shown as STN 3 in Figure 53.

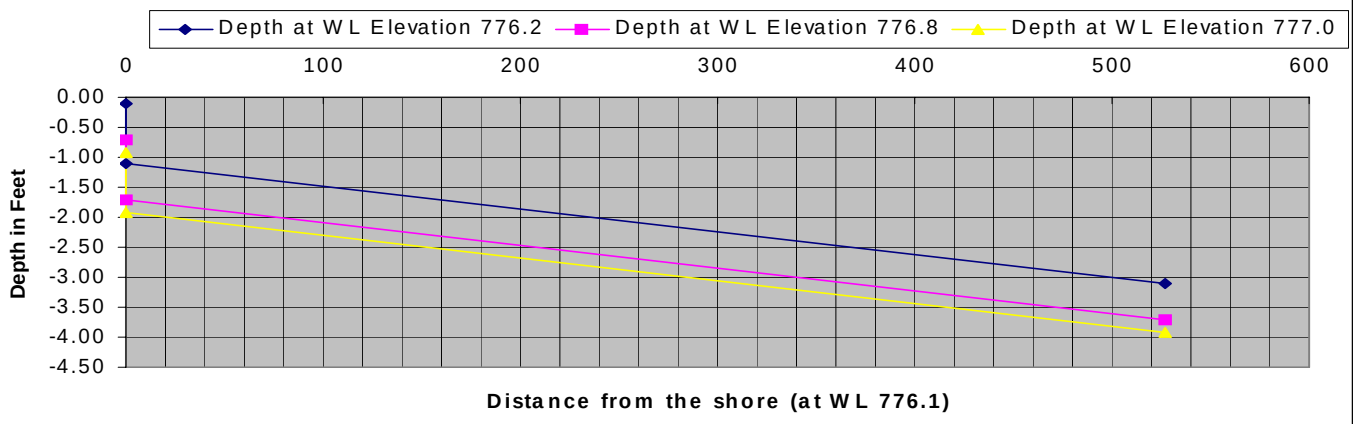


Figure 58. Highwood is shown as STN 13 in Figure 53.

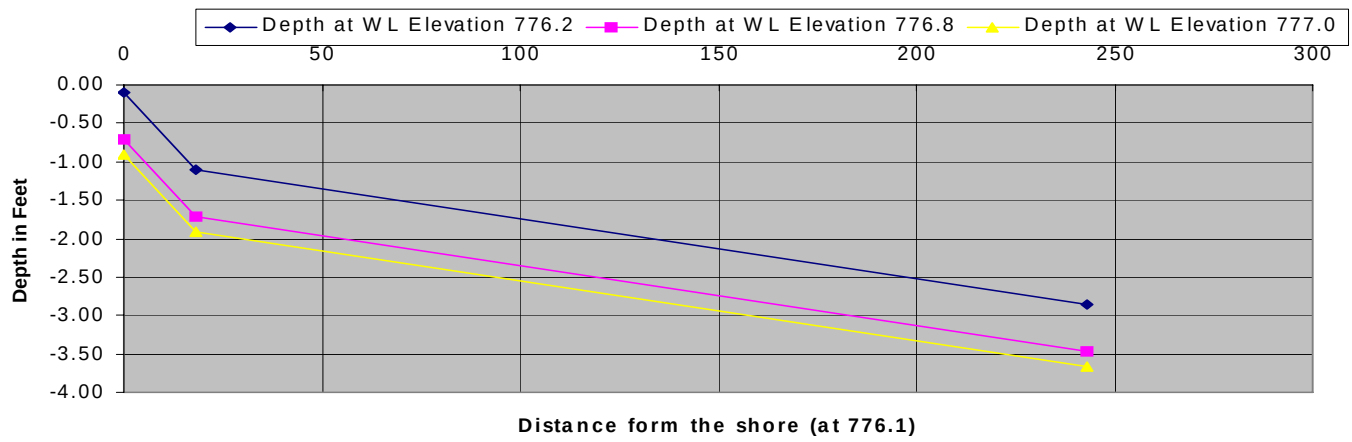


Figure 59. North Shore is shown as STN 4C in Figure 53.

