LAKE WINNEBAGO
REGULATION MEETING

USACE Detroit District
16 October 2019
AGENDA

- Regulation Team Introduction
- Basin Overview
- FRNSA Update
- Major Stakeholders
- Current Weather Conditions
- Operations Overview
- 2018-2019 Water Level Explanation
- 2019-2020 Water Level Strategy Development
- Open Discussion/Questions
FOX RIVER NAVIGATION SYSTEM AUTHORITY UPDATE

By Jeremy Cords, CEO
FOX-WOLF RIVER BASIN

**Fox-Wolf River Basin**

Drainage Area = 6,430 mi$^2$

**Lake Winnebago**
- Surface Area = 206 mi$^2$
- Length = 28 mi
- Width = 10 mi
- Maximum Depth = 21 ft

7 day travel time from upper reaches of basin to Lake Winnebago

Inflow = Oshkosh + Local Inflow to Lake
Outflow = Appleton USGS gage + evaporation
STAKEHOLDER GROUPS

- Environmental
  - Wisconsin DNR
  - USFWS
  - Property Owners

- Recreational
  - Hunting and Fishing
  - Boating
  - Property Owners

- Agricultural
  - Seasonal Crops
  - Private Industry
  - Property Owners

Locations:
- Lake Poygan
- Winneconne
- Lake Butte des Morts
- Upper Fox River
- Wolf River
- Oshkosh
- Lake Winnebago
STAKEHOLDER GROUPS (CONT.)

Municipal
- Neenah Water Treatment Plant
- Neenah-Menasha Wastewater Treatment Plant
- Appleton Water Supply
- Menasha Water Treatment Plant
- Menasha Utilities
- City of Oshkosh

Environmental
- Wisconsin DNR
- USFWS
- Property Owners

Recreational
- Hunting and Fishing
- Boating and Yacht Clubs
- Property Owners

Private
- Paper Mills
- Property Owners

Lake Winnebago
Lower Fox River

**Municipal/Public**
- Appleton Wastewater Treatment Plant
- WDOT
- Kaukauna Utilities
- Heart of the Valley Metropolitan Sewerage Commission
- Wrightstown Wastewater Treatment Plant
- City of De Pere

**Recreational**
- Hunting and Fishing
- Boating
- Fox River Navigation System Authority
- Kaukauna Utilities
  - Kayaking Interests
  - Property Owners

**Environmental**
- Wisconsin DNR & USFWS
  - Bass Spawning
  - Sturgeon Spawning
  - Walleye Spawning
- Industry
- Property Owners

**Private**
- Power Generation Utilities
- Industrial Users
- Property Owners

Federal Dam
Private Dam
A wide variety of stakeholders produces **compounding and competing needs**
- Upper Pools
- Lake Winnebago
- Lower Fox River
### CURRENT WEATHER AND BASIN CONDITIONS

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Current Lake Level</strong></td>
<td>3.11 feet</td>
</tr>
<tr>
<td><strong>Inflows at Oshkosh</strong></td>
<td>13,225 cfs, 3 day average</td>
</tr>
<tr>
<td><strong>Outflows at Appleton</strong></td>
<td>14,700 cfs</td>
</tr>
<tr>
<td><strong>5 Day Rainfall Forecast</strong></td>
<td>0.6 inches, mostly Monday</td>
</tr>
<tr>
<td><strong>Winds</strong></td>
<td>Strong NW winds</td>
</tr>
<tr>
<td><strong>Soil Moisture</strong></td>
<td>Very high, nearly 6 inches above normal</td>
</tr>
<tr>
<td><strong>Forecasted Water Level Trend</strong></td>
<td><strong>Steady decline after winds settle</strong></td>
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</table>
USACE uses several stream gages throughout the basin in regulation decisions.

Gages are operated by USACE and partner agencies USGS and NWS.

- Water Level
- Water Level and Precipitation (USACE)
- Water Level and Velocity
USACE uses several stream gages throughout the basin in regulation decisions.

Gages are operated by USACE and partner agencies USGS and NWS.

4 Lake gages provide an average lake level.
There are 8 federal dams on the lower Fox River, managed for flood risk, hydro power, municipal and industrial uses, and recreation.

