

# 2023 Lake Fairlee Water Quality Monitoring Results: Lay Monitoring Program and LaRosa Partnership Program

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VT Department of Environmental Conservation, UVM Lake Champlain Sea Grant





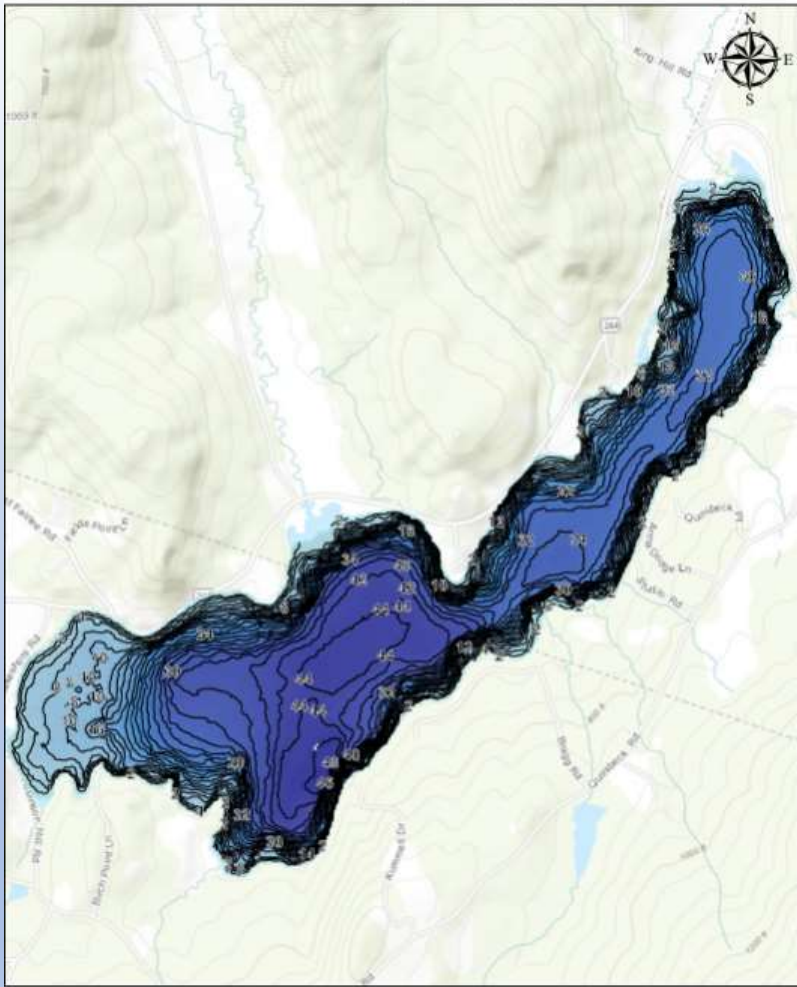
# Lay Monitoring Program (LMP) 2023 Lake Sampling Overview

- Biweekly from June through August (total of 6 samples for summer mean):
  - *Basic Sampling*: Measure Secchi disk transparency depth (clarity)
  - *Supplemental Sampling*: Collect epilimnetic and hypolimnetic water samples that are lab tested for total phosphorus (nutrient) concentration and chlorophyll-a (algae) concentration
  - Pilot caffeine sampling (wastewater)
  - Complete a lake sampling webform (and report cyanobacteria conditions)





# Lake Fairlee, Fairlee, VT



## Legend

Depth (ft.)

