Controlling Harmful Algae Blooms with Hypolimnetic Oxygenation at Newman Lake, WA

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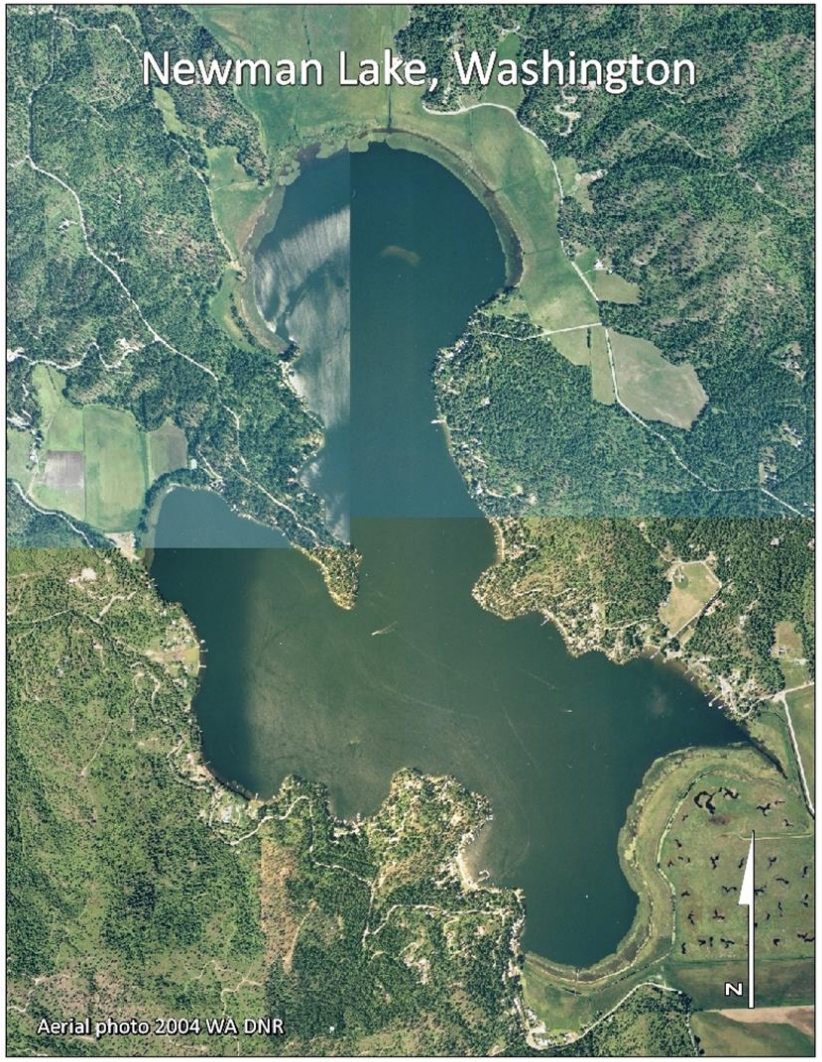


Newman Lake – Background

- 1,200 acres with avg depth of 5.1 m
- No natural surface water outlet
  - Direct aquifer infiltration
- 85% of residential development in watershed occurs within 1,000’ of shoreline
- No sanitary sewer system
- 303(d) list for Total Phosphorus
- Algae problems present since 70’s

Initial WQ Improvement Efforts

- 1985 – ECY grant for watershed study
- 1989 – Whole lake alum treatment
- 1992 – Speece Cone installed
- 1997 – Micro floc alum system installed

