Nitrogen Loading, Sulfate Reduction, and the Over-Fertilization of Normandale Lake, Bloomington, MN

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Lake Conditions Before Treatment (June 28, 2016)
South Lake Cornellia: P, Secchi, Choro-A.
2016 Citizen Survey Results: Nine Mile Creek Watershed

**Question 10:** Are there one or more water bodies in your community that you are concerned about? If so, which ones? (662 responses)

![Bar chart showing responses to Question 10](image)
Weir on lake’s upstream side:

Large pipe on downstream side
Draining Normandale Lake: 2018

August 30

Drained lake
Alum Treatments on refilled lake:
After Treatment (June 28, 2019)
July 24, 2019. Image of macrophyte regrowth in west end of Normandale Lake
2020: Macrophyte mats exposed during low flow periods in center portion of lake
Normandale Lake:
Total P, Chl-A, and Secchi Depth.
Inlet/Outlet Chemistry, before and after lake treatment

Filtered

Anions and Cations by Ion Chromatography
NO3 and NH4 at Normandale Lake’s inlet and outlet in 2017 (Pretreatment)
Notes:
(1) A large amount of ammonium left the lake in June, right after treatment.
(2) Ammonium was utilized in the lake before and after treatment.
Notes:
Lake appeared to become N limited again, shortly after lake treatments.
NMCWD Sampling Locations in relation to Normandale Lake

- North Branch
- South Branch
- Normandale Lake
- Main Stem
Summer Averages

NO₃-N (mg/L)
Golf course upstream of Normandale Lake on South Branch
Notes:
Sulfate concentration at the inlet is often higher than at the outlet.
Negative impacts of sulfate reduction

(1) H2S is poisonous and smells bad
(2) Creates MeHg as a toxic byproduct
(3) Promotes nutrient release from sediments (Myrbo et al, 2017).
Interpretation – Normandale Lake:

(1) Macrophytes accumulate in the lake all summer by capturing the N passing through the lake.

(2) Shallow “Flow-through” lakes can have very high external N-loading rates.

(3) Excess macrophyte growth leads to sulfate reduction.
Summary

- Total P, Secchi disk, Chlor-A standards identify floating algae blooms but missed Normandale Lake’s macrophyte problem.
- Alum treatment and lake drawdown had excellent initial results but N limitation returned by the end of the first summer.
- External N loading leads to nutrient feedback loop:
  - Macrophyte over-abundance
  - promotes summer O2 depletion
  - sulfate reduction => accelerated nutrient release from sediments