Blackmans Lake Cyanobacteria Management Plan

Public Meeting on Draft Plan

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Science + Planning + Design

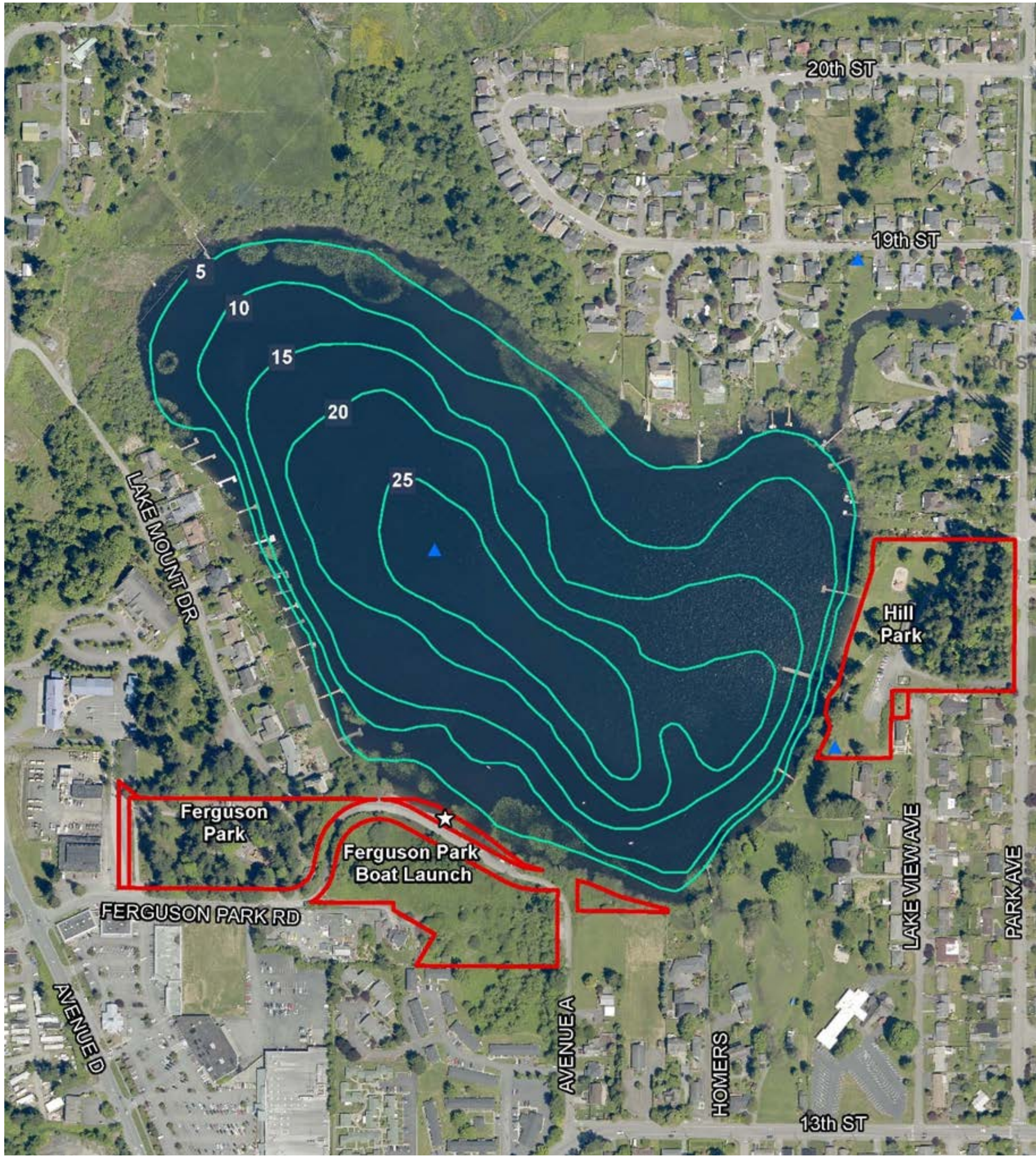
City of Snohomish Washington

DEPARTMENT OF ECOLOGY State of Washington

Snohomish County Washington

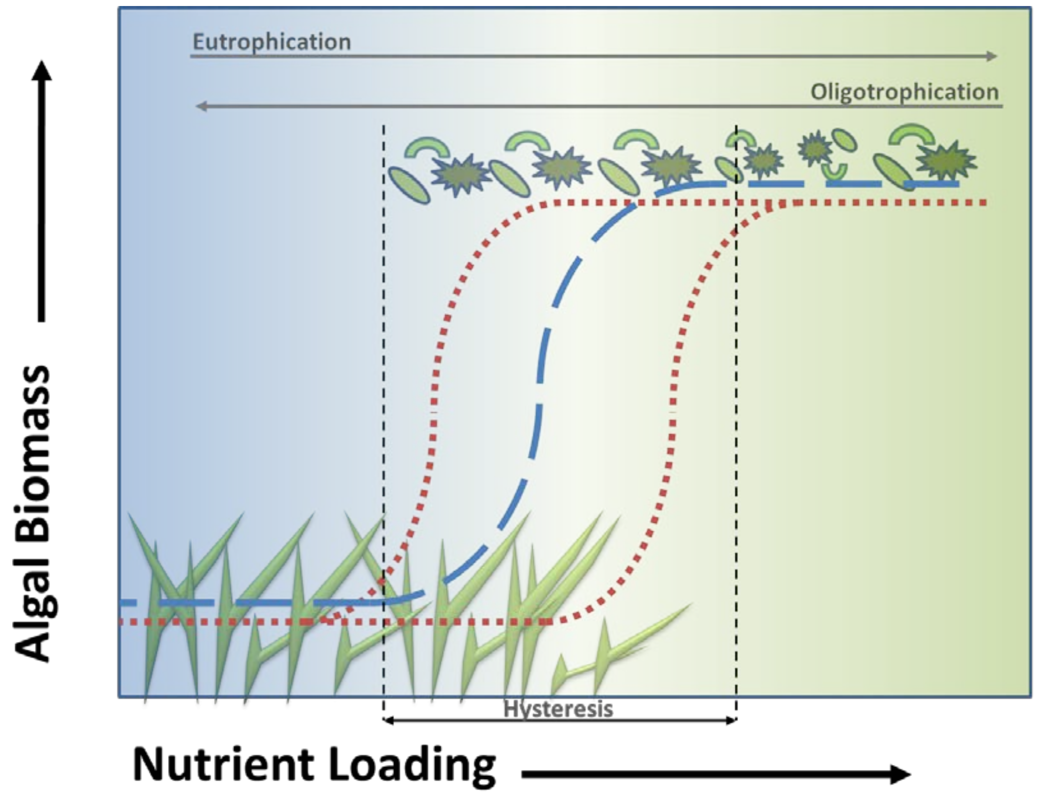
Presentation Outline

1. Eutrophication/Cyanobacteria Background
2. Project Objectives and Activities
3. Water Quality Findings
4. Water and Phosphorus Budgets
5. Management Objectives
6. Recommended Management Actions
7. Management Costs and Funding
8. Next Steps
9. Questions and Answers



Lake Eutrophication

- Increasing nutrients in a lake, frequently from land runoff, which increases algae growth and decay
- Natural and cultural nutrient sources



- Moderate amounts support ecological diversity and fish productivity
- Excessive amounts impact ecology and human activities

Lake Trophic State

Classes

- **Hypereutrophic**
- **Eutrophic**
- **Mesotrophic**
- **Oligotrophic**

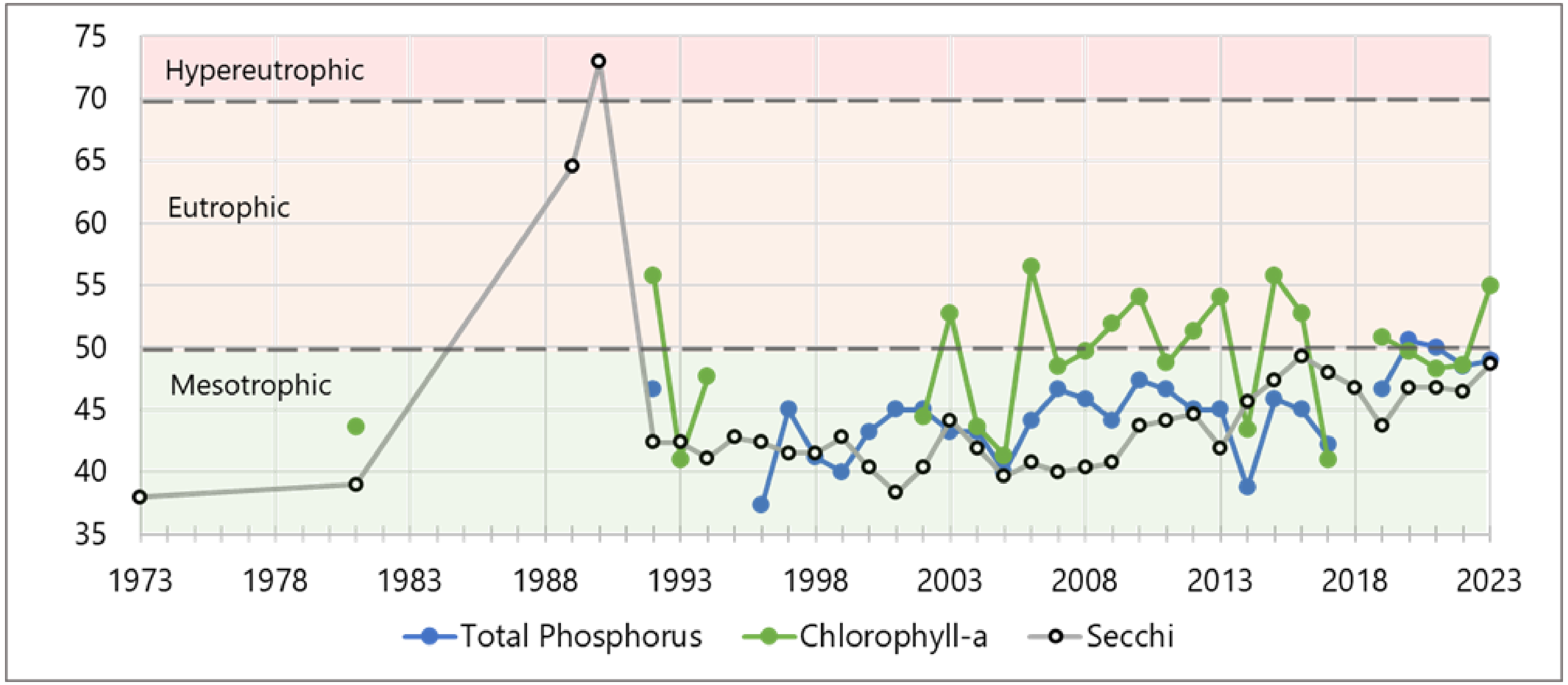
Indices (Summer Mean)

- **Total Phosphorus**
- **Chlorophyll-a**
- **Secchi Depth**

Echo Lake TSI:

