



NONPOINT SOURCE SUCCESS STORY

Minnesota

Multiple Projects Improve Water Quality in Lake Rebecca

Waterbody Improved

The beautiful Lake Rebecca Park Reserve offers opportunities for outdoor fun and is a haven for wildlife, including trumpeter swans. Elevated phosphorus in Lake Rebecca led to frequent algae blooms during the summer months, which caused low dissolved oxygen levels, poor water clarity, and fish kills. It also affected the lake's recreational use. As a result, the Minnesota Pollution Control Agency (MPCA) added Lake Rebecca to the Clean Water Act (CWA) section 303(d) list in 2008. The Three Rivers Park District (TRPD) led efforts to apply alum to the lake and implement projects to control the invasive curly-leaf pondweed, treat stormwater from developed areas, and improve a nearby livestock operation's management of manure and stormwater. Phosphorus levels dropped, and MPCA removed Lake Rebecca from the impaired waters list in 2018.

Problem

Lake Rebecca is just west of Minneapolis in the Lake Rebecca Park Reserve, which is owned and managed by the TRPD (Figure 1). The lake offers many recreational resources such as fishing piers, boat access, swimming area and beach areas. Lake Rebecca is also surrounded by pedestrian hiking trails, paved and single track biking trails, horse trails, picnic areas, play areas, and an off-leash dog park. The lake is of high recreational importance to the TRPD. The lake is frequently monitored for chlorophyll-*a* (Chl-*a*), total phosphorus (TP) and Secchi disk transparency. The Lake Rebecca Park Reserve is also a haven for wildlife, including free-flying trumpeter swans, which can be seen in the park year-round. Several hundred swans gather there during late fall. The Lake Rebecca Park Reserve is part of the TRPD's Trumpeter Swan Restoration Program.

Lake Rebecca experienced frequent algae blooms during the summer months. This decreased oxygen in the water column and contributed to poor water clarity, caused fish kills, and impacted other recreation such as swimming. In 2008, average TP concentrations were 74 micrograms per liter ($\mu\text{g/L}$), Chl-*a* was 44 $\mu\text{g/L}$ and Secchi depth was 1.26 meters (m). Since 1994, the highest annual average concentrations of TP and Chl-*a* and lowest transparency were all observed in 2007, with TP concentrations recorded at 130 $\mu\text{g/L}$, Chl-*a* at 97.9 $\mu\text{g/L}$, and Secchi at 0.6 meters. These failed to meet the applicable state water quality standards for nutrient/eutrophication biological indicators requiring

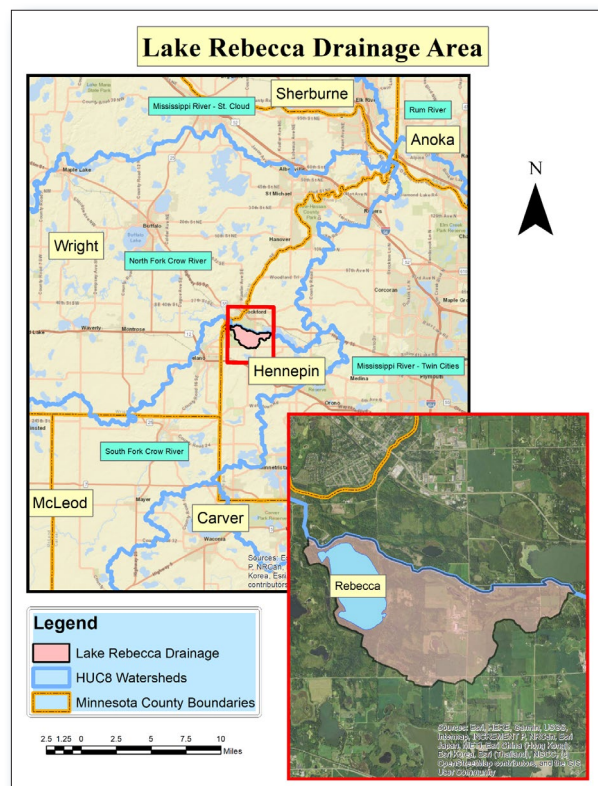


Figure 1. Lake Rebecca is in the South Fork Crow River watershed in eastern Minnesota.

that TP is less than 40 $\mu\text{g/L}$, Chl-*a* is less than 14 $\mu\text{g/L}$, and Secchi depth is greater than 1.4 m Secchi (for deep lakes in the North Central Hardwood Forest Ecoregion [NCHF] ecoregion). As a result, MPCA added Lake Rebecca to the impaired waters list in 2008.

