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US Army Corps of Engineers
Detroit District

Great Lakes Update

Guide to the Monthly Bulletin of Great Lakes Water Levels

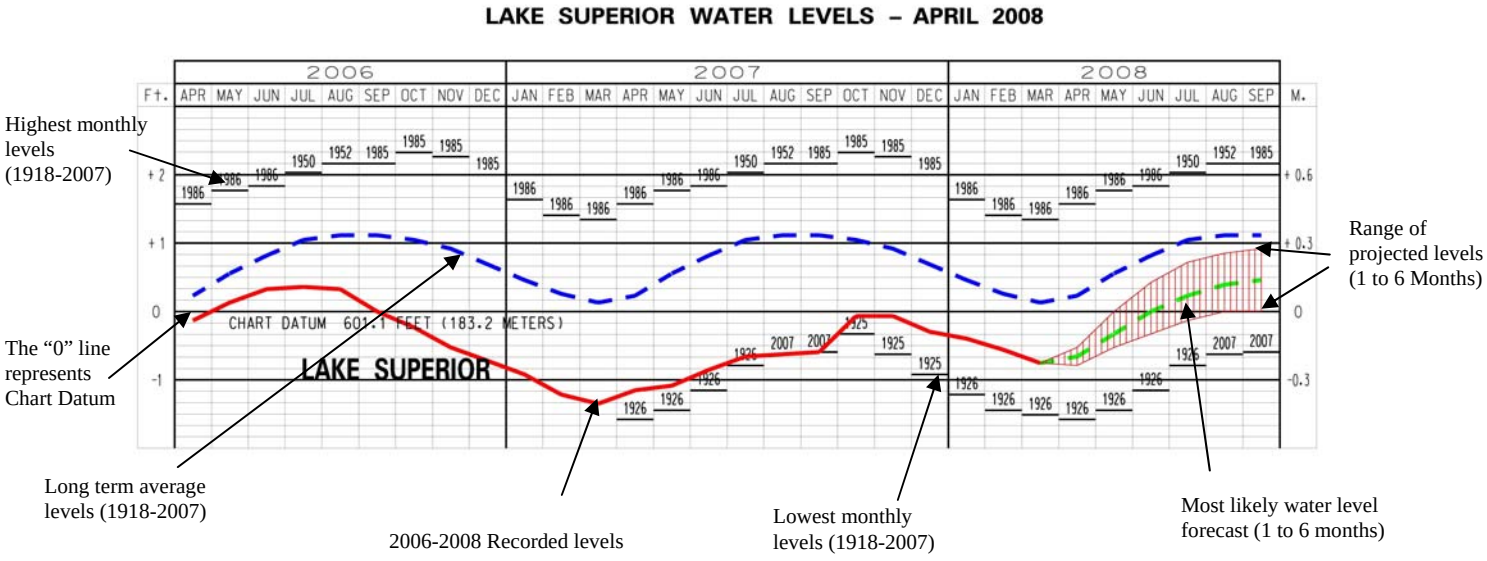
The Detroit District of the U.S. Army Corps of Engineers has been publishing the *Monthly Bulletin of Great Lakes Water Levels* since 1952. This *Great Lakes Update* will serve as a guide to reading the water level charts making up the *Bulletin.* It is hoped that this information will make the *Bulletin* easier to understand and more useful to the reader.

Overview

The latest version of the *Monthly Bulletin* gives a graphical look at water levels for all the Great Lakes and Lake St. Clair. For forecasting purposes, Lake Michigan and Lake Huron are considered one lake. The two are connected at the deep Straits of Mackinac and rise and fall together. All water levels are shown as monthly mean surface elevations.

Each lake's water level is portrayed by a hydrograph, or plot of water surface elevation over time. Depending on the time of year, between 12 and 24 months of recorded water level data are shown on the graphs. The graphic below is the April forecast for Lake Superior. It shows in detail the different information shown on each hydrograph.

All water levels shown on the *Bulletin* represent still water, a water surface that is undisturbed by wind or wave action.



The water levels in the *Monthly Bulletin* are shown relative to the Chart Datum for each lake. Chart Datum is a vertical plane to which navigation chart information such as water depths are referred. The water depths shown on NOAA's navigation charts are at a water surface elevation equal to the Chart Datum for that location. Chart Datum is also known as Low Water Datum.