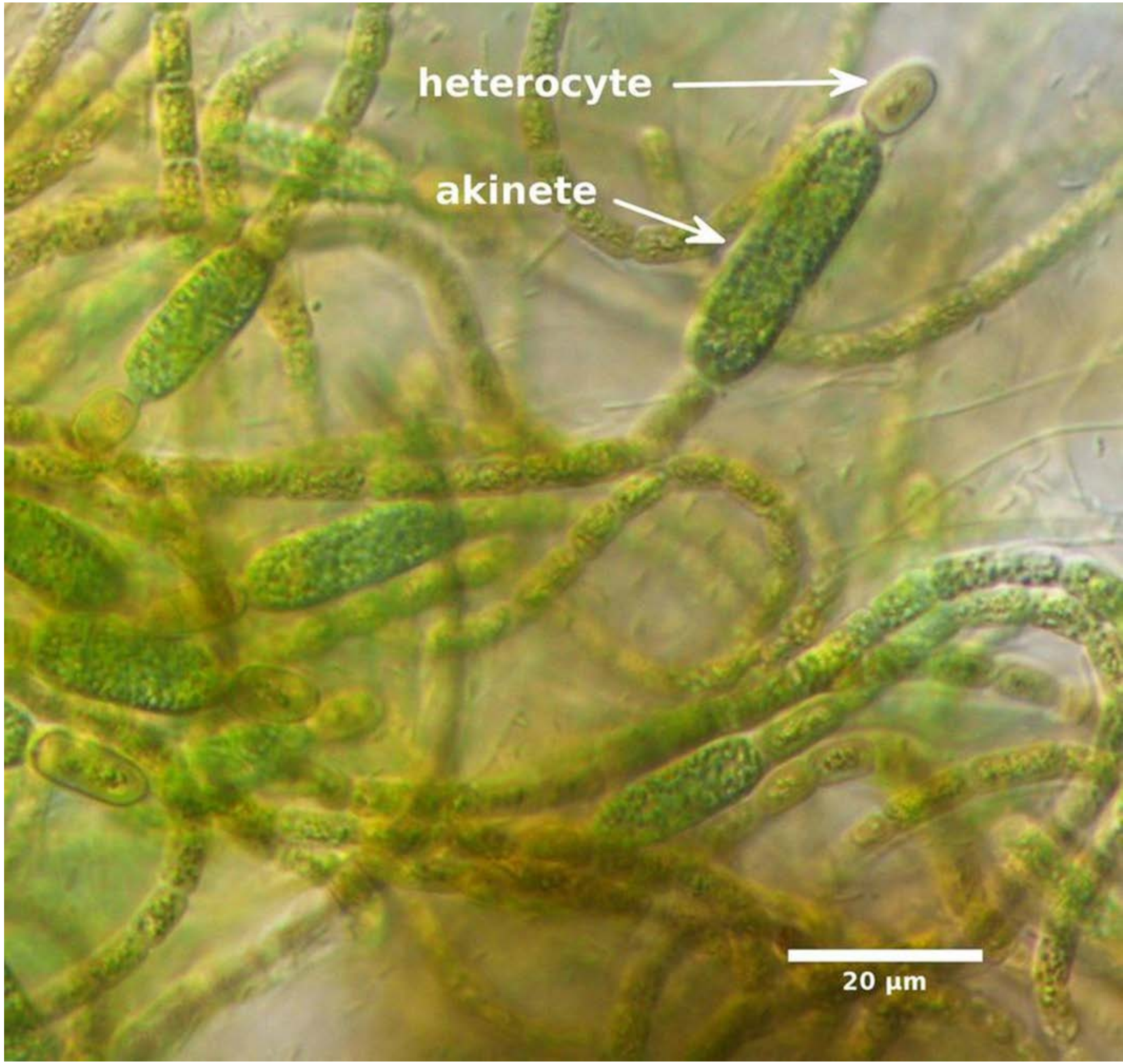
- **Eutrophic Chl-a**
- **Mesotrophic TP/Secchi**
- **Increasing TP and decreasing Secchi**

Trophic Class	Trophic State Index	Total Phosphorus (µg/L)	Chlorophyll-a (µg/L)	Secchi Depth (meters)
Hypereutrophic	> 70	> 96	> 56	< 0.5
Eutrophic	50 to 60	24 to 48	7.2 to 20.1	1 to 2
Mesotrophic	40 to 50	12 to 24	2.6 to 7.2	2 to 4
Oligotrophic	< 40	< 12	< 2.6	> 4
Blackmans 2023 (2004-2023 range) (2004-2023 mean)	TP = 49 **Chl = 55** Secchi = 49	22.3 (11-25) (18)	12.0 (3-14) (7.8)	2.2 (2.1-4.1) (3.0)



Cyanobacteria

- Blue-green Algae – primitive algae group with bacteria structure and photosynthetic pigments
- Competitive advantages:
  - Vertical migration
  - Phosphorus luxury uptake
  - Non-preferred food for grazers
  - Some can fix nitrogen gas
  - Lower energy needs – can grow under lower light conditions



Project Hypothesis and Objectives

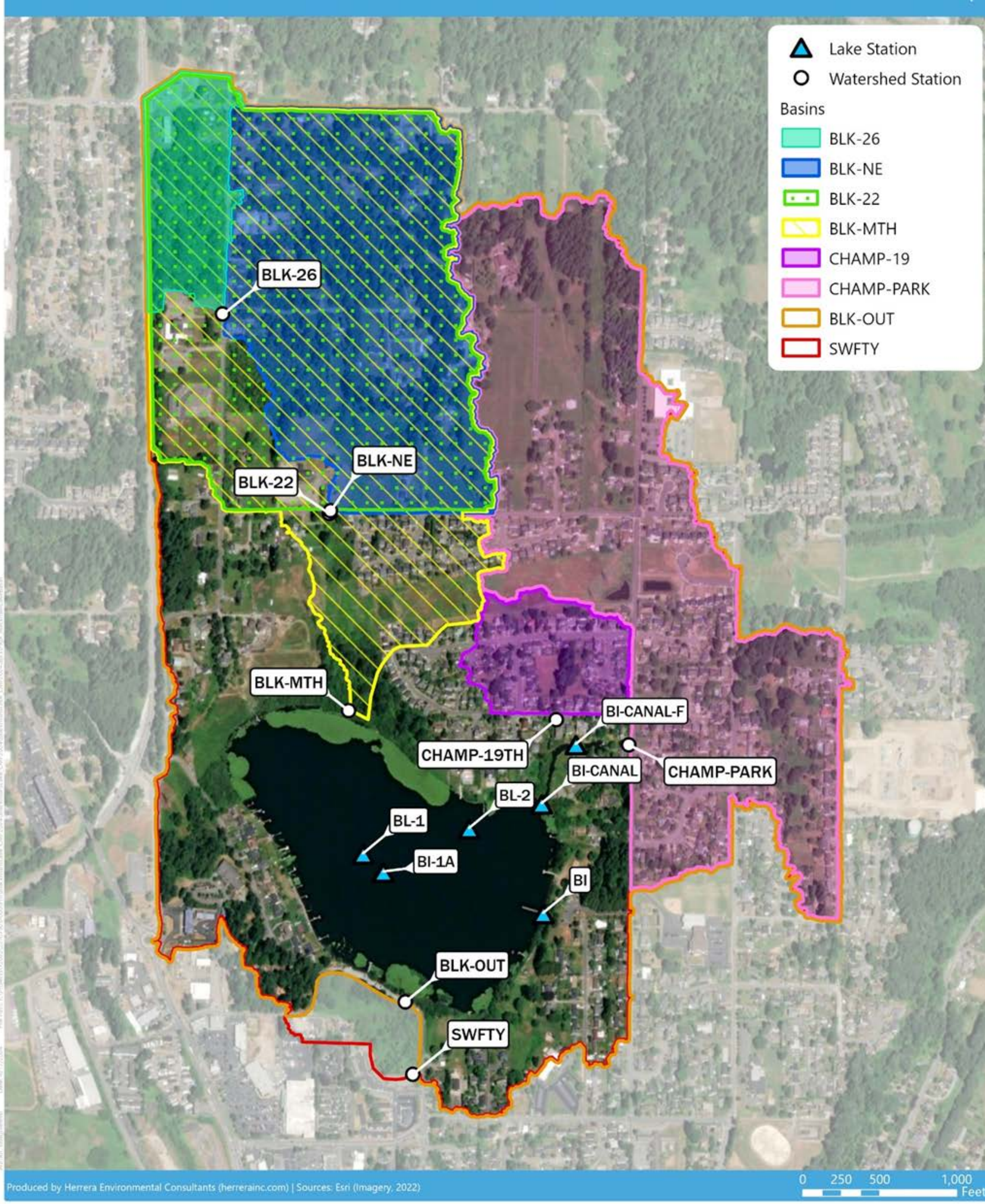
Hypothesis:
Algae are limited by phosphorus and their primary phosphorus source is internal loading from anoxic sediment release, but watershed sources may be important.

Project Objectives:

- Collect/evaluate data to understand causes of toxic algae blooms.
- Develop water/phosphorus budgets to identify controllable P sources.
- Predict needed P reduction to meet chlorophyll objective and reduce bloom frequency.
- Evaluate feasible watershed management alternatives for reducing P inputs and in-lake management alternatives for reducing P supply or other factors favoring cyanobacteria over other types of algae.
- Prepare a cyanobacteria management plan including funding sources.

Project Monitoring Program

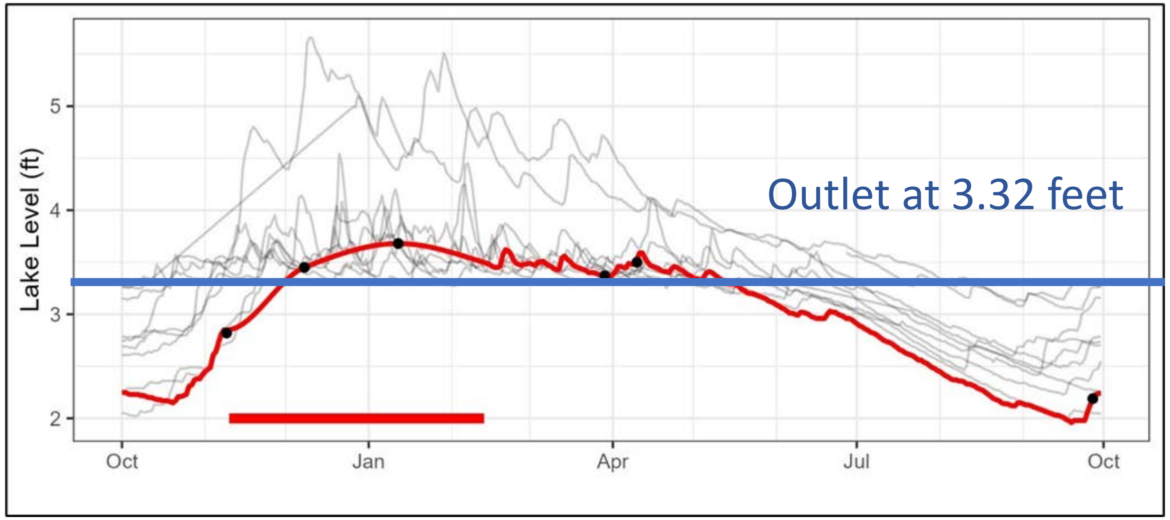
Component	Element/Parameters
Hydrological	Precipitation and lake level (Oct 2022 – Oct 2023)
	Stormwater/lake discharge (6 storm, 3 base)
Stormwater Quality	Discrete sampling for total phosphorus (6 storm, 3 base)
Lake Water Quality	Profiles of temperature and DO (2/month May-Oct)
	Routine sampling for Secchi depth, TP, and chl-a (Oct-Oct). Supplemental sampling for PO4, TN, NO3+NO2, Canal chl-a, phytoplankton, and zooplankton (3-5 summer events)
	Counts of waterfowl, boats, anglers, and swimmers
	Cyanotoxin sampling for microcystin and anatoxin-a
Sediment Quality	Core sampling for phosphorus fractions, total iron, percent solids, bulk density