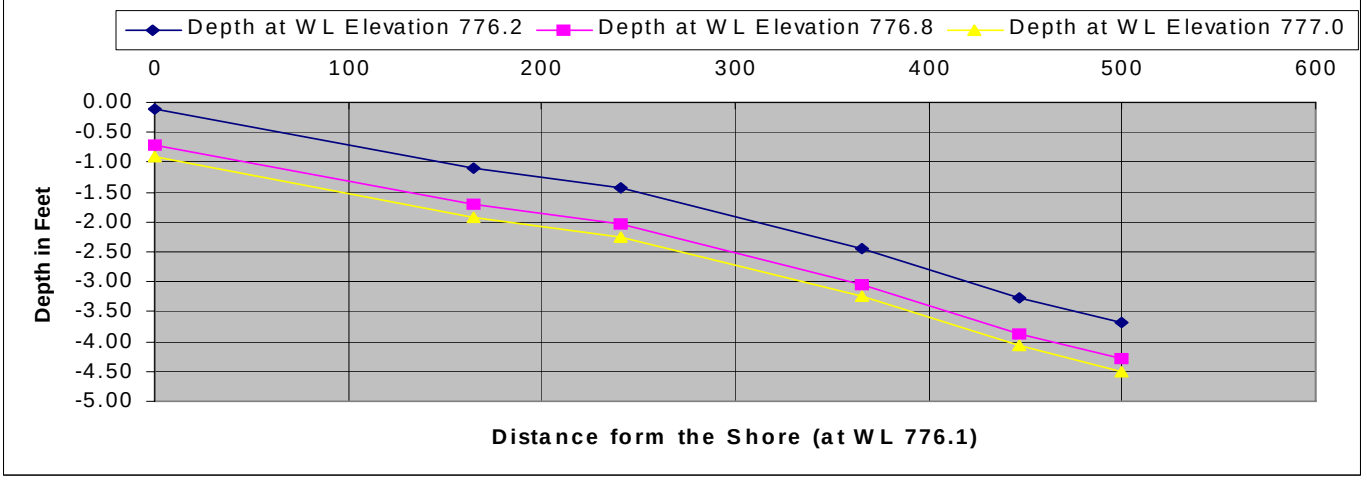
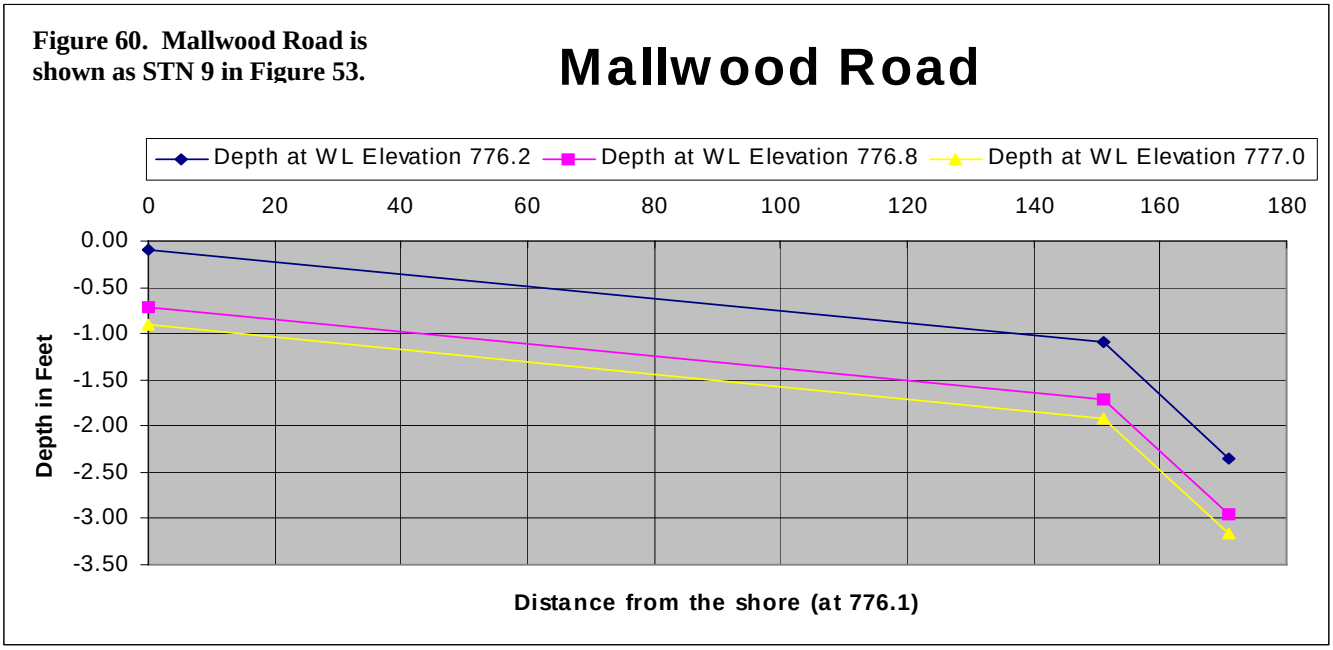