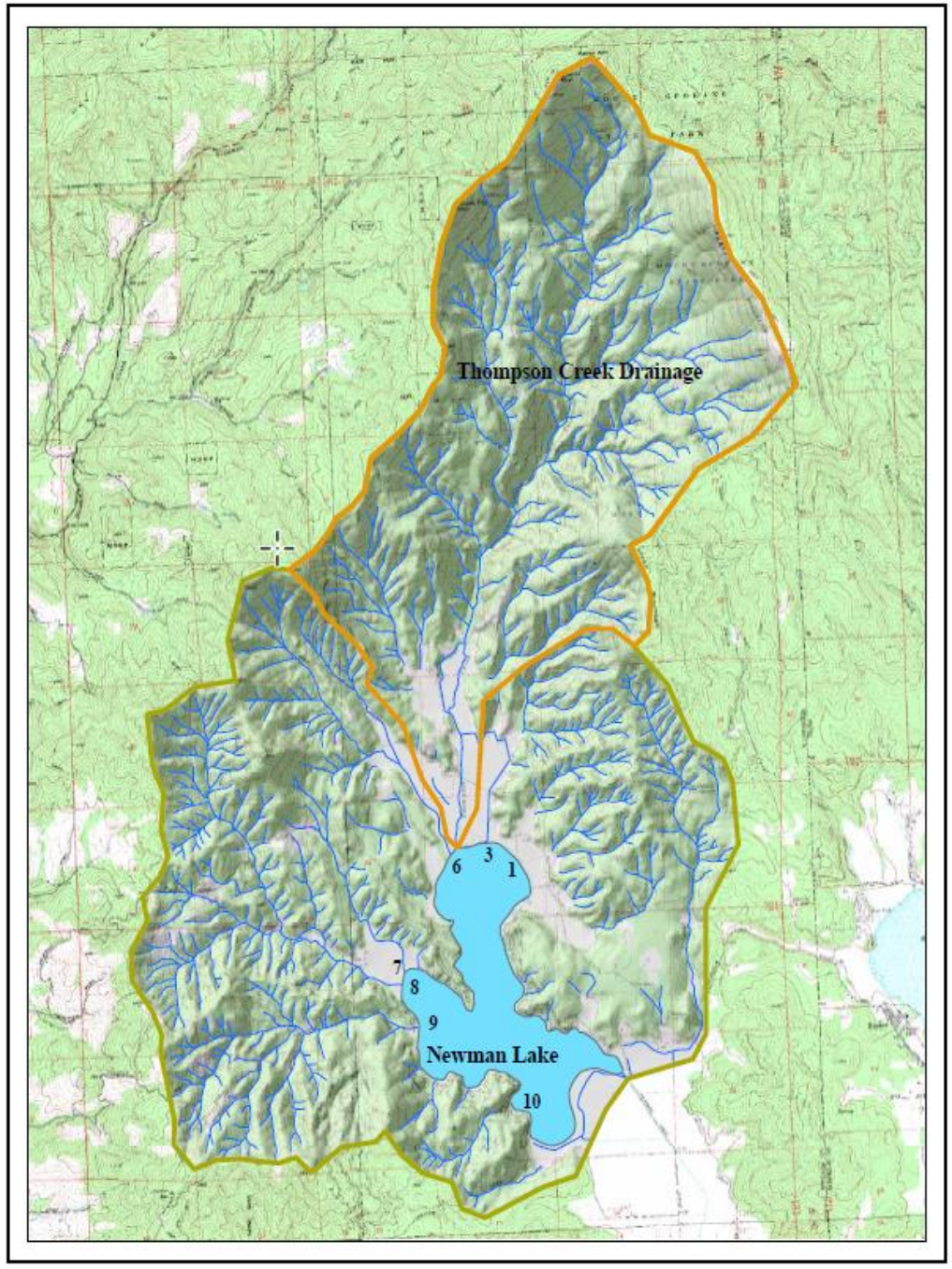
