

## MEMORANDUM

### Peer Review of the Dane County Lake Level Management Guide for the Yahara Chain of Lakes

Submitted to the Dane County Board of Supervisors

7/2/12

#### Background

In 2010 the staff of the Dane County Land and Water Resources Department (the "Department") prepared the *Dane County Lake Level Management Guide for the Yahara Chain of Lakes* (the "Guide"). The Guide was approved on October 13, 2010 by the Dane County Lakes and Watershed Commission.

The Guide is an attempt to formalize Dane County's process for meeting DNR lake level orders on four lakes in a riverine system. It was initiated as a response to concerns raised after 2007-2008 flooding events in Dane County. The Guide reflects the Land and Water Resources Department's on-the-ground experience with managing the lake levels since 2003.

Because of the uniqueness and complexity of the Yahara Chain of Lakes system (Lakes Mendota, Monona, Waubesa, Kegonsa and Stoughton Pond), the Executive Committee of the County Board of Supervisors requested that an independent peer review be conducted to assess the management goals and operational strategies identified in the Guide.

In April 2012 the Office of the County Board convened individual experts, all of whom work outside of Dane County government on issues related to the Yahara Lakes system, to form a peer review group to evaluate the Guide and to make recommendations based on their evaluation. Several of the participants in the peer review group are internationally respected experts and all are intimately familiar with the Yahara Lakes system and its complexities. The participants in the peer review group are listed in Appendix A on page 9 of this memorandum.

In this memorandum the peer review group offers findings and recommendations based on the current state of knowledge of flows and water levels in the Yahara Chain of Lakes. Over the past several years, collaborative efforts by Dane County, the Wisconsin Department of Natural Resources, the City of Madison, the University of Wisconsin, and the U.S. Geological Survey have yielded important new data and insights about the relationships between lake levels and flows into and out of the lakes. Furthermore, a computer model of lake levels and flows has been developed through a collaborative effort between the University of Wisconsin, the City of Madison, and Dane County. When fully developed, this model can be used to predict lake levels and flows based on precipitation data. With further development, the computer model also can be used to quantify the economic and environmental benefits and costs of alternative lake management practices. This new modeling capacity will enable evaluation of new strategies for managing the lakes.

## **Peer Review Process**

The members of the peer review group individually reviewed the Guide and then held four separate meetings to jointly evaluate and discuss the management goals and operational strategies identified in the Guide. Land and Water Resources Department staff were available to answer reviewers' questions about the Guide. The County Board Office's Audit Analyst coordinated the process and facilitated the meetings.

Once the group completed its analysis of the Guide it collectively prepared this memorandum, which presents the peer review group's recommendations regarding specific management goals and operational strategies identified in Chapter 4 of the Guide. The memorandum also contains more general recommendations regarding the structure and other content in the Guide.

The following are general questions that were posed to the peer review group and their general responses. The questions were devised to cover the scope of review that was determined by the County Board members who requested this review.

1. *Are the strategies in the Guide effective in maintaining lake levels in compliance with the DNR orders for each lake?* It is important to recognize that it is impossible to meet the DNR lake level orders on all lakes at all times for the range of floods and low flows that may occur in the Yahara Lakes system. The Guide provides a good description of the operating methodology that has been used for the past several years to "share the pain" with respect to managing high water levels on the lakes, as well as to manage normal and drought conditions. We make a number of relatively modest recommendations for adjustment to the management system in the discussion below.
2. *Are the management goals and strategies identified by the Guide achievable?* The management approach described in the Guide can meet the goals most of the time.
3. *Are these the best operational strategies?* They are appropriate strategies given the physical limitations of the system. We make some recommendations that could improve the effectiveness of the strategies.
4. *Are the appropriate tools and resources available?* Not at present, but important tools are currently under development and additional equipment, such as aquatic plant harvesters, could be important to have available. We make recommendations for additional research and operational analysis that will improve the effectiveness of lake level management.
5. *Are there other tools and resources required to meet the DNR orders?* The approach of the Guide and of our review is to be as effective as possible given the physical limitations of the existing system. We provide comments about some additional projects that could be undertaken.

## I. General Recommendations

The peer review group recommends that the Department consider making the following general additions to the Guide:

1. Add a statement in *Section 1—Introduction* regarding the need to revisit this Guide intermittently to assess whether the strategies are still effective based on what is indicated by future modeling and monitoring as they occur.
2. Include text within the Guide or in an appendix explaining the rationales behind the various operational strategies identified in the Guide so that it is not only useful for staff implementation, but also for public information.
3. Add language indicating that there must be a watershed-based approach to lake level management.