Figure 60. Mallwood Road is shown as STN 9 in Figure 53.



Shoreland Zoning

With higher water level the OHWM may migrate shoreward. This could mean that marginal structures may become nonconforming since they will be closer than 75 feet to the lake. In order to be legal, these structure will have to be moved or removed over time.

Archaeological

There are 27 archaeological sites recorded on the shores of Lake Koshkonong. One located on Carcajou Point is listed in the National Register of Historic Places. Many of the lakeshore sites are at least partially low lying and extend to the water's edge. The raising of the lake level could lead to substantial erosion of significant archaeological deposits.

State law (s.44.40 Wis. Stats.) requires state agencies, including the Wisconsin Department of Natural Resources, to determine if their actions may impact historic properties that are listed in their inventories, and to consult the Wisconsin Historical Society if impact is likely to occur. The Environmental Assessment is such an action. Therefore, any change in raising the water level cannot be accomplished until the Historical Society has had a chance to review a proposal and make a determination as to the disposition of affected sites. The State Historical Society has not been contacted at this point due to workload considerations. If the water level is not raised, there is no need to have the Historical Society take a look at possible impacts.

DNR EVALUATION OF PROJECT SIGNIFICANCE

Primary and Secondary Environmental Effects and Their Significance

Discuss which of the primary and secondary environmental effects listed in the environmental consequences section are long-term or short-term.

The primary negative effect of this proposal will be the continued and accelerated loss of riparian wetlands. Of particular immediate concern is the change in forested wetlands. This relatively rare habitat in Southern Wisconsin will be drastically changed. It can be anticipated that large stands of trees will be affected by permanently saturating root zones and in some cases outright permanent inundation. Ultimately, much of this forested wetland habitat will be destroyed. It is unlikely that new land-ward forested wetlands will evolve as a result of this proposal. Forested wetland losses are likely to be permanent.

Other riparian wetlands will recede from their current borders as water levels rise. Historical evidence has shown us that the recession of wetlands at the borders is continuing but it will be accelerated by an increase in water levels. In some cases it may be possible for wetlands to migrate up slope as a result of increased inundation. However, expansion of wetlands inland will be limited by adjacent topography, current land use and the availability of suitable soils. Wetland losses are likely to be permanent.

Permanent, increased, water levels on Lake Koshkonong wetlands is a systemic problem with long-term negative consequences. The described impacts of increased water levels cannot be justly compensated by remedial site-level "fixes", such as the construction of stone dikes and wetland armoring. To recover and protect Lake Koshkonong wetlands, management agencies must continue to address the underlying causes of wetland loss. For Lake Koshkonong the underlying primary causes are the combined effects of increased water levels, excessive nutrient inputs, and dominance of exotic common carp.