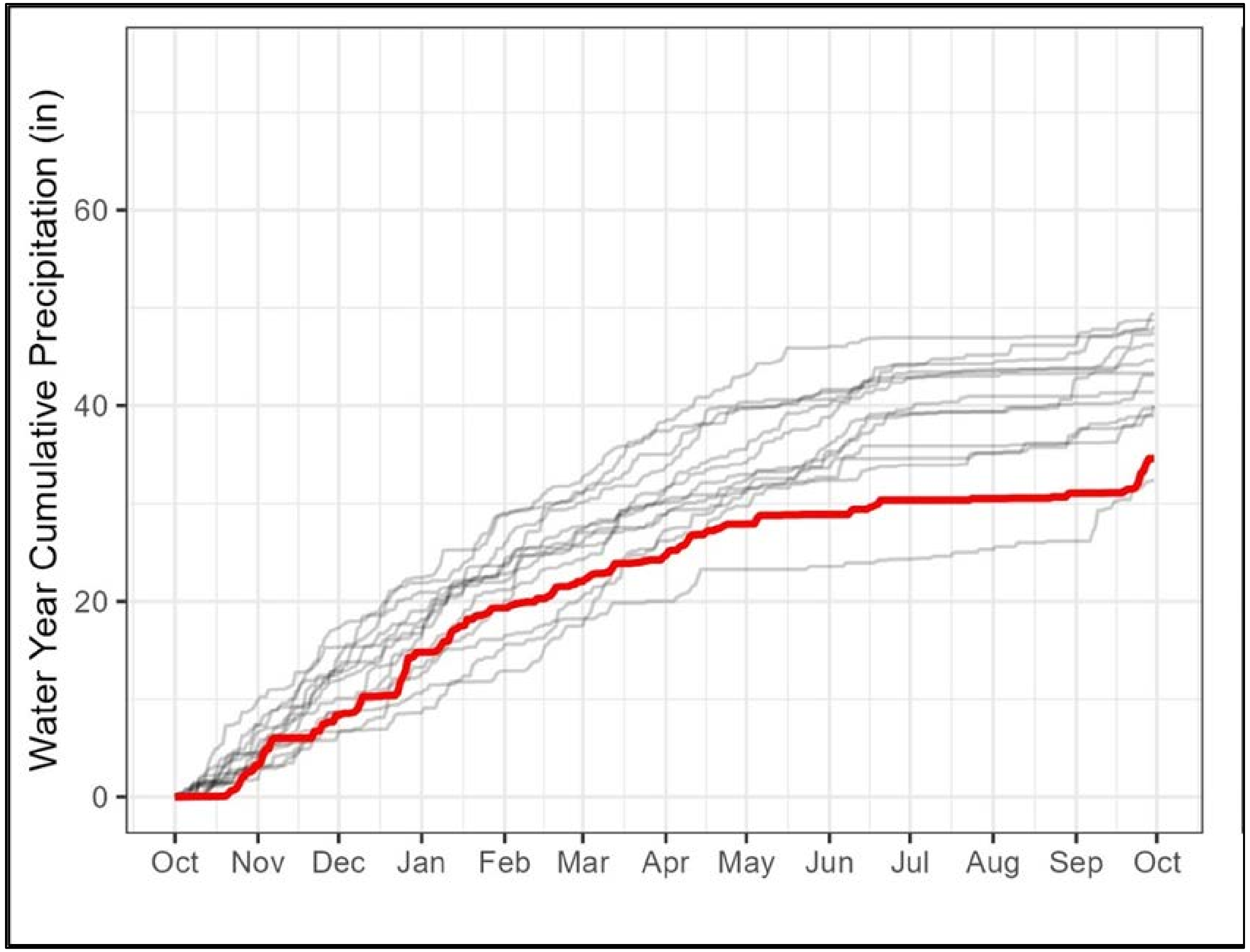


Thank You Anthony, Kay, other volunteers, Cory, and Jen!

