



Removing phosphorus and mercury from Devil's Lake

Germany is known for its beer, well-engineered cars, and the Wahnbach process. That's right, the Wahnbach process. The growing need for clean water in West Germany led to the development of a process to purify river water for human consumption. Built on the Wahnbach Reservoir near Bonn, this innovative water treatment process was the basis of the pilot plant designed by Mead & Hunt at Devil's Lake.

With its boulder-covered bluffs and clear water, Devil's Lake is a popular tourist attraction. In fact, it is the most heavily used state park in Wisconsin. Although it is one of southern Wisconsin's clearest lakes, water clarity problems have surfaced in recent years.

Following years of complaints about deteriorating water clarity, the Wisconsin Department of Natural Resources (DNR) conducted a detailed limnological study of the lake. The study concluded that the clarity problems caused by late summer and early fall algal blooms were due to high levels of phosphorus stored in the deep water lake sediments. The phosphorus migrates from the sediment into the water throughout August and September after the water loses oxygen. As the lake begins to destratify, phosphorus is transferred to the surface waters where algal blooms develop.



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History of the area

Devil's Lake is part of a "terminal moraine," which is a river of soil and rock left behind by the last glacier. This geological event created a natural dam resulting in a spring-fed lake surrounded by unusual rock formations.

Since the late 1800s, Devil's Lake has attracted many residents and tourists because of its unique characteristics. Almost two centuries of human activity, in and around the lake, contributed to the water clarity problems. Individual residential septic systems and a leak in a public collection system resulted in phosphorus loadings.

In 1910, Devil's Lake became a state park. Since that time, Wisconsin has been purchasing residential property on the lake to eliminate loadings from septic systems. In addition, the break in the public collection system was repaired, virtually eliminating the original sources of phosphorus. However, this didn't solve the problem because there wasn't a dilutional flushing outlet to remove the phosphorus already in the lake.

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Wisconsin DNR Bureau of Research

Research indicated the best way to control the algal blooms was to control the phosphorus. And although the phosphorus-loading sources were eliminated, the lake sediments and bottom waters still contained high levels of phosphorus. One solution was to remove the phosphorus-rich bottom waters. The problem was Devil's Lake is primarily spring-fed with water levels that fluctuate up to three feet annually. Intentionally removing water, without replacing it, would drastically lower lake

levels. With these considerations, the DNR began to investigate the Wahnbach system and other water treatment practices done in Germany.

Wahnbach system

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The basis behind the Wahnbach system is the treatment of incoming water with chemicals designed to eliminate phosphorus at the source. Since they were unable to eliminate phosphorus loadings upstream of the reservoir, they designed a system to remove phosphorus as it comes into the reservoir.



Richard Lathrop, DNR Bureau of Research, was the catalyst behind the pilot plant on Devil's Lake. After touring treatment plants near Bonn and Berlin, Lathrop and other DNR scientists looked at the possibility of removing the phosphorus in Devil's Lake with this process. Based on the original Wahnbach treatment design, general specifications were developed. After receiving one of only two 1994 grants from the Environmental Protection Agency (EPA) Clean Lakes Program, the pilot plant was designed.

Local implementation

The pilot plant consists of an intake, a series of tanks used to mix the influent with an iron salt and a tower filter. The iron salt forms ferric hydroxide precipitates, which binds the phosphorus. Once this is achieved, polyelectrolytes are used to gather the precipitates. The water is then discharged into a 14-foot-high filter tower where the particles are trapped and the clean water passes back into the lake.

The water sent into the filter has a layer of coagulated materials that had to remain together for the filter to be most effective. Realizing that pumping the water up into the filter would break up this formation, the engineers modified the design to elevate the field laboratory. This allowed for a gravity flow so the coagulated materials, or flocculent, stayed together as it entered the filter.

Once the filter becomes clogged, a float switch shuts off the influent pump, closes the effluent valve, and begins the backwash cycle. This cycle suspends the flocculent and backwashes it into the storage tank. The flocculent is then thickened through settling and hauled to a sewage treatment plant.

"We had a lot of little bugs in the system at the very beginning, and Mead & Hunt was right there helping us get them resolved," said Lathrop. "We had a defined window of time to work on the lake. It wasn't where you could wait a month and delay it and get it fixed. I was pleased that Mead & Hunt was there and responsive to our needs. We needed that help to get this thing operational."

Through a trial and error process, the pilot plant proved to be a success by eliminating phosphorus levels from the influent water by more than 90 percent. Mercury levels were reduced by 60 percent as an added benefit achieved through this process. Due to the success of this plant, the DNR is planning on using the remaining EPA grant funds to run a modified version of the plant this fall. The new plant will incorporate dissolved air floatation, which will eliminate the 14-foot-high filter tower and the need for the elevated field laboratory.

The future

As communities and lake associations begin to look seriously at water quality issues and ways to clean up lakes and streams, these studies will prove invaluable.

"Based on our information, there are several lakes in Wisconsin that have a similar situation," said Bill Buth, Mead & Hunt project manager. "This study presents another option for these lakes, which up until now have had very limited options."