Discuss which of the primary and secondary environmental effects listed in the environmental consequences section are effects on geographically scarce resources (e.g. historic or cultural resources, scenic and recreational resources, prime agricultural lands, threatened or endangered resources or ecologically sensitive areas).

Several rare wetland community types occur along the shores of Lake Koshkonong, as identified in the Natural Heritage Inventory and the Rock County Natural Area Inventory. The high-quality floodplain forest communities and the rare species they support could be significantly degraded. An unusual peat mound wetland, and wet prairie and sedge meadow habitats also could experience serious adverse impacts. One of the best known populations of a Federally Threatened and State Endangered plant found on wet to wet-mesic prairie near the lakeshore could be seriously impacted. A Federal Recovery Plan for this plant was approved by the U.S. Fish & Wildlife Service in 1999. Recovery goals established for this species, which would allow ultimate de-listing, could be more difficult to meet if this large population is lost. The population is among very few in the state that are large enough to be considered viable in the long-term, but needs further habitat protection to meet recovery goals in this ecological region for high viability.

The wetlands surrounding Lake Koshkonong support a large number of rare bird species, including the Endangered Forster's Tern, large numbers of Special Concern Black Terns, and the Threatened Cerulean Warbler and Acadian Flycatcher. Nesting and foraging habitat impacts from higher water levels would further impact these species. Impacts to other rare plants, including the small yellow lady's slipper orchid (Special Concern) and kittentails (State-Threatened) are unknown without further study.

Comprehensive rare plant, bird, insect and herptile surveys have not been conducted across the affected area. It is highly likely that other rare species occur in these habitats. Many plants now listed as endangered or threatened were documented historically in the wetlands north of Lake Koshkonong.

Discuss the extent to which the primary and secondary environmental effects listed in the environmental consequences section are reversible.

As discussed above, this proposal will likely result in permanent wetland loss at an accelerated rate. It may be possible to reverse some of the wetland losses with a concerted long term summer draw down or periodic summer draw downs. The reestablishment of submerged plants and riparian wetlands have been successfully accomplished at other shallow lakes by implementing summer drawdowns, and could be instituted at Lake Koshkonong. However , the hydrology of Lake Koshkonong would dictate the appropriate time to implement a draw down. For example, the high water of the summer of 2004 was driven by early spring runoff, a bad time to try to implement a summer draw down on the Lake. Conversely the prior two year period had relatively low spring runoff and would have been good years to implement a summer draw down. In the absence of a plan to revitalize the new shore vegetation, wetland losses will be permanent. Even with periodic summer draw downs the losses of forested wetlands as a result if raising water levels will be permanent.

Significance of Cumulative Effects

Discuss the significance of reasonably anticipated cumulative effects on the environment (and energy usage, if applicable). Consider cumulative effects from repeated projects of the same type. Would the cumulative effects be more severe or substantially change the quality of the environment? Include other activities planned or proposed in the area that would compound effects on the environment.

There are many shallow water lakes in Wisconsin of larger and smaller scales. Lake Winnebago, Lake Puckaway, Beaver Dam Lake, Big Muskego Lake, and Lake Poygan are just a few that have similar management issues to Lake Koshkonong. Human perturbations, primarily, non-point and point source nutrient loading, introduction of exotic species, and water-level changes have caused changes in the ecosystem function of these shallow lakes. Many larger shallow lakes in Southern Wisconsin have shifted to an alternative stable state characterized by high turbidity, phytoplankton blooms, loss of submersed macrophytes and recession of emergent plants, low waterfowl use, and altered fish communities (benthivores/planktivores like carp tend to dominate). Lake Koshkonong is among them. Management and restoration planning efforts to date universally seek to recover their earlier attributes that these lakes provided (clearer water conditions, abundant macrophytes, and improved fisheries and wildlife). Examples of success are found among some of them (Puckaway, Big Muskego, Miss. R. Pool 8) and typically involve aggressive management approaches including emulating natural disturbance events like drought through drawdowns, and drastic fish stock reductions of rough fish populations. Drought is a disturbance event and a natural component of ecosystems that promotes diversity and renewal processes. The wetland drought/renewal process is often eliminated with the establishment of dams and water level orders.