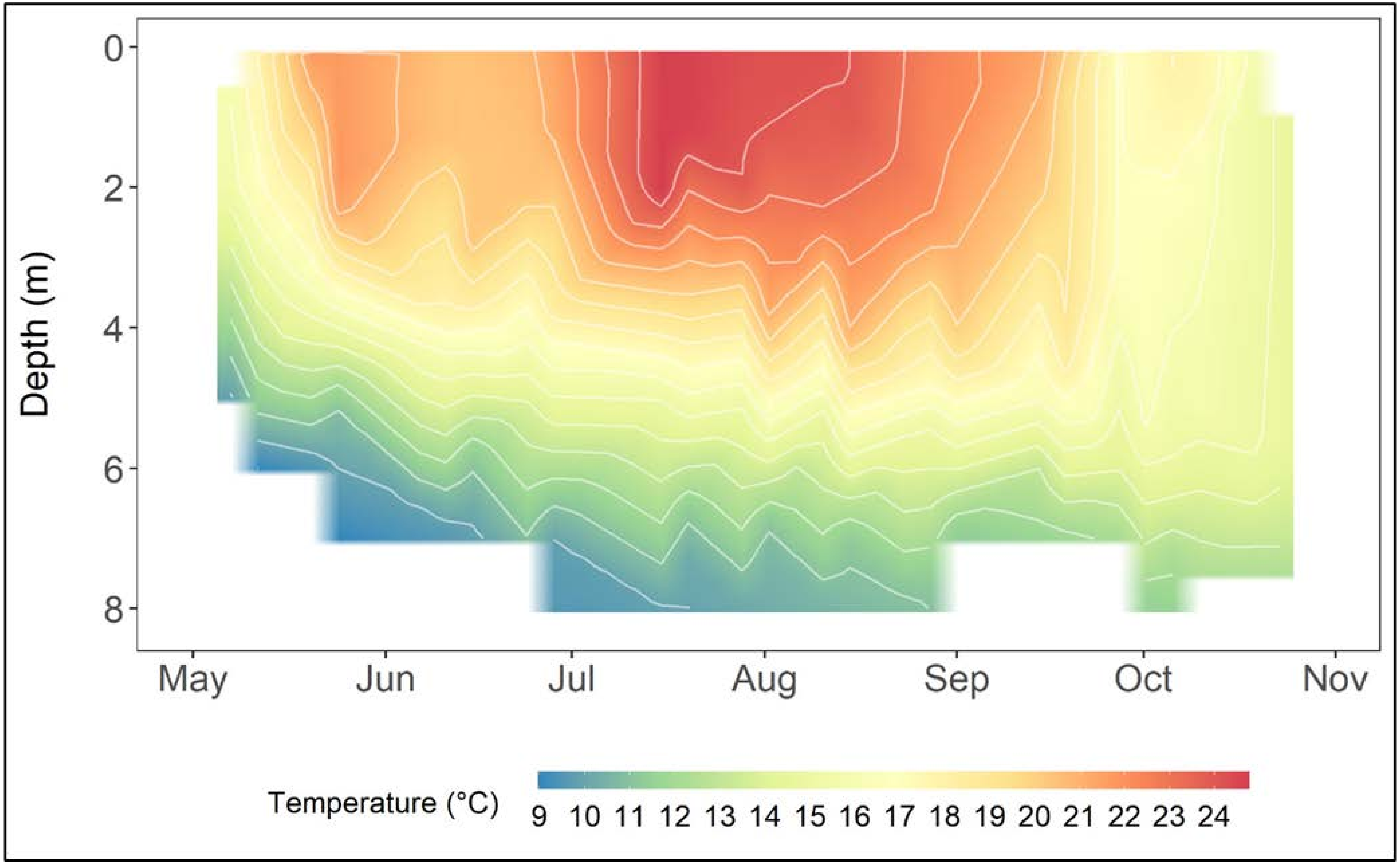
Hydrological Monitoring Results

- Low rainfall year
- Low lake level year

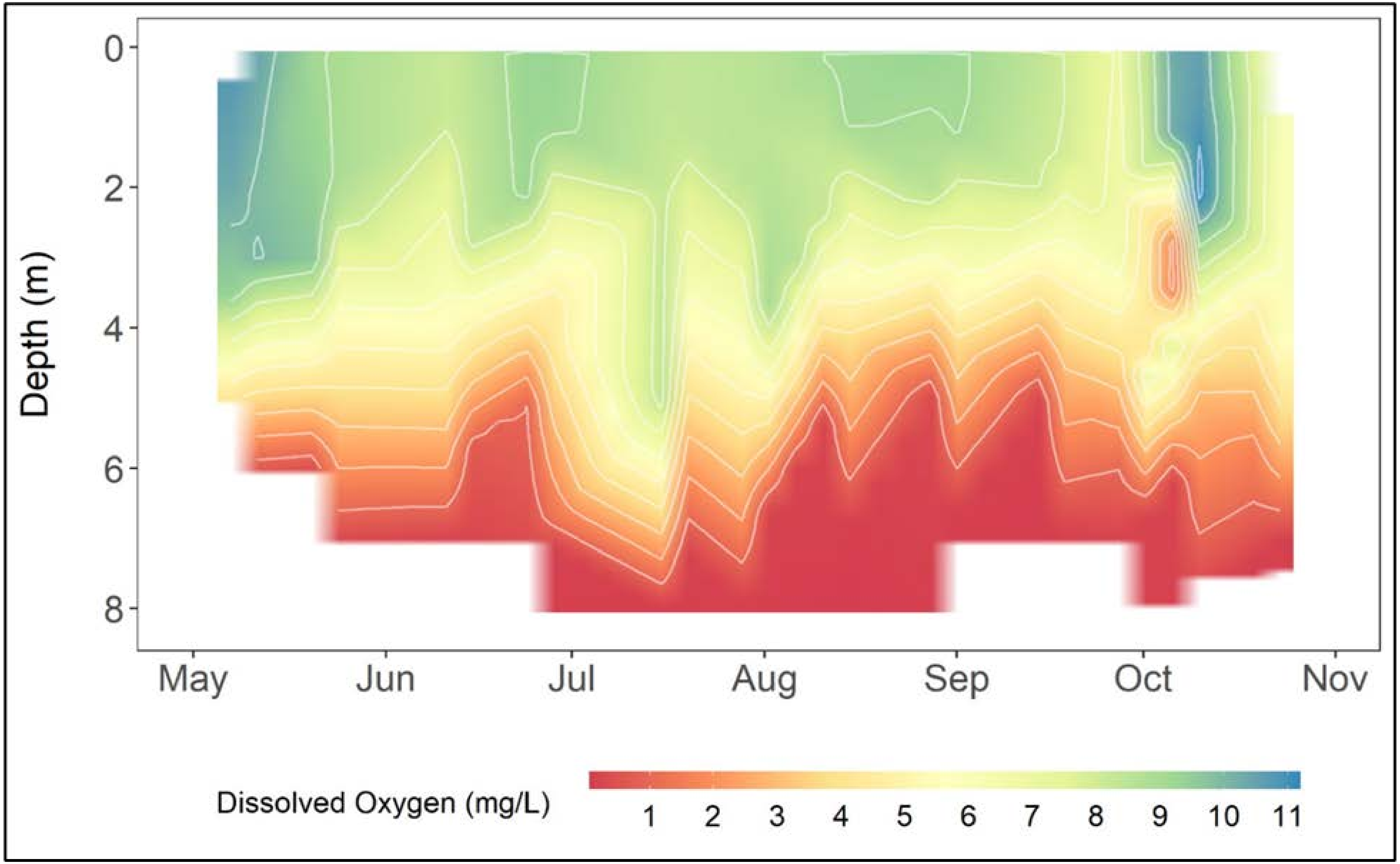




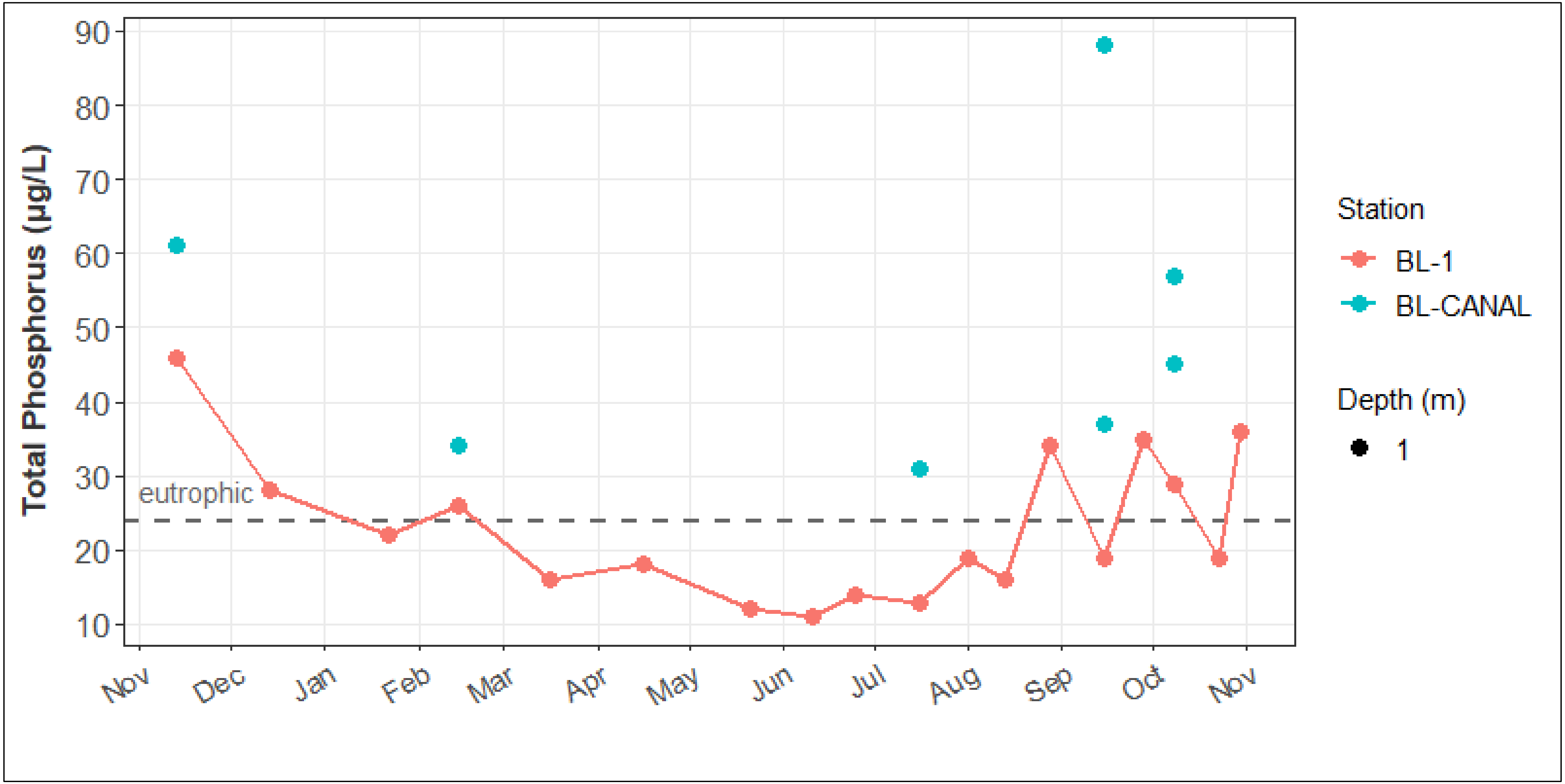
Lake Temperature