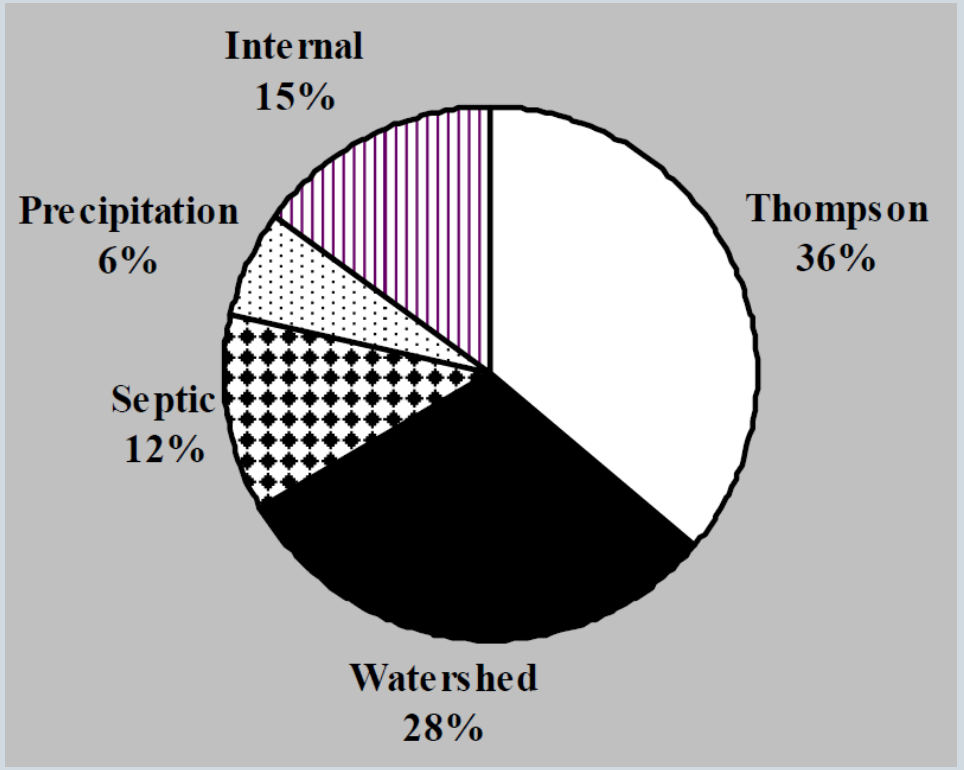