## II. Specific Recommendations on Section Topics

### a. Section 4.1 – Normal Lake Levels

Given the currently available information, we recommend continuation of the present policy for managing the lakes under normal conditions. However, as discussed in Section III of this memo, new data and analytical tools will make it possible to objectively evaluate the potential benefits of a modified policy, such as maintaining the normal summer level of Lake Mendota below the middle of the mandated summer range to reduce flood risk. Note that Yahara Lakes Advisory Group 2 (YLAG2) considered versions of such a modification and recommended continuation of the present policy pending the outcome of future analysis.

### b. Section 4.2 – High Lake Levels

The review group discussed possible operational strategies during flood stage and a variety of different approaches and combinations of approaches. However, we determined that more data and modeling will be necessary to inform effective decision-making regarding different or additional management and operational strategies in this section. In the interim, we make the following two specific recommendations:

**Tenney Park Lock and Dam:** A major concern during high flows and high lake levels is the overtopping of the Tenney Park Lock and Dam.

1. The Guide should state that the management goal for the Tenney gate system should be that Lake Mendota does not exceed an elevation of 852 feet.

**Stoughton Dam:** Downstream of the Dane County-owned dams is the Stoughton Dam, which is owned and operated by the City of Stoughton. The Stoughton Dam is in the process of becoming a hydropower dam regulated by the Federal Energy Regulatory Commission (FERC).

2. DNR and Dane County need to take advantage of the opportunities in the FERC licensing process, including being placed on the FERC list as a party of interest that may comment on this licensing process, in order to reserve the ability to modify the Stoughton Dam's levels and flows during flood events. More information should become available about Stoughton Dam's levels and flows during flood events through forthcoming modeling with the INFOS model described in this memo. It will be important for the County to reserve a "placeholder" in the license in the event that additional future information becomes available that indicates specific management of flows at the Stoughton Dam will be effective in overall management of the lake levels.

**c. Section 4.2.1 – Slow-no-Wake**

Restricting boat traffic to slow-no-wake speed 200 feet or closer to the shore results in a measurable reduction in boat wake waves affecting the shoreline. However, restricting boat traffic to slow-no-wake speed at distances farther than 200 feet offshore produces very little reduction in boat wake wave energy at the shoreline. We see little rationale for declaration of whole-lake slow-no-wake orders based on high water levels alone.

1. The Department should reassess the need for declaration of whole-lake slow-no-wake orders based on high water levels alone.
2. The Guide should retain the provision to declare whole-lake slow-no-wake orders for debris that could create a navigation hazard that may be associated with flood conditions or for other public safety conditions.

**d. Section 4.3 – Low Lake Levels**

1. In or after the current first paragraph in this section, add language regarding the 4.9 foot differential specified in the lake level orders being in effect during low level conditions, as well as normal conditions.
2. Add language in this section indicating that during winter season low lake level conditions, recreational boating is not a priority from a water level management perspective.
3. Add language in this section indicating that during droughts, lake levels may drop below their ordered minimum levels due to the requirement to pass flow from each dam to maintain flow in the river below. Each dam's water level order sets a minimum flow.

4. Add the following language to this section: “DNR water level orders require the Yahara Lakes’ dams to release the following low flows:

- a) Lake Mendota – April 1 through May 15 – one tainter gate open at 0.3 feet; Remainder of the year – at least 4 cfs
- b) Lake Waubesa – April 1 through May 15 – at least 50 cfs; Remainder of the year – at least 10 cfs
- c) Lake Kegonsa – Minimum flow amount is not stated but requires operation coordination of the Lake Mendota, Lake Waubesa, Lake Kegonsa and Stoughton Dams by Dane County Parks Commission. Practically that means between 10 to 15 cfs.
- d) Stoughton – Minimum of 15 cfs”

**e. Section 4.4 – Aquatic Plant Harvesting**

Aquatic plant harvesting has a significant impact on the outflow of the system, the lake levels, and the duration of time that the lakes are above summer maximum elevation. During large flood events that last two or three months, most of the bridges only cause the river elevation to be 0.1 to 0.2 feet higher. During the summer, aquatic plants in the river may cause the river to be 2.0 feet higher for any given high flow. Dense growths of aquatic plants can substantially reduce the hydraulic capacity of the river system and cause major flood problems. This is especially true in the river system between Squaw Bay and Lake Waubesa, and the river system between Lake Waubesa and Lake Kegonsa.