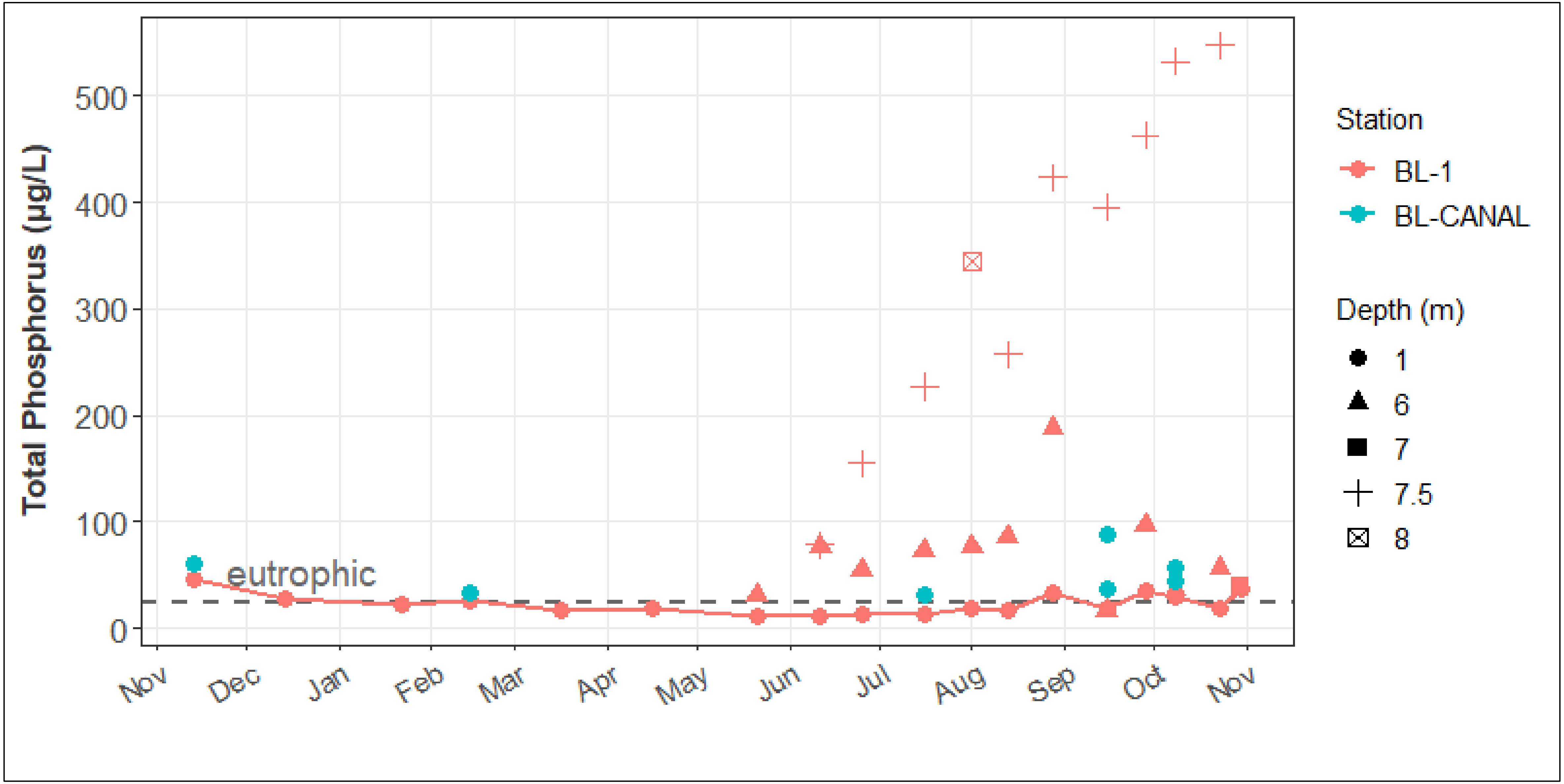
Lake Dissolved Oxygen



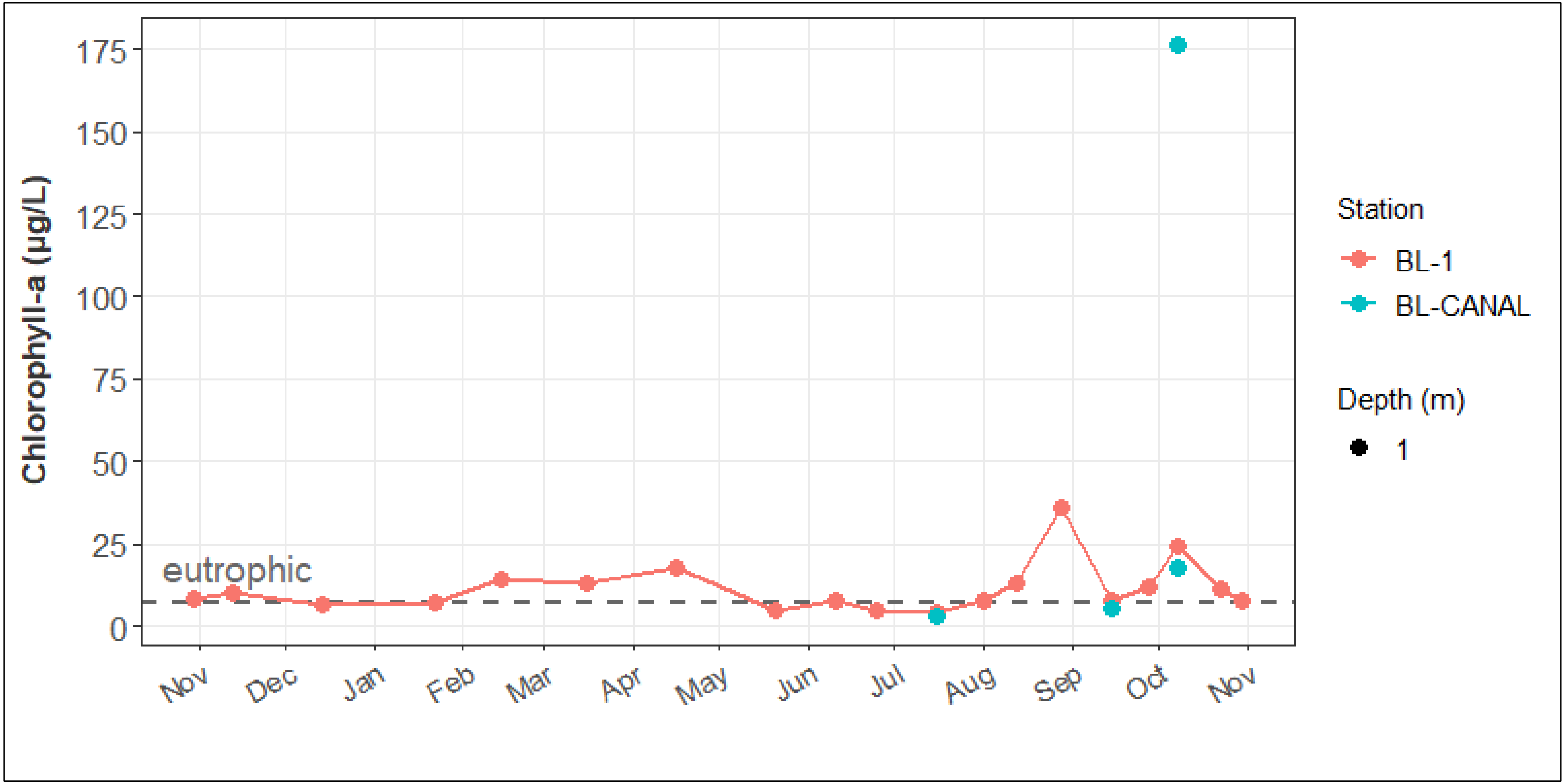
Lake Total Phosphorus Surface



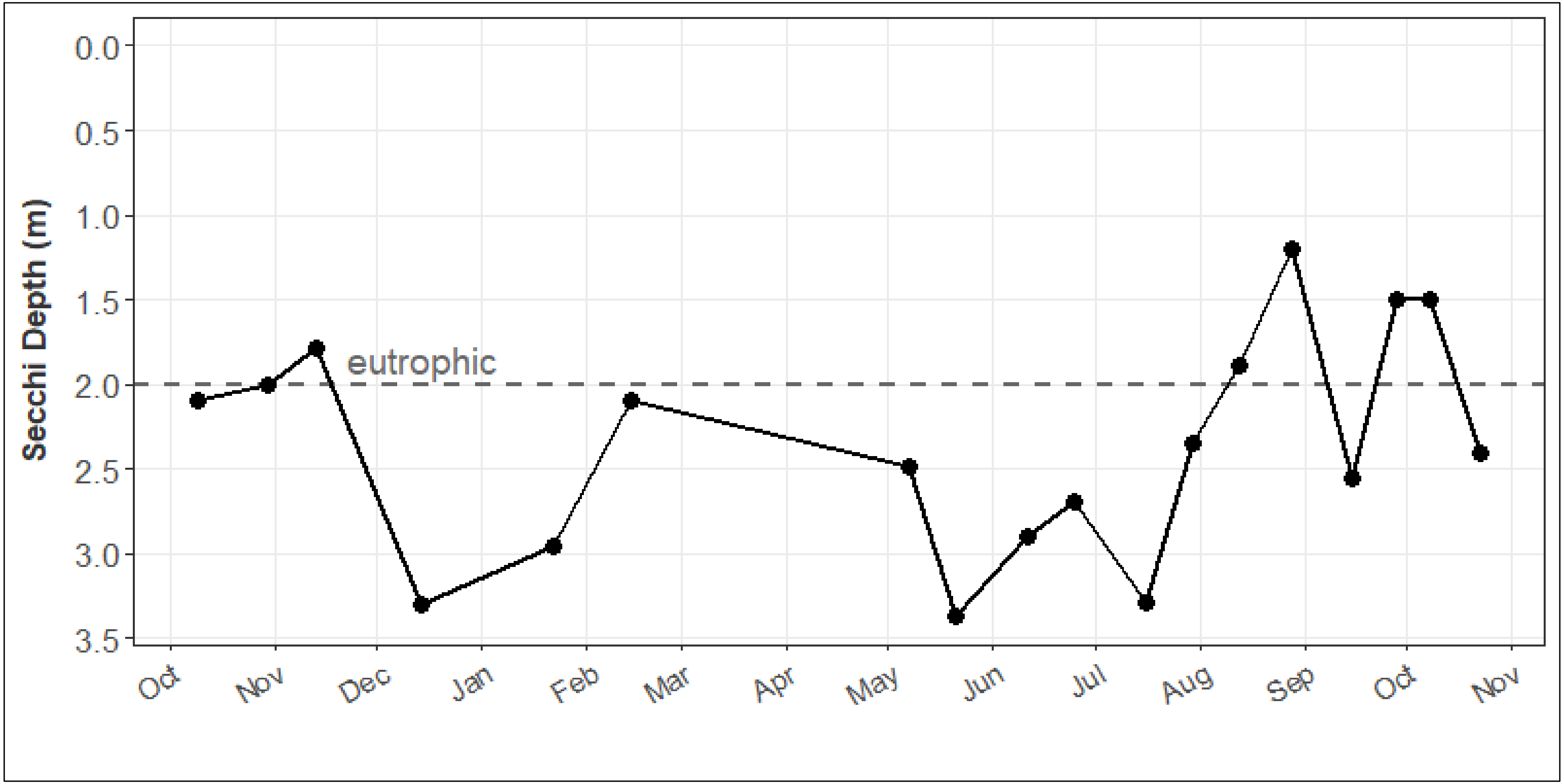
Lake Total Phosphorus Surface and Bottom