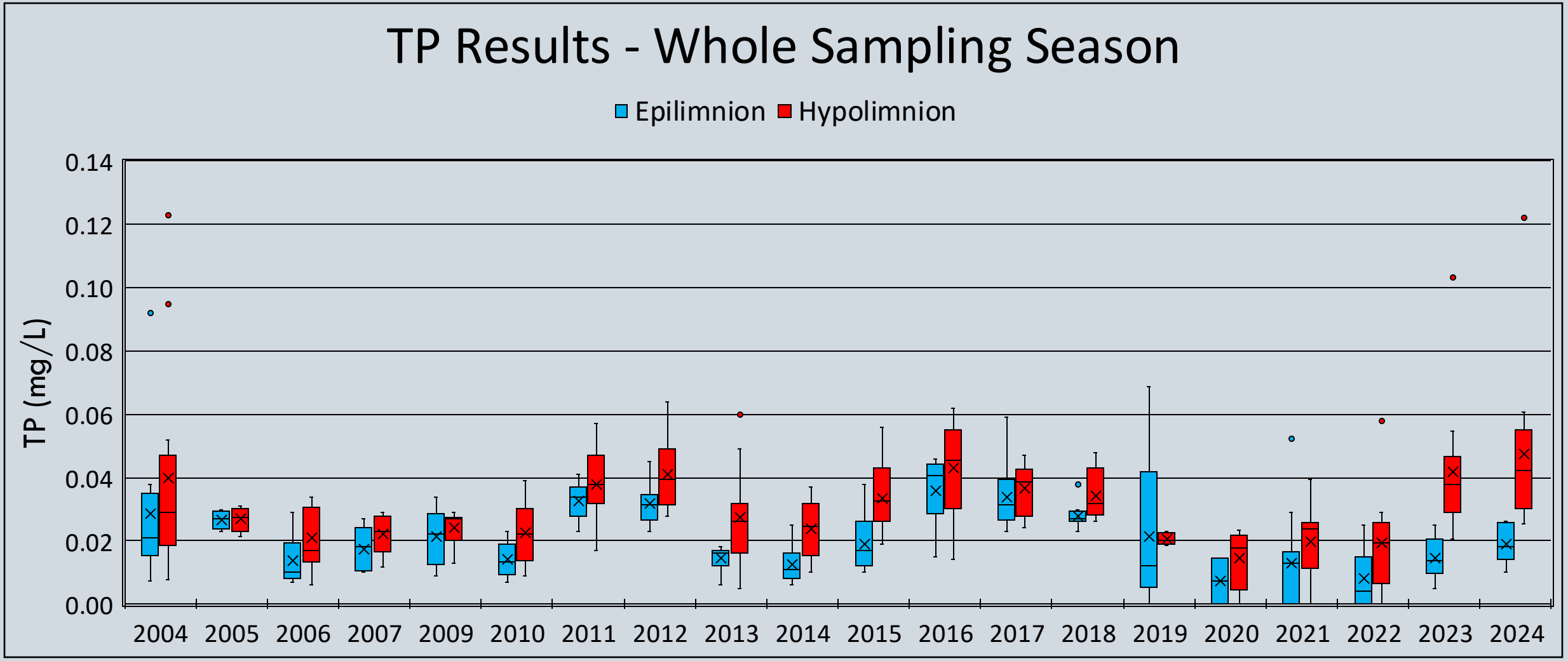
Figure 2. The Newman Lake watershed along with monitored inlet locations (numbered)