These lakes are also managed for multiple uses. Some of these uses are in direct opposition to the welfare of other uses. For example, the deeper recreational pools are often times desired by the boating public but those deeper pools come at the loss of riparian habitat. Likewise, we know that shallower pools and allowing for more routine drought like conditions (deep summer draw downs) will further riparian wetlands and submergent plants. However, these regimes come at the expense of decreased or more difficult navigation and navigational access. These ecosystems are inherently shallow in nature, and because of their shallow nature contain highly valuable fish and wildlife habitat. Because of their shallow nature power boating aspects of navigation has been historically limited to their deeper open pool areas. Establishing operating rules is often a balancing act between the competing public trust interest within the water body. While, weighing public trust issues is always done, it is never done to the exclusive benefit of one aspect of the public trust. Approving this proposal would establish a precedent that navigation and navigation access issues far outweigh the negative aspects associated with loss of riparian habitat. Accordingly, approving this proposal would likely result in justification of higher water levels on other shallow water lakes at the expense of loss of habitat.

Likewise, the winter draw down on Lake Koshkonong has been established as a balance of issues. Ideally, the winter draw down would have been set for early October but was delayed until November 1 to

accommodate the navigational interest of duck hunters. To minimize shore land damage from ice it is probably advantageous to have very deep winter draw downs. However, deep winter draw downs can affect ice fishing access and fish movements. It is likely that approval of this proposal would result in other winter draw downs being challenged for the exclusive benefit of one aspect of the public interest.

Significance of Risk

Explain the significance of any unknowns that create substantial uncertainty in predicting effects on the quality of the environment. What additional studies or analysis would eliminate or reduce these unknowns?

Groundwater impacts

The proposal will increase groundwater levels near the lake. The extent of the area affected is unknown. In order to better understand this issue it would be necessary to have near lake soil surveys and groundwater monitoring. A ground water model coupled with near shore monitoring may give a better idea concerning the extent of the effect on increased groundwater levels. This information would help to establish whether or not there are private septic fields that may be impacted and to further quantify the extent of impact to the adjacent forested wetland.

Inundation

The actual increased inundation at higher pools is not known. RKLD has provided near shore surveys that give some insight to the area that may be affected. While the survey does show the extent of the 777.0 msl contour at many points around the lake it does not indicate the extent of the land that will be affected by raising the pool to 777.0 msl. For, example the survey does not reach into the Mud Lake area but rather stops along the North Shore. From reviewing the survey it would appear that the Mud Lake area would be unaffected which we know is not true. The survey also did not include the river upstream of the lake or the river below the lake to the Indianford Dam. A survey conducted while the pool is at 777.0 msl would be a better indication of the effect of raising the pool. Aerial photographs taken at 777.0 msl and 776.2 msl would also better describe the inundation area.

OWHM: From the information assembled within this document it would appear that the OHWM may have been artificially raised by operation of the dam. Whether or not this is the case can only be established by long term proper operation of the dam and monitoring the location of the OHWM.

Winter Draw Down Effects

There are several competing theories concerning the effect of the current winter draw down. Much of the discussion centers around the impact on submergent plant beds and adjacent riparian wetlands. One theory suggests that freezing and desiccation are negatively affecting plants. The second theory suggests that plants are being benefited by the draw down by moving ice action away form wetland boundaries. To address these questions RKLD and DNR began a survey program two years ago to assess the change in plant communities at several transects. Unfortunately due to an in-operable dam we have not been able to institute the draw down required by the 1992 order until two years ago. Not enough data exist from the transect survey to assess the affects from the winter draw down. In order to properly assess the effects from the winter draw down on plant communities at least 5 to 10 years of data would be desirable.