**General Recommendations for Section 4.4:**

- 1. The Department should continue to maintain annual reports on aquatic plant harvesting.
- 2. Include more information in this section about the methods the County uses for measuring aquatic plant growth (e.g., acoustic Doppler and other tools).
- 3. Include background information regarding the Dane County Aquatic Plant Management (APM) Committee’s 2006 review of the County’s aquatic plant harvesting priorities. Example: The County Board’s Aquatic Plant Management Committee was established to review the overall aquatic plant management program and research on herbicide treatments. You can find the APM Committee’s final report (2006) at this link:  
<http://danewaters.com/management/AquaticPlantCommittee.aspx>

One of the APM Committee’s background documents was the Lakes and Watershed Commission’s Ad-Hoc Work Group Report (2004) including its recommendations for improving the efficiency and effectiveness of the mechanical harvesting program. That report is found here: [http://www.danewaters.com/pdf/apm\\_workgroup\\_report.pdf](http://www.danewaters.com/pdf/apm_workgroup_report.pdf)

For Dane County’s current aquatic plant harvesting priority maps see:  
[http://www.countyofdane.com/lwrd/parks/aquatic\\_plant\\_harvesting.aspx](http://www.countyofdane.com/lwrd/parks/aquatic_plant_harvesting.aspx).

**Specific Recommendations for Section 4.4:** Targeted, aggressive aquatic plant harvesting during high lake levels could have a significant positive impact on water flow and maintaining lake levels. Aquatic plant harvesting in Squaw Bay and the channel to Lake Waubesa is important. Aquatic plant harvesting between Lake Waubesa and Lake Kegonsa is critical. Harvesting aquatic plants is the main tool we have to maintain high flows and lower lake levels.

1. Aquatic plant growth should be monitored for the entire length of the system and aquatic plant harvesting plans should be determined based on field observation, streamflow data, and ability to get harvesters into different reaches. The most critical stretch is immediately below Babcock Dam and through Lower Mud Lake.
2. The United States Geological Survey (USGS) makes streamflow measurements of the Yahara River and determines the impact of aquatic plants on the stage discharge relationship. These measurements not only determine the flow of water volume in cubic feet per second (cfs), but also the impact of aquatic plant growth on the flow of the river. The County should use these measurements, as well as the Exchange Street gage, to measure the success of the aquatic plant harvesting effort.
3. Consider more frequent discharge measurements at the Yahara River streamflow gage at Babcock Park as the signal or trigger for intensive aquatic plant cutting.

### **III. Additional Research Recommendations**

#### **A Vision for Future Management of the Yahara Lakes**

The manager of the Yahara Lakes must use the available control structures to allow the passage of water through the system so as to minimize flooding, maintain recreational lake levels, satisfy regulatory requirements, and meet ecosystem needs. These objectives commonly conflict. Managing the lakes to minimize flood risk on one lake will increase flooding on other lakes. Managing the lakes to minimize the aggregate flood risk on all of the lakes will increase the likelihood of extreme low levels on all of the lakes. Given the conflicting objectives and the sluggishness of the system, lake managers have done a commendable job.

However, the future brings much greater challenges. Increased development in the watershed will increase the quantity of stormwater, even with the current Dane County stormwater controls. Climate change is likely to increase the magnitude and frequency of extreme storm events. The management of the lakes and the watershed must be adapted to prevent increases in flood risk.

Dane County and its partners have begun the process of developing new tools that will enable more effective management of the lakes. In the last few years, the County and its partners have significantly improved the capacity to measure lake levels, streamflow, and precipitation. UW-Madison Professor Chin Wu has developed a web-accessible hydraulic model of the Yahara Lakes system (the Integrated Nowcast-Forecast Operation System, or "INFOS") that accurately models water levels and flows, capturing, for example, the impact of aquatic plants on system flows. Currently UW-Madison Professor Ken Potter is developing a hydrologic model for predicting watershed flows into the lakes based on precipitation measurements. Once developed, this model will be incorporated into INFOS.

This new measurement and modeling capacity will enable lake managers to evaluate the impact of current and proposed management practices on lake levels and flows under present and future climate and land use conditions. For example, when fully developed, INFOS can be used to evaluate the degree to which lowered summertime levels on Lake Mendota would affect both flood and drought levels on all of the lakes. INFOS also can be used to evaluate the benefits of structural modifications of the flow system, such as dredging.

For this new measurement and modeling capacity to be most effective, the benefits and costs associated with lake levels and flows must be estimated. Given that little economic analysis has been conducted on the Yahara Lakes, it will take several years to complete a comprehensive analysis. In the meantime, much can be learned from the application of INFOS.

### **Specific Research Recommendations**

Additional evaluation, studies, and research are needed to inform future decisions and operational strategies for lake level management. The County should investigate the “what if” scenarios of future lake level management. This possibly could be coordinated with recommendations for further studies in the YLAG2 report (e.g., recommendations for a dedicated observational network and modeling to assess the current lake level orders and how they balance public and private interests).

Please note that Appendix B of this memo lists examples of the lake level management related activities that have been initiated to date, including past analyses and research.