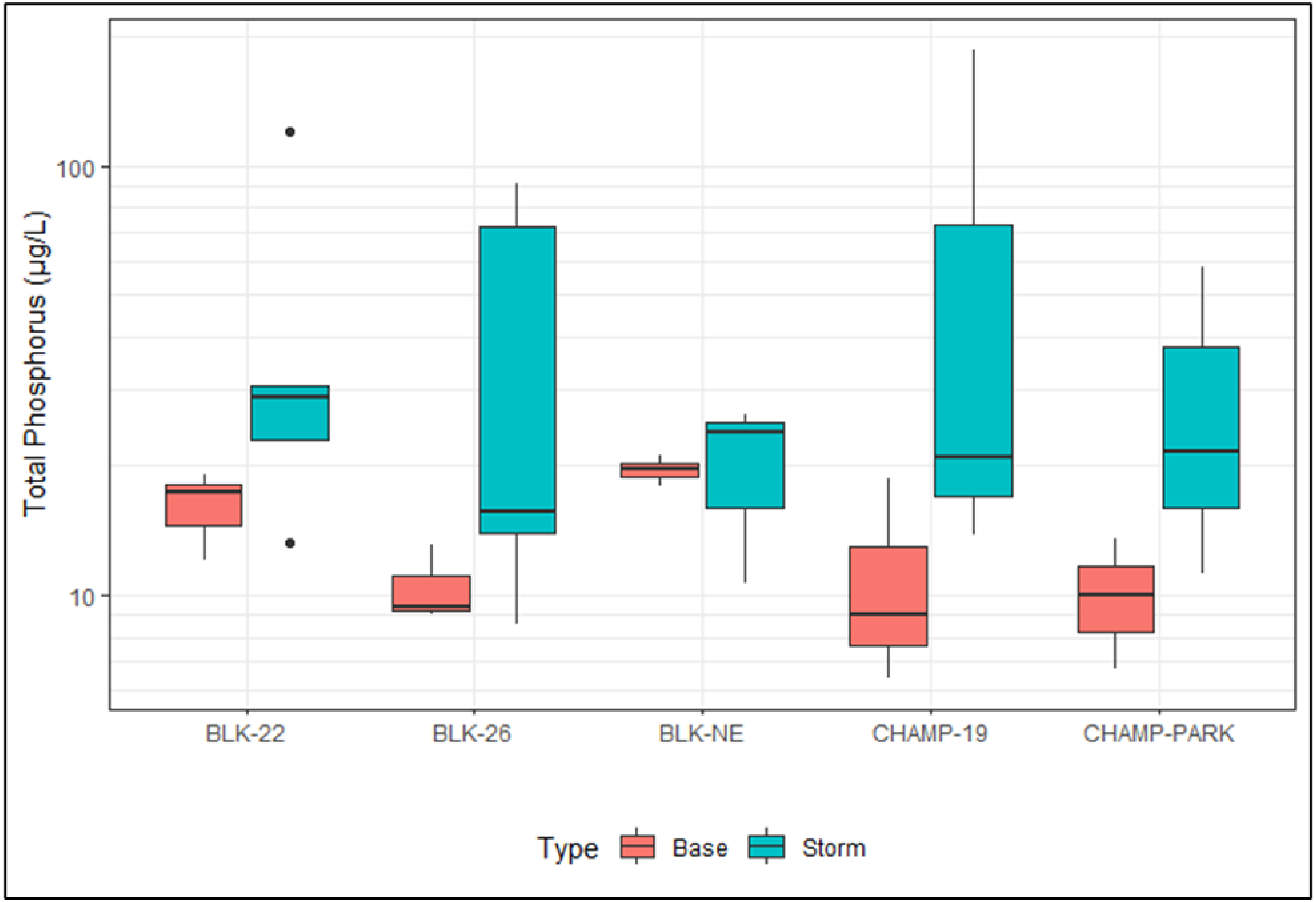
Lake Chlorophyll-a



Lake Secchi Depth



Stormwater Phosphorus Results



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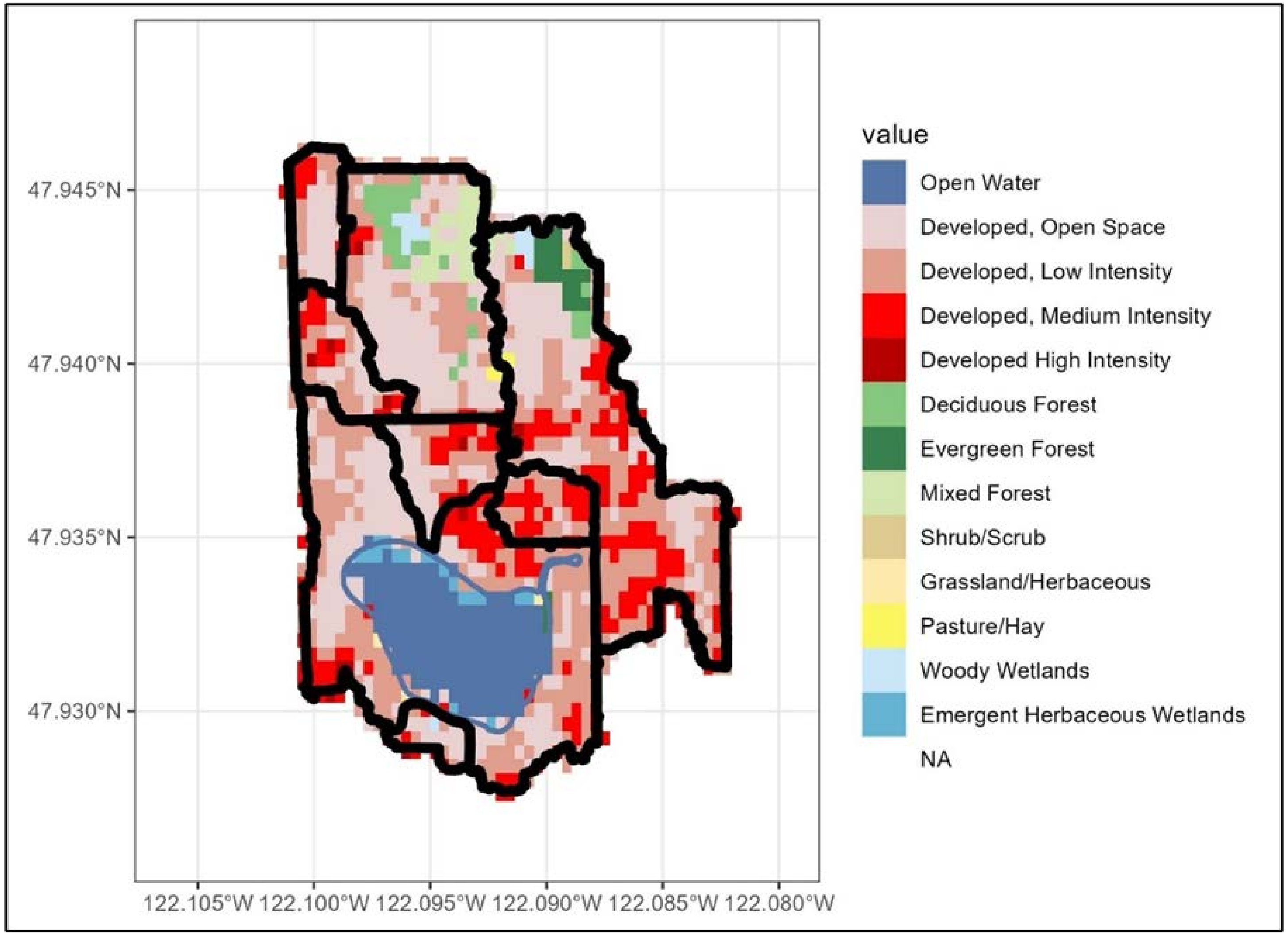
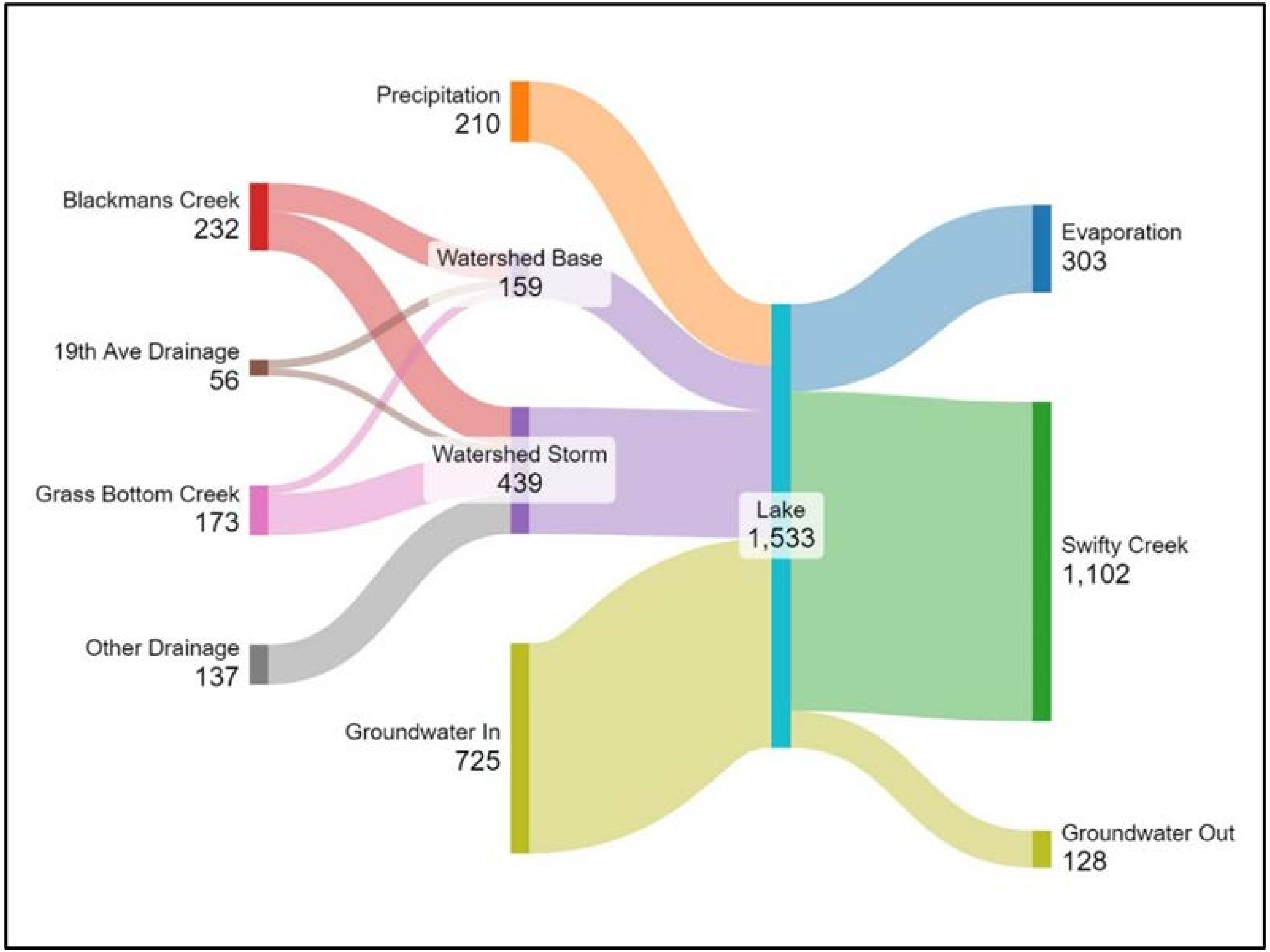
Lake Water and Phosphorus Budgets

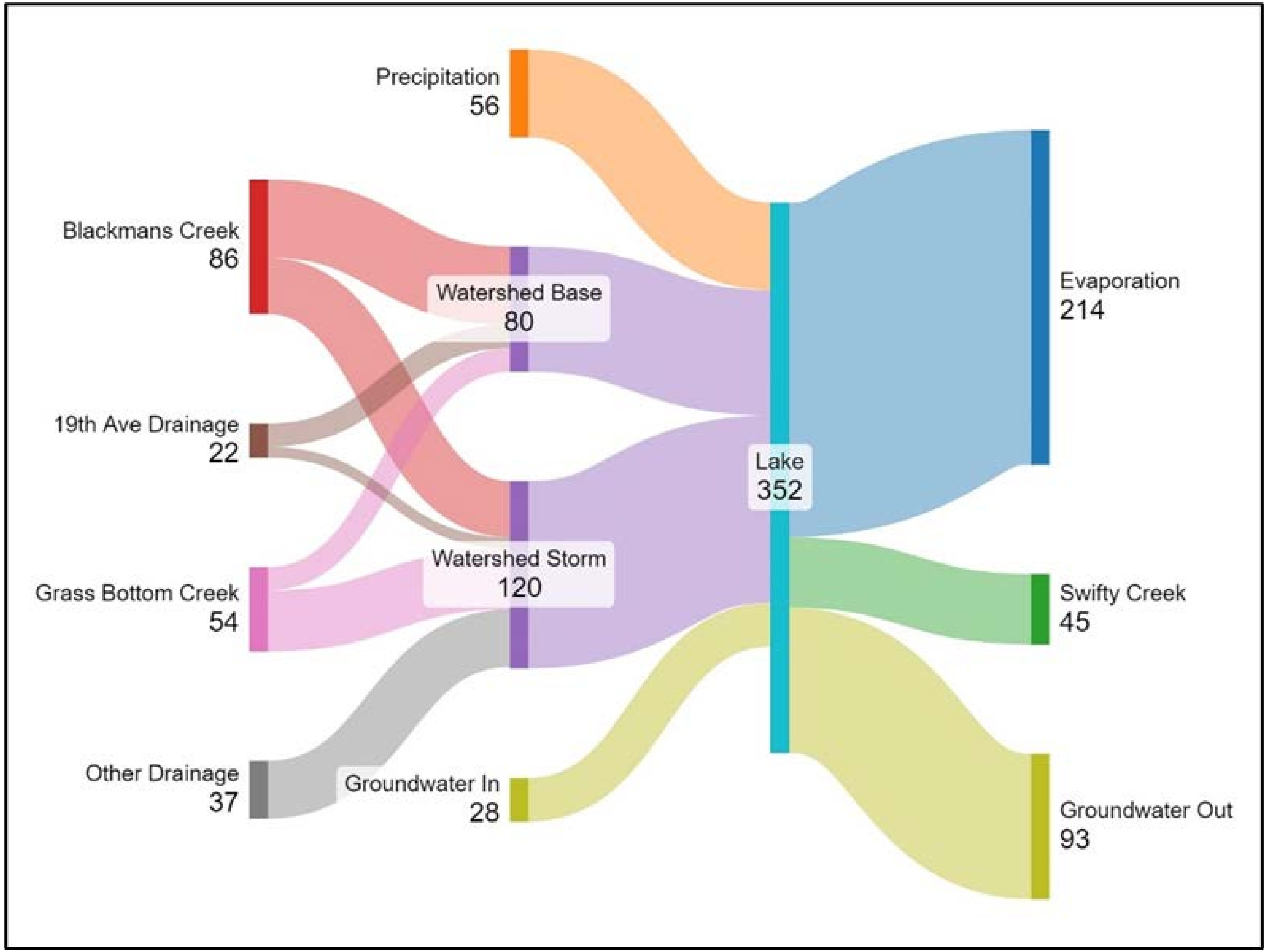
- Estimate monthly inputs and outputs of water and TP for each watershed monitoring basin and unmonitored nearshore basin using simple runoff modeling
- Estimate internal sediment TP loading as average of results for 4 methods