There is a distinct Chart Datum for each lake, which is shown on each graph. These datum planes have fixed elevations relative to the International Great Lakes Datum of 1985 (IGLD 1985). The IGLD 1985 has its zero base at Rimouski, Quebec near the mouth of the St. Lawrence River (approximately sea level).

The grid upon which the water levels are plotted has a scale in feet to the left and in meters to the right. The major divisions are every 1 foot (.3 meter), while the smaller divisions are every 2 inches (5 centimeters).

The table of water levels in the lower right hand corner of the *Bulletin* presents the average water level for the previous month. These water levels are considered provisional and are subject to change. Changes are usually minor and reflect any final revision to the preliminary gage data. Historic information is also presented in the table. Data included are the previous year's level, the maximum and minimum levels for the month and the long term average (1918-2007) water level for the month. All data presented in this table are given in feet and meters and are referenced to IGLD 85. The values plotted on the hydrograph, show the corresponding lake level elevations in the table, minus the Chart Datum elevations.

A product similar to the Corps' is issued in Canada. To ensure consistency, the important information provided in the two products including the forecast is the same. The data are coordinated under the auspices of the Coordinating Committee on the Great Lakes Basic Hydraulic and Hydrologic Data. This committee was established in 1952 to determine and maintain agreed upon data for the Great Lakes. These data include water supply and lake outflows, to drainage areas and lake volumes.

Historic Data

All water levels shown on the *Monthly Bulletin of Lake Levels* are determined based on a network of water level gages. These gages are maintained by the National Ocean Service in the United States and the Canadian Hydrograph Service in Canada (Table 1). Their locations were selected based on their data record, geography and accessibility. They are spread around each lake in order to provide a lake-wide water surface elevation. The gages' geographic locations can be seen on the front of the mailed version of the *Bulletin*. Prior to 1994, water levels shown on the *Bulletin* were based on a "master gage" for each lake.

Lake Superior Gages Duluth, MN; Marquette and Point Iroquois, MI; Michipicoten and Thunder Bay, Ontario
Lake Michigan-Huron Gages Harbor Beach, Mackinaw City and Ludington, MI; Milwaukee, WI; Thessalon and Tobermory, Ontario
Lake St. Clair Gages St. Clair Shores, MI and Belle River, Ontario
Lake Erie Gages Toledo and Fairport, OH; Port Stanley and Port Colborne, Ontario
Lake Ontario Gages Rochester and Oswego, NY; Port Weller, Toronto, Cobourg and Kingston , Ontario

Table 1: Great Lakes Water Level Gage Network

When using a master gage, the water levels presented are for that location only, and may not be representative of the entire lake surface. Short term events like wind and storms have been known to drastically affect water levels on a daily or even hourly basis. These changes are without a large change in the volume of water.

Crustal Movement

Over long periods of time, a phenomenon known as crustal movement or rebound has had an effect on the vertical datum planes used to reference water levels.

Current crustal movement in the Great Lakes basin is the result of the natural rebound of the Earth's crust from the weight of the glaciers that covered the region thousands of years ago (Figure 1). The force pushing down on the Earth's crust was much less near the edges of the glacial shield. This produces highly variable rates of rebound across the Great Lakes basin. The highest rates of crustal rebound are found in the northern reaches of the Great Lakes basin.

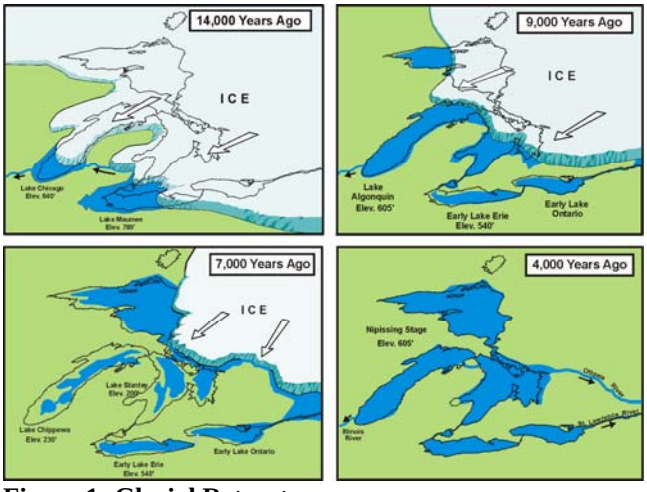


Figure 1: Glacial Retreat

The affect of crustal rebound on water levels is still being studied. Water levels are measured with reference to a vertical plane. In the Great Lakes' case this plane is IGLD 1985. As Earth's crust moves, so does the plane of reference. As time passes, the "tipping" of the crust causes the network of water level gages around the lakes to read skewed levels for the same still lake surface.