TMDL (2007)

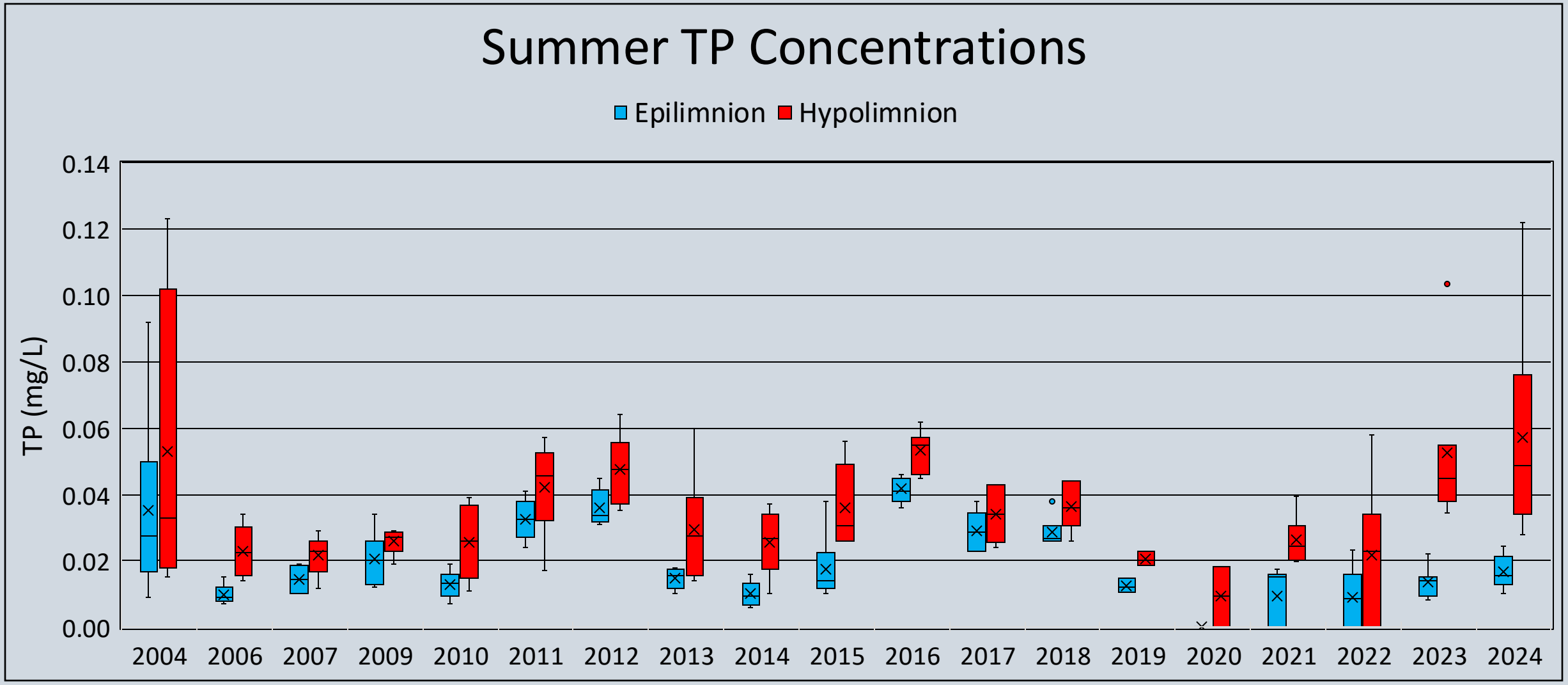
- Goal is to limit epilimnion TP to 20 µg/L during summer