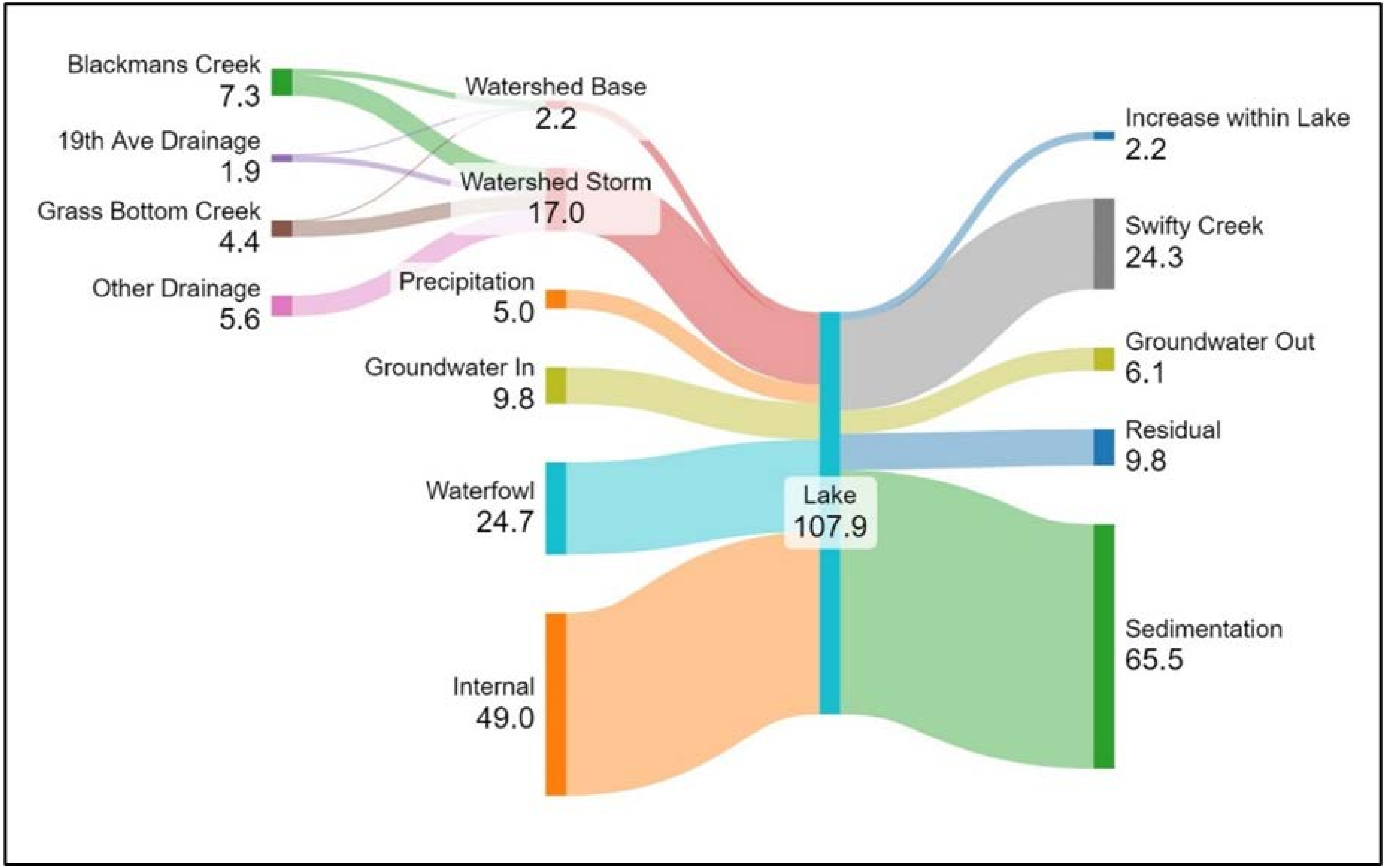
Lake Annual Water Budget (1,000 m^3)



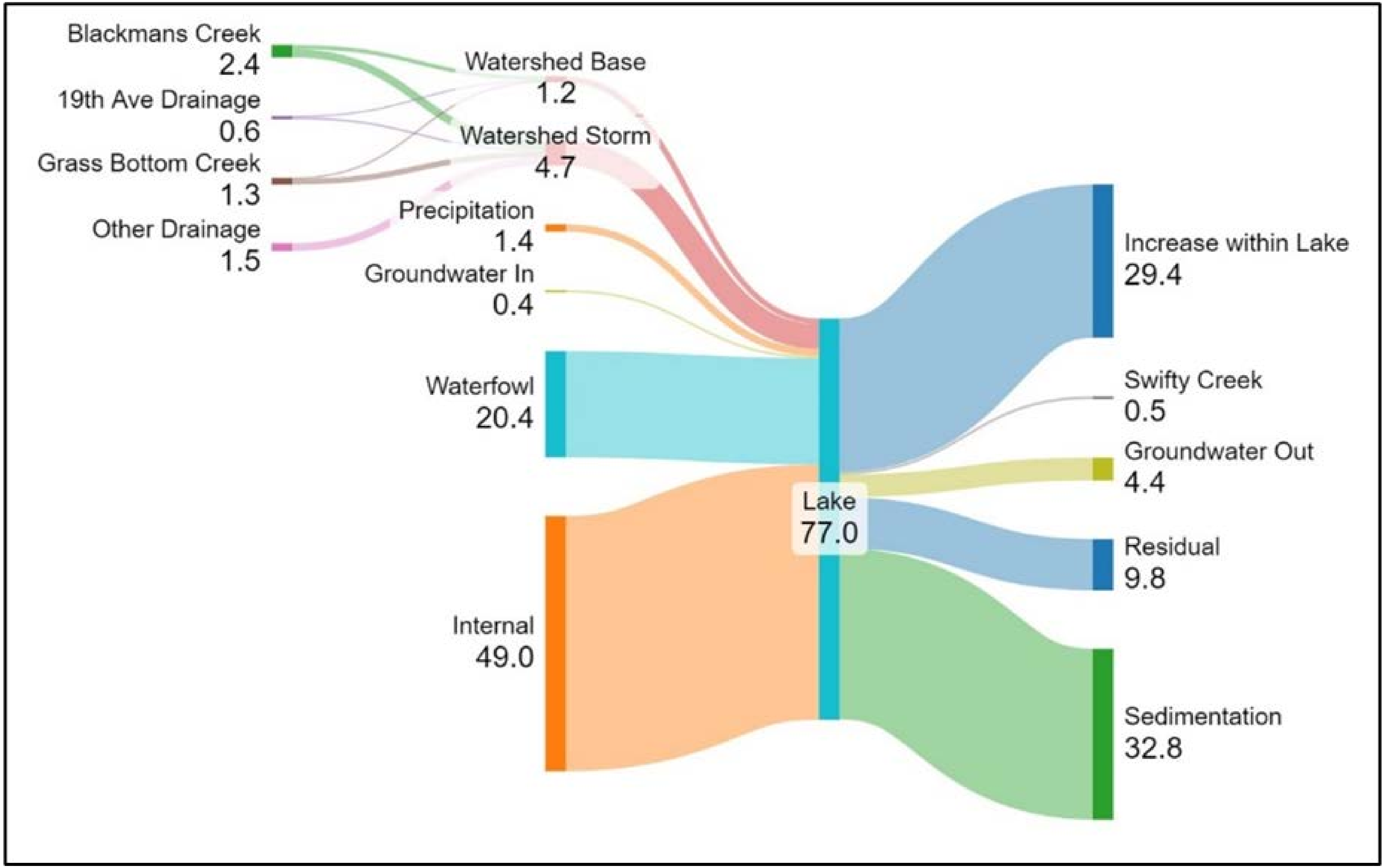
Lake Summer Water Budget (1,000 m³)



Lake Annual Phosphorus Budget (kg)



Lake Summer Phosphorus Budget (kg)



Blackmans Lake Management Goal and Objectives

Goal:

Improve and protect lake uses by decreasing cyanobacteria blooms.

Objectives:

- Meet Ecology's criteria for no lake impairment within a 5-year period:
    - No more than one year with two or more events with cyanotoxins exceeding state recommended guidelines
    - No more than one year with a public health advisory lasting three weeks or longer
- Reduce trophic status to mesotrophic or better with average summer (June through September) surface:
    - Chlorophyll-a ≤7.2 µg/L (mesotrophic vs. 7.8 µg/L 20-year mean)
    - Total phosphorus ≤18 µg/L (20-year mean vs. 24 µg/L mesotrophic)
    - Secchi depth ≥ 3.0 meters (20-year mean vs. 2.0 meters mesotrophic)

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Lake Management Alternatives

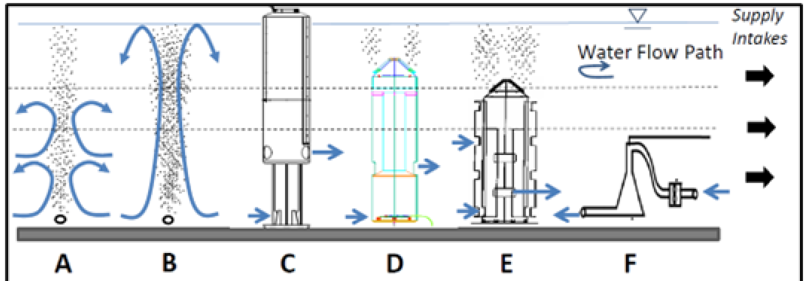
In-Lake Controls - Feasible

1. **Hypolimnetic Oxygenation***
2. **Phosphorus Inactivation***
   - **Buffered alum**
   - **Lanthanum (EutroSorb-G)**
3. *Lake Circulation*
   - *Surface or whole*
   - *Aeration*
   - *Solar Bee*
4. *Nannobubbler*
5. *Ultrasound (LG Sonic)*
6. *Biomanipulation*
   - *Carp removal*
   - *Zooplankton control*
7. *Algaecides*

* **Recommended**

In-Lake Controls - Infeasible

1. *Microbes/Enzymes*
2. *Dye*
3. *Barley Straw*
4. *Dilution/Flushing*
5. *Drawdown*
6. *Hypolimnetic Withdrawal*
7. *Dredging*



Schematic Diagrams of Aeration and Oxygenation Techniques

A variety of apparatus is available for managing thermal stratification and respiration in water supply reservoir systems. Some prevent stratification. Some adjust the location of the thermocline to expand epilimnetic mixing depth or establish high quality layers at the elevation of a raw water intake. Some add oxygen to the hypolimnion without changing stratification.

A. Line Diffuser with Low Enough Gas Flow to Maintain Stratification
B. Line Diffuser with High Enough Gas Flow to Prevent Stratification
C. Traditional Full-Lift Hypolimnetic Aeration
D. Submerged Partial-Lift Hypolimnetic Aeration
E. Depth-Selective Layer Aeration
F. Conical Oxygen Contactor, A.K.A. "Speece Cone".

Modified from: Moore, et.al, 2015

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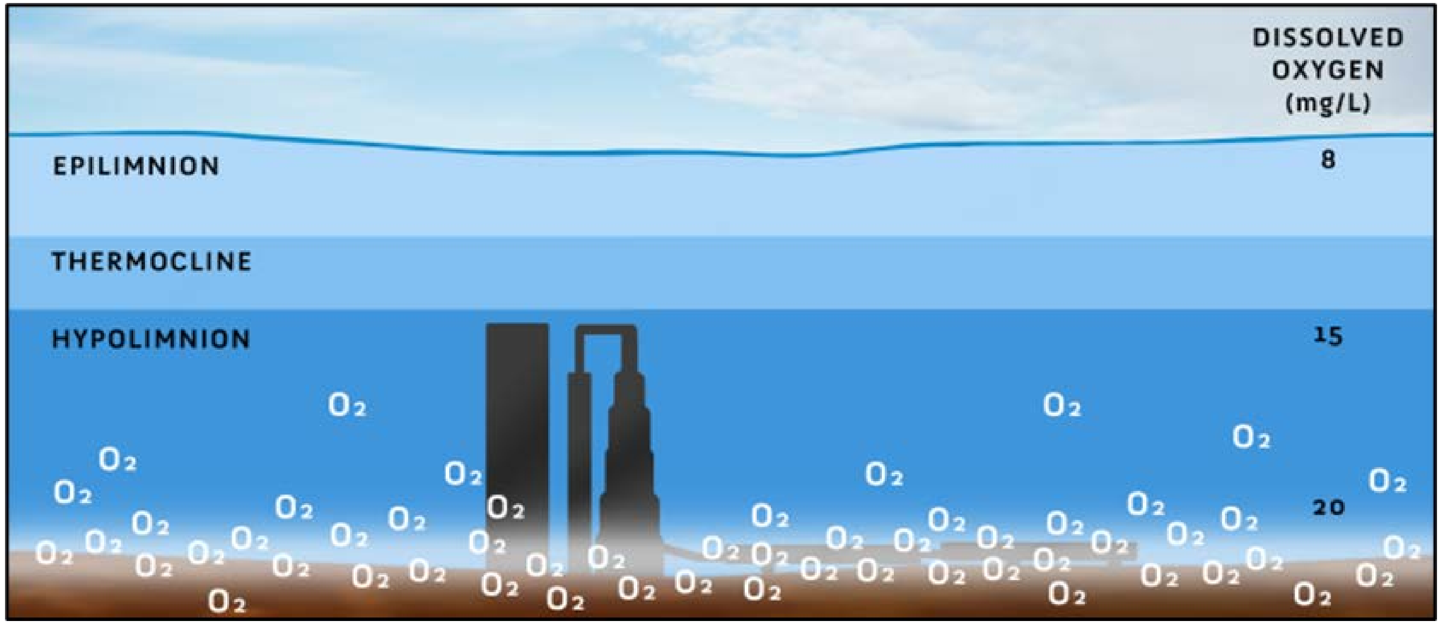
Oxygen Saturation Technology