To correct for the natural phenomenon of crustal rebound, the vertical datum used to present Great Lakes water levels is periodically revised. The last revision took place in 1992 when IGLD 1955 was replaced by IGLD 1985. Elevations assigned relative to the new datum meant that at the time the revision took place, all gages on a lake essentially recorded the same water level for a still surface elevation. The *Monthly Bulletin* has been shown using IGLD 1985 since January of 1992 and using the water level gage network since January of 1994.

Forecasting Lake Levels

Water level forecasts are based on the amount of water the lakes will receive in the coming months. This value is known as the net basin supply (NBS). Each lake receives water in the form of precipitation, runoff and inflow from the upstream lake. Water is lost via evaporation and outflow to the downstream lake. Fluctuations in water level are directly related to the amount of precipitation the basin receives, as well as air and water temperature.

Trying to predict future water levels is comparable to predicting the weather. As with weather forecasts, there is a limit to how far into the future water level forecasts can be made. Also, just as there is large variability in weather forecasting, water levels can vary widely from what is predicted.

The *Monthly Bulletin* presents a six month water level forecast. The forecast is for a still lake surface and does not account for local rises that may be caused by storms or wave action.

The upper and lower boundaries represent the possible range of water levels that could occur if the lake were to receive water supply much above or much below the averages usually expected each month. These upper and lower boundaries are based on actual past water supply records, and represent very wet and very dry conditions.

The best estimate or most probable water level forecast is primarily based on the current hydrologic conditions in the drainage basin. Key issues associated with this include recent precipitation, amount of water in the snow pack, frost depths, status of the groundwater table and air/water temperatures. One and three month forecasts of temperature and precipitation are also used. These forecasts are provided by the National Weather Service.

Forecasting water levels is very much a science, but also very much an art. Of the tools used to create the forecast, the most important can be weather predictions. It is well known that extreme weather conditions are not well forecasted. Extended periods of drought or record breaking precipitation are some of the causes of extreme water levels. Most recently, a prior year of drought in the Lake Superior basin lead to new record low water levels in August and September 2007. Then from mid-September through October, well over 10 inches of rain fell in the Lake Superior basin and caused a large jump in water level. Forecasts made in early October showed the lake at or below record lows and did not yet account for the large increase in water supply.

How Can I Get the Forecasts

The *Monthly Bulletin* can be viewed in few different ways. The first of which is by postal mail. Over 4000 *Bulletins* are mailed out each month to locations across the United States. The mailed version is black and white and usually arrives to the subscriber by the middle of the month. A smaller graphic of each lake is shown on an 11 by 17 folded newsletter. Also included is a look at the past month and past 12-month precipitation, outflow in the connecting channels and water supply information. Great Lakes Update Articles like this one, supplement the *Bulletin* in January, April, July and October.

Another method of getting the *Bulletin* is by email subscription. The Detroit District of the Corps of Engineers posts a full color version of the *Bulletin* to its website once it is completed, usually in the first few days of the month. A user can download the 11 by 17 product or a full one page look at an individual lake. To sign up for the email service or see the online versions of the *Monthly Bulletin* please visit:

http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/waterlevelforecasts/monthlybulletinofgreatlakeswaterlevels/

Near the bottom of this site is a link to enter an email address. Once the user has entered an email address they will receive a monthly email reminding them that the *Monthly Bulletin* has been updated.

If you wish to remove yourself from the postal mail subscription list or to change your mailing address, please send an email with your name and address to hhpm@usace.army.mil.

The Detroit District welcomes comments on all of our forecast products. Please email questions and comments to hhpm@usace.army.mil. To contact the District by phone call toll free 1-888-694-8313 and select option 1. The Detroit District's mailing address is:

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