The peer review group suggests that the Department consider the following additional recommendations for lake level management for the Yahara Chain of Lakes:

1. Continue to study options for lowering flood stages and increasing the outflow in the Yahara River system.
2. Investigate the idea of pumping water out of Lake Waubesa and into Lake Kegonsa or the Bad Fish Creek.
3. Explore the cost and effectiveness of large concrete culverts that would carry water from Lake Waubesa to Lake Kegonsa.
4. Conduct studies to determine future flood elevations and flows. Only ten to fifteen percent of the Lake Mendota watershed is developed. Professor Ken Potter has shown that development increases storm runoff. He has studied the response of Lake Mendota to a six inch rainfall from 1930 to 1995. In 1930, Lake Mendota would rise six inches. In 1995, Lake Mendota would rise ten inches. Additional studies should be conducted to determine the flood elevation and flows that would occur 25 and 50 years from now.
5. To quantify the impact of aquatic plant harvesting, including changes in flood elevations and duration of flooding, a flood routing study and analysis should be conducted. Using the lake levels of Lakes Monona and Waubesa and the daily discharge records from Lake Waubesa for the 1993 and/or the 2008 flood events, an inflow flood hydrograph for those events could be determined. Once the inflow

hydrograph is determined, one could route the same flood hydrograph through the system using the rating curve with no aquatic plants in the river and then route the flood through the system with a one foot shift in the rating curve.

6. Gather better lake bed elevation information for the 0 to 3 foot deep shallow areas in order to determine, for example, how lowering water levels would affect lake access for private residents and the public.
7. Gather detailed riverbed elevation information from Babcock Dam through Highway AB to effectively inform hydraulic modeling and alternatives analyses.
8. Other recommendations for further study are being compiled by the YLAG2 group and may be complementary to the recommendations made in this report.

#### **IV. Additional Funding**

Additional funds should be budgeted for further evaluation, studies, and research.

1. Funding for aquatic plant harvesting, lake and river monitoring systems, and discharge measurements should continue.
2. If the recommendation to increase targeted aquatic plant harvesting is implemented, funding would need to be increased to support maintenance of the existing fleet of aquatic plant harvesters since more intensive use will require increased maintenance.
3. Per the recommendation in *Section 4.4 – Aquatic Plant Harvesting* for additional streamflow discharge measurements, this protocol could require up to six additional discharge measurements per year with an estimated annual total cost of approximately \$2,000. USGS would be able to provide a 30% cost share to help sustain this effort.

## APPENDIX A

### PARTICIPANTS

#### Peer Review of Dane County Lake Level Management Guide for the Yahara Chain of Lakes

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## APPENDIX B

### CURRENT LAKE LEVEL MANAGEMENT RELATED ACTIVITIES

(Note: This list provides a sample of recent activities and is not intended to be all-inclusive.)

<u>ACTIVITY</u>	<u>WHEN CONDUCTED</u>	<u>CONDUCTED BY</u>
INFOS Model Development	2009 – ongoing	City of Madison/ UW/Dane County
Lake Waubesa and Lake Kegonsa Dams Repaired, including gate automation	2012	Dane County
Convened Yahara Lakes Advisory Group 2 (YLAG2)	2011	DNR/Dane County
Hydraulic analysis of Highway 113/RR/ Westport Rd	2010	City of Madison
Hydraulic analysis of Upper Mud Lake RR Trestle	2010	Dane County
Hydraulic analysis of RR bridge in Stoughton	2010	DNR
Meeting with DOT on RR bridges	2010	DNR/Dane County/City of Madison
Survey of high water levels from Monona to Kegonsa	2010	DNR/City of Madison
Belle Isle, Monona Storm Sewer Lift Stations	2010	FEMA/City of Monona
Increase aquatic plant harvester fleet	2009	Dane County
Memo identifying known constrictions	2009	DNR/Dane County
Lake Planning Grant for INFOS	2009	DNR to City of Madison
Tenney Dam Stability Analysis	2009	Dane County
Temporary Draw Down Orders for Kegonsa and Stoughton	2009	DNR
Tenney Park Lock and Dam Repaired	2006	DNR/Dane County

<b><u>ACTIVITY</u></b>	<b><u>WHEN CONDUCTED</u></b>	<b><u>CONDUCTED BY</u></b>
Infiltration Standards	2006	Dane County
Aquatic Plant Management Committee	2006	Dane County
Dredge Upper Mud Lake RR Trestle	2005	Dane County
Additional Gages added:		
- East Main St., Madison	2003	USGS/Dane County
- Lake Waubesa	2003	USGS/Dane County
- Exchange St. Yahara River	2003	USGS/Dane County
- Lake Kegonsa	2003	USGS/Dane County
- Forton St., Stoughton	2003	USGS/Dane County
- Hwy 113	2001	USGS/DNR/Dane County/ Town of Westport
Convened Yahara Lakes Advisory Group (YLAG)	2001	DNR/Dane County