External & Internal TP Load

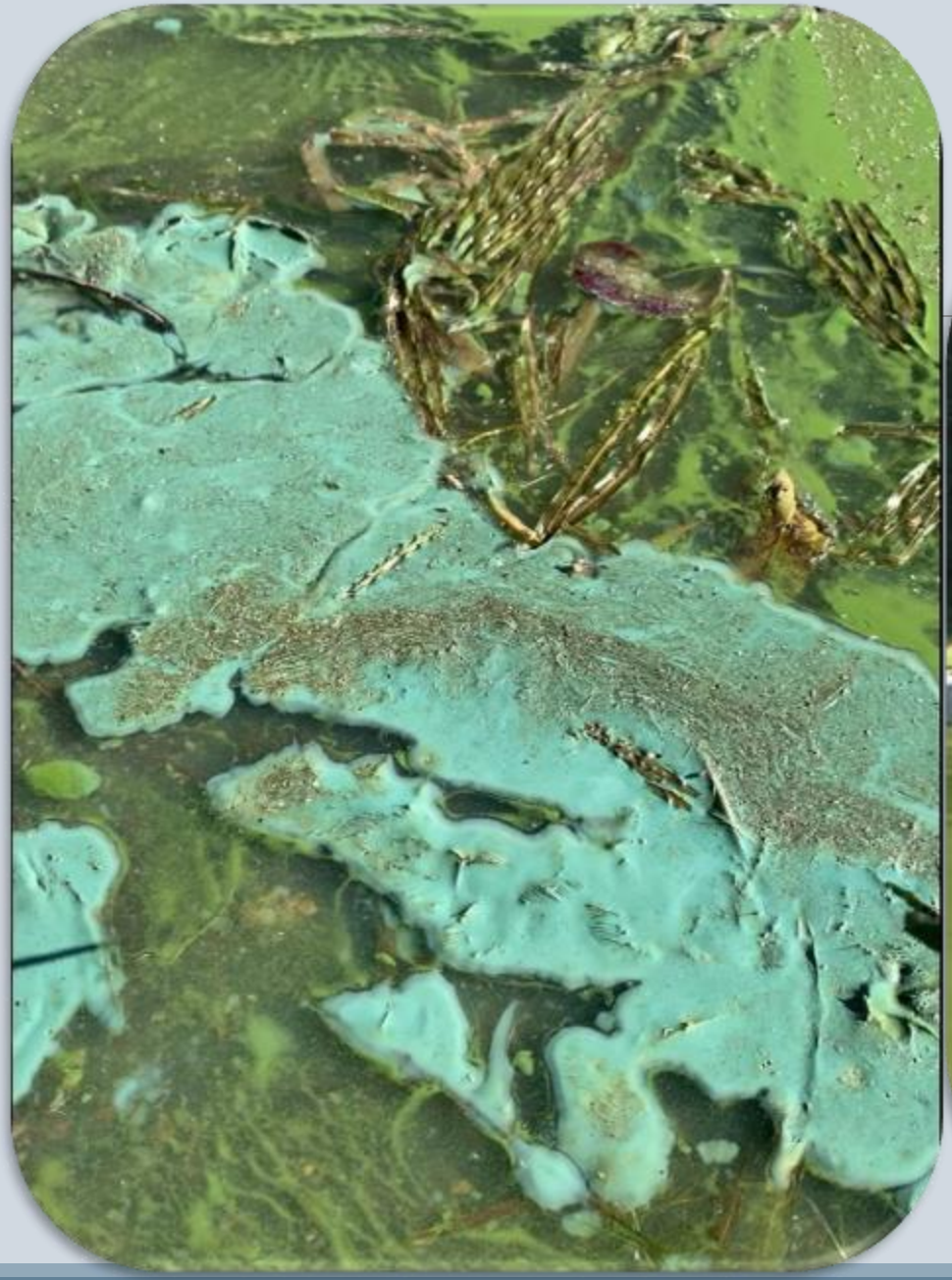


TP Distribution @ Mid Lake Station between April - October



TP Distribution @ Mid Lake between June - Aug

Algae Problems Persisting



What to do?

ARP to the Rescue

Jacobs Phase 1a report (2021) → Speece cone failing

- Design Performance: **902 – 1,172 kg O_2/day**
- Measured Performance: **600 kg O_2/day**
- Hypolimnetic Oxygen Demand (HOD) = **1,541 kg O_2/day** (Jacobs 2023)

ARP Grant Project Goal → Reduce algae bloom occurrences

Phase 1 (2023) – Lake Analysis

- Create Newman Lake specific solution
- Oxygenation?
- Alum injection?