Rare, Threatened and Endangered Species

As discussed above there are three ongoing studies funded by Department grants that will shed more light on the impact of higher water levels on wetlands rare, threatened and endangered species. None of these studies are progressed enough to be useful for this analyses, however the forestry study is likely to be completed before any final action on the Districts petition. The results of the remaining two studies, although relevant, will likely not be available on a time frame consistent with the timeline for the Department's action.

Archaeological

State law (s.44.40 Wis. Stats.) requires state agencies, including the Wisconsin Department of Natural Resources, to determine if their actions may impact historic properties that are listed in their inventories, and to consult the Wisconsin Historical Society if impact is likely to occur. The Environmental Assessment

is such an action. Therefore, any change in raising the water level cannot be accomplished until the Historical Society has had a chance to review a proposal and make a determination as to the disposition of affected sites. The State Historical Society has not been contacted at this point due to workload considerations. If the water level is not raised, there is no need to have the Historical Society take a look at possible impacts.

Explain the environmental significance of reasonably anticipated operating problems such as malfunctions, spills, fires or other hazards (particularly those relating to health or safety). Consider reasonable detection and emergency response, and discuss the potential for these hazards.

It is apparent that the trash racks and wicket gates have not been properly maintained or operated for at least the last 10 years and probably much longer. Failure to operate and maintain the powerhouse as part of the spillway works is likely to result in higher water levels on a more routine basis. It would appear that failure to operate and maintain the powerhouse has had an effect on the OHWM. In addition it is likely that failure to operate the powerhouse could accelerate wetland loss due to higher water levels.

Significance of Precedent

Would a decision on this proposal influence future decisions or foreclose options that may additionally affect the quality of the environment? Describe any conflicts the proposal has with plans or policy of local, state or federal agencies. Explain the significance of each.

Most of the original (condition at statehood) aesthetic character and biologic character of the lake has changed as a result of loss of wetlands and submerged plant beds. These changes have resulted from the maintenance of higher water levels and the introduction of carp into the system. This proposal will further change the character of the lake and move one more step away from any possible hopes of restoring the past biology, water quality or natural scenic beauty of the lake.

Significance of Controversy Over Environmental Effects

Discuss the effects on the quality of the environment, including socio-economic effects, that are (or are likely to be) highly controversial, and summarize the controversy.

Lake Koshkonong is listed on the federal 303d list as an impaired waterbody. The listed impairments are eutrophication, sedimentation, and habitat. This proposal is likely to cause more sedimentation into the lake from accelerated erosion and habitat loss from the destruction of riparian wetlands. Water quality will not be improved as a result of this proposal and will likely be negatively affected. Accordingly, this proposal will make removal from the 303d list more difficult.

As stated earlier, forested wetlands and riparian wetlands will be lost as a result of this project. Wisconsin has lost almost half of the wetlands present at time of statehood. Recognizing this historic loss and the importance of wetlands for fish and wildlife habitat, it has been the policy of the State to preserve wetlands whenever possible (see NR 1.95 and NR 103 Wisconsin Administrative Code). This proposal would be inconsistent with existing department policy on wetlands.

Boating access may be slightly improved and it is possible that Lake Koshkonong could see some additional boating as a result. Lake Koshkonong is also notorious for submerged obstructions. A slightly higher water level may reduce these obstructions but it is also just as likely that we will experience navigation closer to the shore with increased depth resulting in boaters finding new obstructions.

ALTERNATIVES

Briefly describe the impacts of no action and of alternatives that would decrease or eliminate adverse environmental effects. (Refer to any appropriate alternatives from the applicant or anyone else.)