Each pool has an authorized limit. The crest of the dam or zero on the vertical scale provides for 6ft of water depth in the navigation channel.
FLOODING IN EARLY OCTOBER

Roadways, parks, and the Football field flooded in Fond du Lac Overnight on Oct 1st and continued through the day on Oct 2nd
Strong northeast winds combined with high water levels on Lake Michigan can cause serious flooding concerns for the greater Green Bay area.

The impacts of additional flow and high water levels will factor into future regulation decisions.
CURRENT AND UPCOMING INFRASTRUCTURE REPAIR PROJECTS

New Piers and Gates at the Kaukauna Dam

Upcoming Projects – New walkways at De Pere, Appleton Upper, and Appleton Lower Dams. New gates at both Appleton Dams. And new gate seals at the Little Kaukauna Dam.
2018-2019 WATER LEVEL EXPLANATION
RECENT HEADLINES FROM GREEN BAY

WETTEST YEARS
RAIN AND MELTED SNOW...

40.11" 2019
39.21" 2018
38.36" 1985
38.15" 2019
38.03" 1985

NWS Green Bay 🔄
@NWSGreenBay

It is official!! 2019 is now the wettest year on record in Green Bay! As of 3pm, we are up to 39.23 of precipitation. This breaks the old record 39.21" set last year. ☀️ #wiwx #record

❤️ 16 3:17 PM - Oct 1, 2019

💬 22 people are talking about this
LAKE WINNEBAGO BASIN - A WET PATTERN

A continuation of the second half of 2018 has resulted in near record precipitation for 2019.

Record set in Green Bay on October 2nd with 3 months remaining.
### WISCONSIN STATE-WIDE PRECIPITATION RECORDS

#### Oct 2018–Sep 2019 12-Month

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<tbody>
<tr>
<td>Oct 2018–Sep</td>
<td>43.58&quot; (1,106.93mm)</td>
<td>31.32&quot; (795.53mm)</td>
<td>12.26&quot; (311.40mm)</td>
<td>124th Driest</td>
<td>Driest since: 2018</td>
<td>1948</td>
</tr>
<tr>
<td>Sep 2019</td>
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#### Oct 2017–Sep 2019 24-Month

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<tbody>
<tr>
<td>Oct 2017–Sep</td>
<td>80.86&quot; (2,053.84mm)</td>
<td>62.67&quot; (1,591.82mm)</td>
<td>18.19&quot; (462.02mm)</td>
<td>122nd Driest</td>
<td>Driest since: 2018</td>
<td>1931</td>
</tr>
<tr>
<td>Sep 2019</td>
<td></td>
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#### Oct 2016–Sep 2019 36-Month

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</thead>
<tbody>
<tr>
<td>Oct 2016–Sep</td>
<td>118.92&quot; (3,020.57mm)</td>
<td>93.98&quot; (2,387.09mm)</td>
<td>24.94&quot; (633.48mm)</td>
<td>122nd Driest</td>
<td>Driest since: 2018</td>
<td>1989</td>
</tr>
<tr>
<td>Sep 2019</td>
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Rain pushed Lake Winnebago above the operating band at the 2018 Regulation Meeting. Decision made to lower target to 1.4 ft based on persistent high flows and high snowpack.

Brief warm up with rain pushed the level upward in January.

Drawdown extent determined by basin conditions and could range from 1.20 ft to 1.70 ft.

Decision made to lower target to 1.4 ft based on persistent high flows and high snowpack.
The Lake reached 1.40 feet on March 12th, just as a heavy snow pack was beginning to melt. With heavy snow and a warming basin, gates were opened on March 11 before melt.
We track and use Snow Water Equivalent (SWE) in making regulation decisions.

2019 had a significantly above average SWE.
SPRING RISE

Warm weather caused a rapid melt of the snow which significantly exceeded discharge capacity. Rapid gate changes were made to accommodate the large inflows as much as possible.

Continued high discharges in an effort to bring the lake back to the operating band.

Rainfall on saturated ground helped push the lake to 3.49 ft twice near the beginning of May.