Phase 2 (2024) – Design

Phase 3 (2024-2025) – Construction

Analysis and Design – Key points

Iron in sediments crucial for TP sequestration

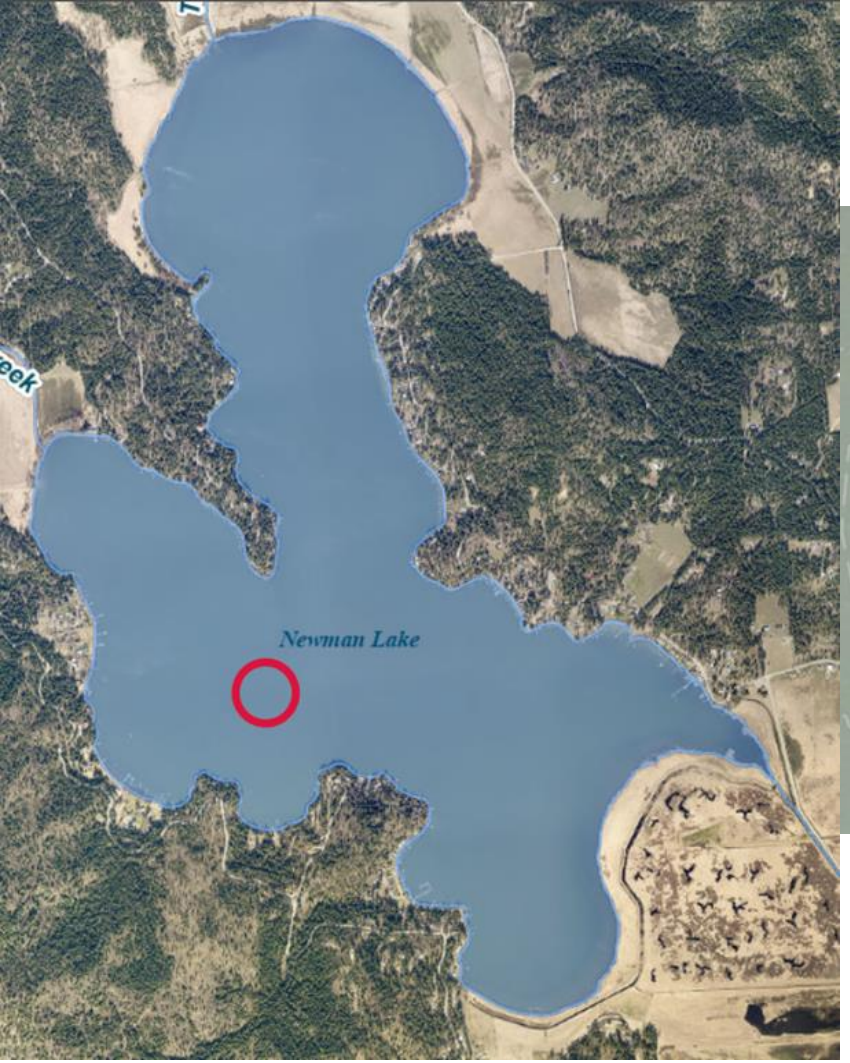
- Ferric iron (Fe^{3+}) → Insoluble, sequesters TP
- Ferrous iron (Fe^{2+}) → Soluble, cannot adsorb TP
- When DO is low, iron reducing bacteria thrive, creating more ferrous iron
  - Ferrous iron strips oxygen from water, thus feedback loop perpetuates problem

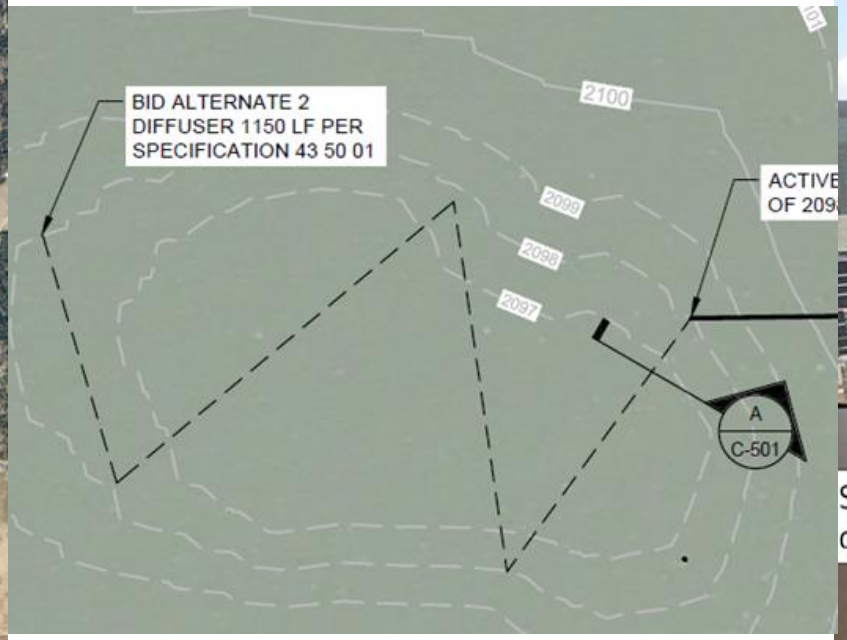
Lake has more than enough iron to sequester TP