Sources of excess phosphorous loading to the lake included landscape contributions and internal loading from lake sediments. A 93-acre horse farm outside of the park was identified as a significant source of external phosphorus loading. Lake sediment core data collected in 2010 was used to determine the mass of potentially releasable mobile phosphorus from the lake sediment—this was used for alum treatment dosing calculations. Compared to other lakes in the Twin Cities metropolitan area, the mobile phosphorous fraction in Lake Rebecca was considered high. The presence of invasive curly-leaf pondweed also presented challenges for management and water quality.

Story Highlights

In 2009, TRPD staff launched efforts to control the invasive curly-leaf pondweed. TRPD staff worked with Hennepin County Environmental Services to improve manure and stormwater management on the nearby horse farm. TRPD also addressed stormwater from the park's developed areas. The most critical project component was the application of aluminum sulfate (alum) to the lake to reduce internal cycling of phosphorus from bottom sediments. TRPD staff worked with contractors to apply alum to the lake in fall 2010 and spring 2011 (Figure 2). In each case, the alum was applied at a dose of approximately 740 gallons per acre over about 220 acres of the 258-acre lake (total dosage rate of about 1,480 gallons/acre). The Rebecca Lake restoration initiative was largely completed in 2011.

Results

Rebecca Lake has generally met standards since completion of the restoration effort (Table 1). Recent summer TP averages have been 25–40 µg/L since 2011 (Figure 3). The anticipated effects of the alum treatment should last 10–15 years. Lake Rebecca was removed from Minnesota's 303(d) impaired waters list in 2018. Lake Rebecca was the first lake in the TRPD to achieve delisting for nutrients.

Partners and Funding

Project partners included TRPD, Hennepin County Environmental Services, Pioneer Sarah Creek Watershed Management Commission, the Metropolitan Council, and the Minnesota Department of Natural Resources. TRPD was awarded a



Figure 2. Alum remains suspended in Lake Rebecca's waters shortly after application.

Table 1. Lake Rebecca data over time.

Description	TP	Chl-a	Secchi
	µg/L	µg/L	m
NCHF: Trophic state thresholds for impairment (pre-2010 cycle)	< 45	< 18	> 1.1
NCHF: Aquatic recreation use standard (Class 2B)	< 40	< 14	> 1.4
1994–2005 Lake Rebecca data (original listing dataset)	81	46.7	1.2
2012–2017 Lake Rebecca data (delisting dataset)	33	14.8	1.8

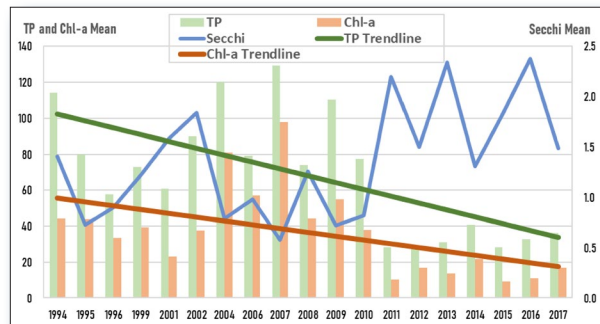


Figure 3. Lake Rebecca annual water quality results (1994–2017).

Lessard-Sams Outdoor Heritage Fund (LSOHF) grant of \$450,000 in 2009 to implement the water quality improvement projects for Lake Rebecca, including a shoreline restoration project, a multi-year curly leaf pondweed control project, and an alum treatment. The total cost of the LSOHF project was estimated at \$480,000 with the TRPD providing an in-kind service match valued at \$30,000. LSOHF funds are provided through the Clean Water, Land and Legacy Amendment to the to the Minnesota Constitution.



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For additional information contact:

Brian Vlach

Three Rivers Park District
763-694-7846

Eric Alms

Minnesota Pollution Control Agency
651-757-2589 • eric.alms@state.mn.us