Ice Out on April 10th.
LARGE SCALE AREAL FLOODING

High Inflow - April 15, 2019

- Embarrass River
- Wolf River
- Upper Fox River

Low Inflow - Aug 8, 2017

- Embarrass River
- Wolf River
- Upper Fox River
Repeated summer storms as part of wet pattern pushed the lake level upward. Gate movements were made in an effort to promote gradual water level declines and flow changes.
# MONTHLY RAINFALL TOTALS

## USACE Rain Gage Averaged Rain 2019

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (&quot;&quot;&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>4.9&quot;</td>
</tr>
<tr>
<td>June</td>
<td>4.75&quot;</td>
</tr>
<tr>
<td>July</td>
<td>3.5&quot;</td>
</tr>
<tr>
<td>August</td>
<td>5.5&quot;</td>
</tr>
<tr>
<td>September</td>
<td>9.3&quot;</td>
</tr>
</tbody>
</table>

27.95" total for the 2019 season

14.26" during the same period 2018

13.39” during the same period 2017

10.75” normal totals for the same period

Source: National Weather Service, Green Bay
2018-2019 FULL YEAR IN REVIEW

2018-2019 Lake Winnebago Stage with # of Open Gates

- 2018-2019 Actual Stage
- Average (1993 - 2019)
- Average Gate Opening (2004-2019)

4 Gage Average

Stage (ft) above Oshkosh Datum vs. # of Gates Open
2019-2020 Year to Date

2019 - 2020 Lake Winnebago Stage with # of Open Gates

- 2019-2020 Actual Stage
- Average (1993 - 2019)

4 Gage Average

Drawdown extent determined by basin conditions and could range from 1.20 ft to 1.70 ft.
WEBSITE REDESIGN

http://www.lre.usace.army.mil/Missions/Great-Lakes-Information/Lake-Winnebago/
WEBSITE REDESIGN

http://www.lre.usace.army.mil/Missions/Great-Lakes-Information/Lake-Winnebago/

Lake Winnebago

Important Notices

The IGLD 1985 relationships in the Lake Winnebago system are currently being updated. Please contact the Chief of Construction & Survey at (920) 388-3720 for more information.

- NEW Lake Winnebago 2019 Strategy Meeting
- Lake Winnebago Regulation Strategy 2018-2019
- Click here for the Lake Winnebago Current Conditions Update (Includes Lower Fox River information regarding high flows)
- Click here for the 2018 Lake Winnebago Regulation Presentation
- Click here for the Revised Lake Winnebago Facts Book

Lake Winnebago Levels and Flows

<table>
<thead>
<tr>
<th>Levels and Flows</th>
<th>Today's Hourly Data</th>
<th>Yesterday's Hourly Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>This Month's Daily Data</td>
<td></td>
<td>Last Months Daily Data</td>
</tr>
</tbody>
</table>

Historical Data

- Water Level for the Last 3 Months: Download Table
PROPOSED 2019-2020 WATER LEVEL STRATEGY

Lake Winnebago Regulation Strategy 2019-2020

Drawdown extent determined by basin conditions and could range from 1.20 ft to 1.70 ft.

Since 2006, ice out has ranged from March 17th to April 22nd with an average date of April 5th. Under this strategy, USACE would continue the practice of maintaining the winter drawdown target until ice out, as conditions allow.
QUESTIONS?
EXTRA SLIDES
Since 2006, ice out has ranged from March 17th to April 22nd with an average date of April 5th. Under this strategy, USACE would continue the practice of maintaining the winter drawdown target until ice out, as conditions allow.

Drawdown extent determined by basin conditions and could range from 1.20 ft to 1.70 ft.
### Historic Lake Winnebago levels above 3.30 ft