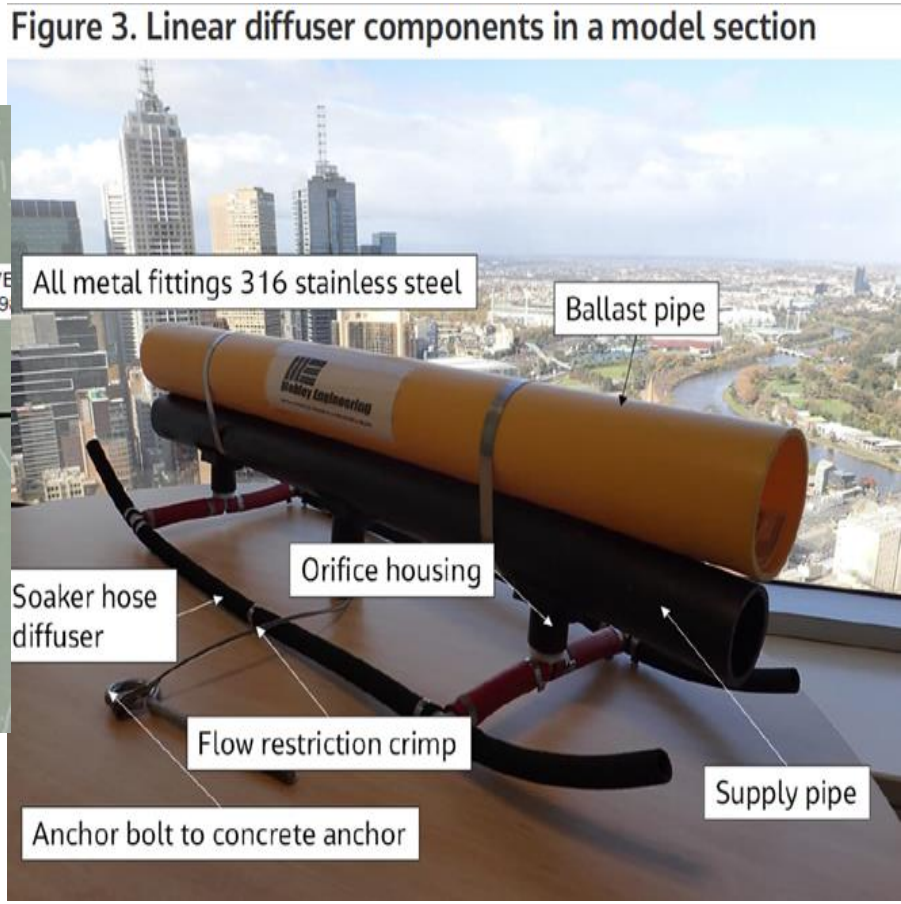
- Need to keep it ferric!

Stratification leads to hypoxia → internal loading of TP

- Hypolimnetic oxygenation ≥ HOD







Line Diffuser Oxygenation System

Designed Oxygen Delivery Rate: **1,911 kg/d**

Expected Outcomes

- Pre-Project Goals
  - TP < 12 µg/L
  - Secchi depth summer avg 4 meter
  - No cyanobacteria cell counts greater than 20,000 cells/mL
  - Microcystin less than 4 micrograms per liter (µg/L)
  - Restore cold water fishery
- Expected Outcomes:
  - Reducing seasonal nutrient availability will reduce phytoplankton concentrations
    - In turn will reduce sediment oxygen demand, with possible compounding effects (Jacobs 2023)
  - Microcystins concentrations never exceed WaDOH recreational toxicity guidelines
  - Oxic hypolimnion will promote healthy zooplankton community → feed on algae
  - Oxic Hypolimnion will permit trout and whitefish populations to exist

Next steps

- Oxygenation is a highly engineered, energy intensive, and expensive (~$3mil) solution
- Long term water quality improvement relies on expanding community commitment toward goal
- Address other sources of TP input
  - On site wastewater disposal
  - Watershed run off

Long Term Success
=
A Collective Effort!

- Spokane Conservation District
- Newman Lake Property Owners Association
- Newman Lake Advisory Board
- The Lands Council
- Gonzaga University
- Jacobs Engineering
- Halme Construction
- Hayley & Aldrich
- Washington State University

Questions?

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