No Change
Lake Koshkonong's environmental condition is not expected to make marked measurable improvements without aggressive: 1) water level management to emulate drought; 2) reductions in nutrient inputs; 3) increased stock suppression of common carp; and 4) commensurate enhancement of the sport fishery through stocking and fishing regulations. Lake Koshkonong is extremely productive, in fact too productive. The combined effects of stable high water levels, excessive nutrients, and impacts of common carp have severely decreased the ecological value of Lake Koshkonong. The stable regulation of Lake Koshkonong water levels is at odds with the natural fluctuation of lake levels, which are critical to the ecological health of Lake Koshkonong's wetlands, and closely tied to its waterfowl and sport fishery. Lake Koshkonong's marshes require periodic fluctuation of inflow to survive. Prior to regulated water levels, the lake level typically dropped during summer months, allowing sediments along the water's edge to dry out and firm up, in some years much more so than others. This drying effect encouraged emergent aquatic plants such as bulrush, arrowhead, and cattail to grow. With the more stable water levels created by the Indianford dam, this low-water effect and drying of sediments no longer occurs. Plant beds that depend on this drying process have decreased in extent or disappeared entirely. Stands of perennial emergent aquatic plants are important to fish and wildlife populations because they provide food, shelter, spawning habitat, and dissolved oxygen. Without these fluctuations, marshes are threatened, essentially the marshes are receding and will continue to decline in the absence of these fluctuations, albeit, much of this recession has already occurred. This habitat loss has adversely affected fish and wildlife and has reduced overall desirable productivity of Lake Koshkonong.

Without change in water levels the Lake Koshkonong fishery will remain cyclic. Without significant improvements in habitat, the walleye population and other sport fish will cycle up and down, as will common carp. Walleye are fairly tolerant of turbid water conditions, and will continue to provide a fishery, as long as there is significant investment in walleye stocking and carp removal.

Elimination of winter drawdown alone
Elimination of the winter drawdown alone is not expected to improve the sport fish populations. Elimination of the winter drawdown would improve winter ice angling, however, at the cost of the summer fishery. This action would also provide improved water level conditions for spawning fish species that are dependent on access to inundated wetlands in the very early spring, particularly northern pike. Even though pike will face more suitable spawning habitats the population may not respond as expected due to the fact that Lake Koshkonong is extremely stable in its turbid condition. The biomass of pike that Lake Koshkonong can support is positively related to aerial coverage of submergent aquatic vegetation (SAV), and elimination of the winter drawdown is not anticipated to improve SAV.

Without a winter drawdown the carp barriers at the Thiebeau and Mud Lake marshes will be less effective, as carp presently move out of the marshes during the fall drawdown.

Shoreline with armored revetments, predominantly riprap will likely be subject to increased damage due to ice/bank interactions like ice-jacking, particularly in snowless, cold winters.

Maintain the current levels and implement successive summer drawdowns
"A Matter of Will--All of these principles come back to the key question of how to balance diverse values and incorporate them into the principles. In looking for balance, we need to be mindful of the fact that both ecosystems and economies are subject to constant change. Related to this, we must resist simply taking a "midpoint" and calling that balance; if, on the ecosystems side, we always take such a compromise position, we end up with incremental, negative cumulative impacts."
(Anonymous)

Summer drawdowns combined with reductions in nutrient inputs; increased stock suppression of common carp; and enhancement of the sport fishery through stocking and fishing regulations hold the most promise toward restoration of aquatic plants with clear water, particularly in Lake Koshkonong's large bays. To shift ecological condition of large turbid shallow lakes requires a combination of several aggressive management tools including temporary reductions in water levels. Even with aggressive management the clear water/aquatic plant dominant condition may very well be quite unstable, and will likely require infrequent drawdowns to maintain plants in the Lake's bays.

Water level management can be used as a tool to improve environmental conditions for Lake Koshkonong. Here a modeling approach has much utility for forecasting Indianford Dam's capacity to emulate a drought event through successive summer drawdowns. Model simulations of all gates open can be used to determine the acreage of Lake Koshkonong's bed that can exposed during the growing season period under various rainfall patterns using historic data. Analysis would answer question; given the influence of the watershed/river, and the influence of the dam, how much riparian vegetation can be restored during dry seasons, or conversely wet seasons?