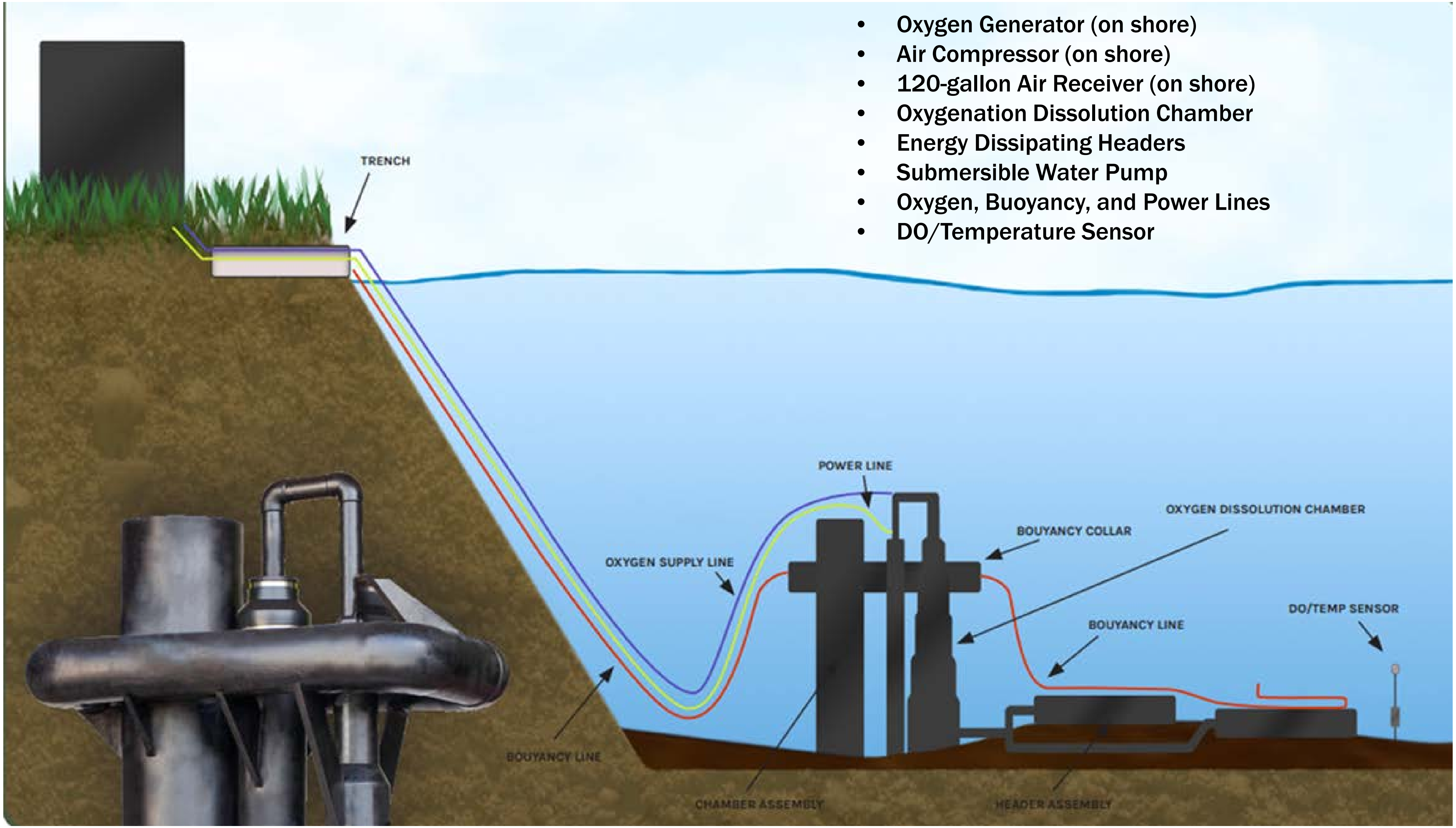
- New technology developed by hypolimnion oxygenation expert, not well tested
- Oxygen generator on shore pumped to mixing system in deepest lake location
- Bottom water withdrawn, injected with high oxygen, and returned
- DO monitored to adjust as needed
- More cost-effective than passive diffusion technologies
- Increases fish habitat
- Less expensive and more sustainable than phosphorus inactivation



Initial 3-yr Install Cost:	\$350k
Annual O&M Cost:	\$20k
Total 20-year Cost:	\$500k
Average 20-yr Annual Cost:	\$35k

Blackmans Lake OST System Components

- Oxygen Generator (on shore)
- Air Compressor (on shore)
- 120-gallon Air Receiver (on shore)
- Oxygenation Dissolution Chamber
- Energy Dissipating Headers
- Submersible Water Pump
- Oxygen, Buoyancy, and Power Lines
- DO/Temperature Sensor



Phosphorus Inactivation Alternatives

- Proven technologies to bind available sediment P:
  - Buffered aluminum sulfate (2:1 alum:sodium aluminate)
  - Lanthanum modified bentonite (EutroSorb-G)
- Applied by boat in small, short-term doses (1-3 years) or large, long-term doses (5-10 years)
- Does not significantly increase bottom oxygen or fish habitat
- More expensive than oxygen saturation technology

Initial Treatment Cost:	$350k
Total 20-yr Cost (2-4 treatments):	$700-1,400k
Average 20-yr Annual Cost:	$35-70k

Watershed Management Alternatives

Source Control Outreach

- LakeWise Program:
  - Lawn and yard care
  - Septic system maintenance
  - Shoreline management
- Construction site inspection
- Waterfowl deterrence

Stormwater Management

- Require phosphorus treatment for new/re-development
- Stormwater system maintenance
- Stormwater treatment system retrofits

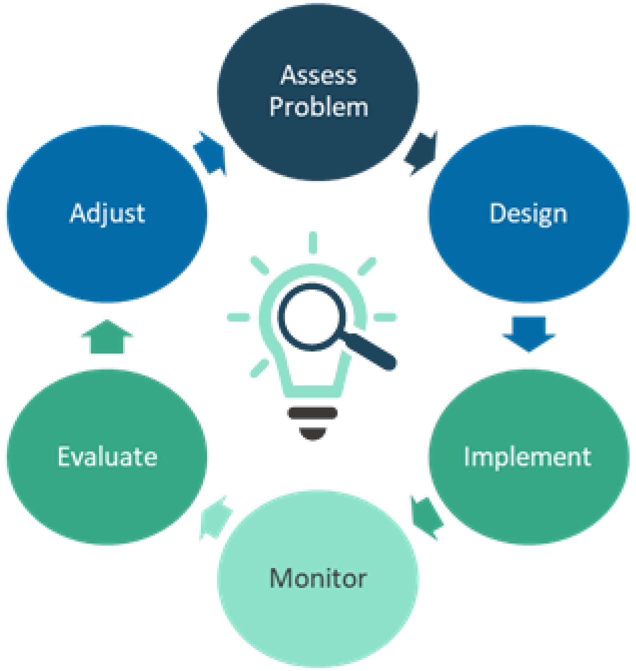
Ecology-Approved Phosphorus Treatment Systems	
Aquip	Modular Wetlands Round or Linear
BayFilter w/EMC Media	PerkFilter
BioPod Biofilter	Phosphorus Optimized Stormwater Treatment System (POST)
BoxlessBioPod Biofilter	StormFilter using PhosphoSorb Media
EcoPure BioFilter 2-Cell	StormGarden Modular Stormwater Bio-filtration System
EcoPure BioFilter 3-Cell	StormTree Biofiltration Practice
Filterra Bioscape	The Kraken
Filterra System	Up-Flo Filter Extended Maintenance Cartridge
FocalPoint HPMBS	Up-Flo Filter w/Filter Ribbons
Jellyfish Filter	Water Treatment Residual Treatment System

Future Monitoring and Adaptive Management

Monitoring Recommendations and Costs

Monitoring Component	Description
Lake water quality	Continue Snohomish County VLMP
Lake level	Continue Snohomish County gauge
Recreational Safety Surveys	Expand existing surveillance program for testing cyanobacteria blooms/toxins and E. coli year-round
Sediment Monitoring	Collect 2 sediment cores every 5 years for phosphorus fractionation
Stormwater/ Inlet Monitoring	Monitor performance of stormwater treatment facilities
Data QA and management	Input laboratory and field data into database, perform data QA/QC
Annual Reporting	Summary of Monitoring Data, Management Effectiveness, and Adaptive Management Recommendations

Adaptive Management



Adaptive Management Cycle. Adapted from Williams et al. (2009)

Total Monitoring and Reporting Cost: $34k/year

Recommended Management Plan Cost Summary

Plan Element	First Three Years (2025 to 2027)		Next 17 Years (2028 to 2047)		20-Year Annual ($)
	Description	Cost ($)	Description	Cost ($)	
Oxygen Saturation Technology (OST)	Permit and install an OST system.	$350k	Ongoing maintenance and electricity costs ($20k/year)	$350k	$35k
Watershed Source Control Education/Outreach	Use existing City and County programs to encourage best management practices in watershed.	$0	Ongoing	$0	$0
New Development and Redevelopment	Revise municipal code to require phosphorus treatment for new and redevelopment.	$0	Ongoing	$0	$0
Stormwater Retrofit Evaluation	Evaluate potential stormwater retrofit locations.	$100k	Implement high-value, multi-benefit stormwater retrofits	$2,000k	$105k
Monitoring and Reporting	Routine/supplemental lake monitoring, bloom and fecal surveillance, stormwater monitoring, sediment monitoring, and reporting ($34k/year)	$100k	Continue ($34k/year)	$580k	$35k
Lake Management Administration	Finance and grant tracking. Adaptive management. Coordination with consultants and contractors. Implementation of management plan ($60K/year)	$190K	Continue ($60K/year)	$1,000k	$60k
	Totals	$740k		$4,000k	$235k

Possible Funding Sources

- City Stormwater Management Budget
- Lake Management District (LMD)
- Special Purpose District (varied independent types)
- State Legislature Budget Allocation
- State Ecology Water Quality Grants and Loans
  - Freshwater Algae Control Grants
  - Clean Water State Revolving Fund loans
  - Centennial Clean Water Program grants
  - Clean Water Act Section 319 federal grants
  - Stormwater Financial Assistance Program grants
  - Stormwater Capacity Grants Program

Flood Control District (Ch. 86.09 RCW) to protect life and property, preserve public health, and conserve and develop natural resources.

Next Steps

- Post Public Review Draft Plan in response to City review comments by early June
- Public comments due by mid-June
- Complete Final Plan in July