<table>
<thead>
<tr>
<th>Date</th>
<th># of days</th>
<th>Peak Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linde Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun/Jul 1993</td>
<td>33</td>
<td>3.81</td>
</tr>
<tr>
<td>Jun/Jul 2004</td>
<td>22</td>
<td>3.71</td>
</tr>
<tr>
<td>April/May 2019</td>
<td>22</td>
<td>3.49</td>
</tr>
<tr>
<td>Aug/Sept 2018</td>
<td>20</td>
<td>3.55</td>
</tr>
<tr>
<td>May 2018</td>
<td>19</td>
<td>3.62</td>
</tr>
<tr>
<td>Jun 2008</td>
<td>16</td>
<td>3.78</td>
</tr>
<tr>
<td>Jul 2010</td>
<td>16</td>
<td>3.48</td>
</tr>
<tr>
<td>Apr/May 1993</td>
<td>14</td>
<td>3.4</td>
</tr>
<tr>
<td>May 2012</td>
<td>10</td>
<td>3.42</td>
</tr>
<tr>
<td>Prior to Linde Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr/May 1973</td>
<td>41</td>
<td>3.65</td>
</tr>
<tr>
<td>Apr/May/Jun 1960</td>
<td>40</td>
<td>4.32</td>
</tr>
<tr>
<td>Mar/Apr/May 1929</td>
<td>40</td>
<td>4.17</td>
</tr>
<tr>
<td>Apr/May 1922</td>
<td>34</td>
<td>4.75</td>
</tr>
<tr>
<td>Apr 1979</td>
<td>25</td>
<td>3.89</td>
</tr>
<tr>
<td>Jun/Jul 1969</td>
<td>25</td>
<td>3.83</td>
</tr>
<tr>
<td>Mar/Apr 1973</td>
<td>22</td>
<td>3.92</td>
</tr>
<tr>
<td>Sep/Oct 1938</td>
<td>17</td>
<td>3.67</td>
</tr>
<tr>
<td>Jun 1945</td>
<td>13</td>
<td>3.56</td>
</tr>
</tbody>
</table>
Ice Cover
January 4, 2019

Ice Out
April 10, 2019

Ice Cover Last Year: Dec 19, 2017
2 inches of SWE lost in 24 hours
The NWS in Green Bay reported that the annual precipitation record was set with 3 months to go in 2019. This follows a record setting 2018.

**YEARLY PRECIPITATION RECORD BROKEN AT GREEN BAY**

**NEW RECORD**
40.26 inches (as of 7 am – Oct 2)

**OLD RECORD**
39.21 inches (2018)

The blue line is average total rainfall and the green is this year. For the 2018-2019 season, **Green Bay received more than 150% of its normal rainfall.**
Last year’s wet pattern continued this year. The basin never received less than 90% of average in a given month and finished at 137% of average for the year.

Above average precipitation from December through March was stored in a large snowpack.
2016-2017 Stage with # of Open Gates

- 2016-2017 Actual Stage
- Average (1993-2016)
- Ice Out (2006-2016)
- Menasha Crest
- Average # of Gates Open (1993 - 2016)

Stage (ft) above Oshkosh Datum

# of Gates Open

1-Oct-16 to 1-Sep-17
• **District Mission: Flood Risk Management, Hydro Power and Navigation**

• The Locks and Dams were constructed in the 1850’s for **navigation** purposes.

• In 1872, USACE was authorized to operate the structures to maintain navigation.

• The **Marshall Order** was established in 1886 to “maintain the level of Lake Winnebago at or below” flood stage, and above the crest of the dam which retains that pool. The term "flood" is to be considered to refer to all stages of water above an ordinary high-water stage.

• The 3-foot 6-inch upper limit specified is 21-1/4 inches above the spillway crest of Menasha Dam. This was determined by the mean annual high-water stage for the 28 year period from 1859 to 1886. Today we operate to keep the level within the limits set by the **Marshall Order**.

• The **Linde Plan** is also used as guidance for habitat protection on management practices within the bounds of the Marshall Order.
HISTORY AND AUTHORITY

• Our mission is **Flood Risk Management.**
• We are mandated to regulate Lake Winnebago within the limits established by the Marshall Order.
• We operate within the Marshall Order limits according to the Linde Plan.

• In 1870 Congress passed legislation to allow for the purchase of the Fox-Wisconsin Waterway from The Green Bay and Mississippi Canal Company, who **retained the water rights to develop waterpower along the river.** The price was set by an arbitrator after deducting the value of waterpower, the value of the Waterway was set at $145,000. The transfer was completed October 28, 1872.
SNOWFALL IN THE BASIN - SWE

March 12th, 2019

Inches of water equivalent:
- > 30
- 20 to 30
- 16 to 20
- 14 to 16
- 12 to 14
- 10 to 12
- 8 to 10
- 6 to 8
- 4 to 6
- 2 to 4
- 1 to 2
- Trace to 1
- Not Estimated


Snow Water Equivalent (inches):

- 0
- 1
- 2
- 3
- 4
- 5
- 6


Snowfall map for March 12th, 2019, showing snowfall distribution across the basin.