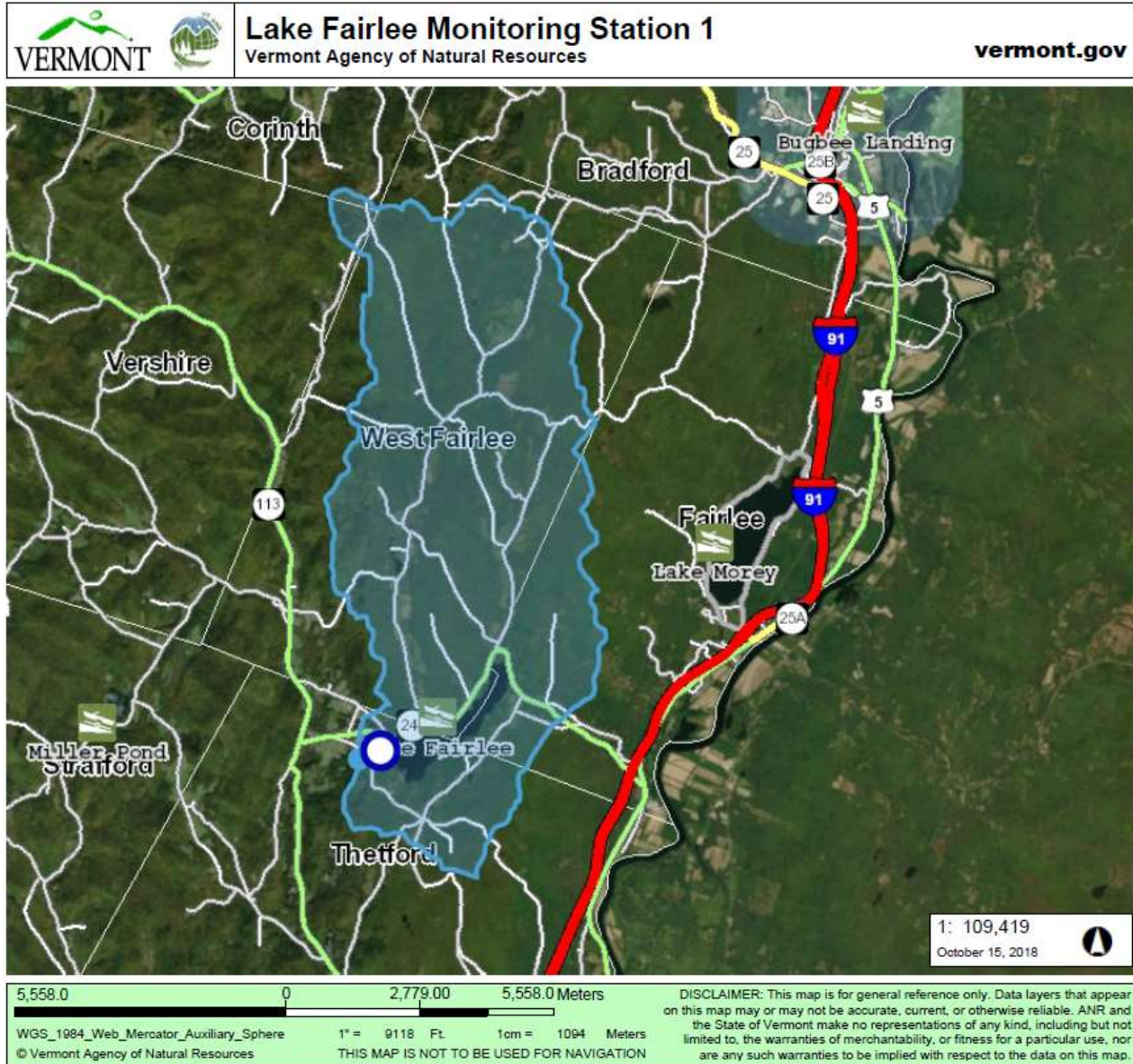
High : 0

Low : 48

Depth Contour (2 ft.)

Source Data Collected: 8/27/2018

0 0.125 0.25 0.5 Miles





# Vermont Lake Score Card

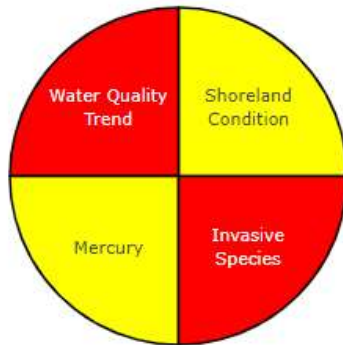
## Lake Fairlee

<https://dec.vermont.gov/watershed/lakes-ponds/data-maps/scorecard>

Scores

Water Quality Data

Lake Information



Watershed: **Moderately Disturbed**

WQ Standards: **Stressed**

### Details

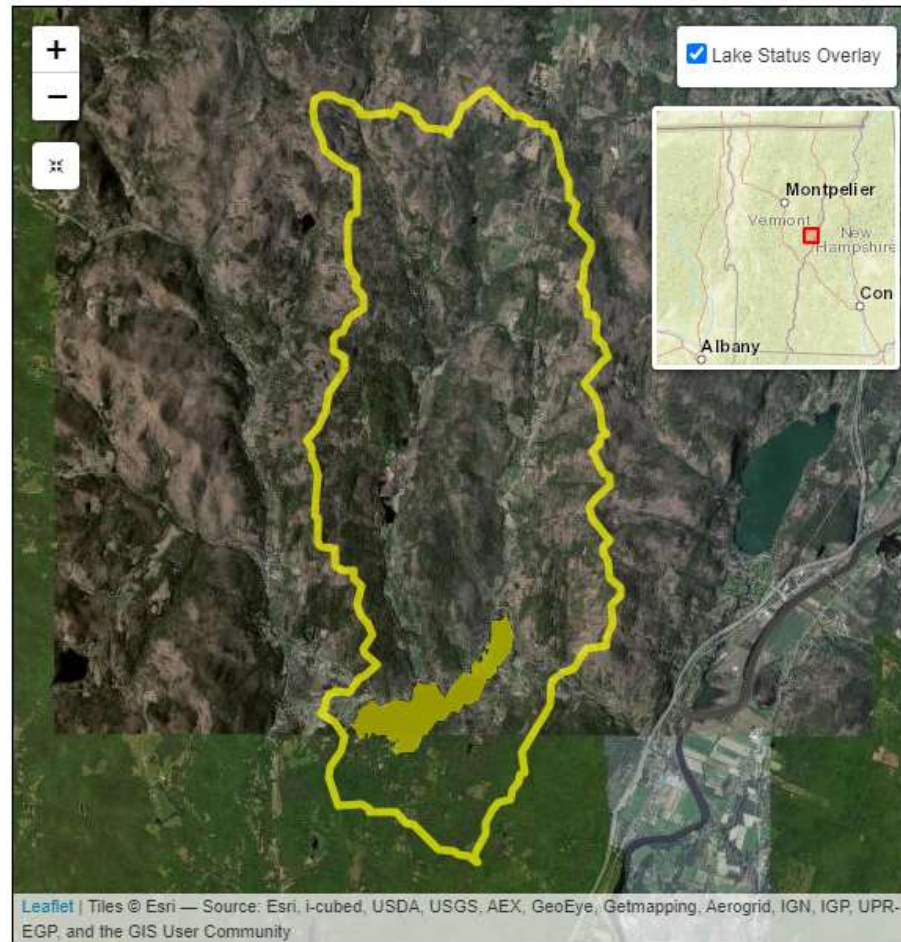
Stressed – Nutrients

Stressed – Phosphorus

### Color Scoring System

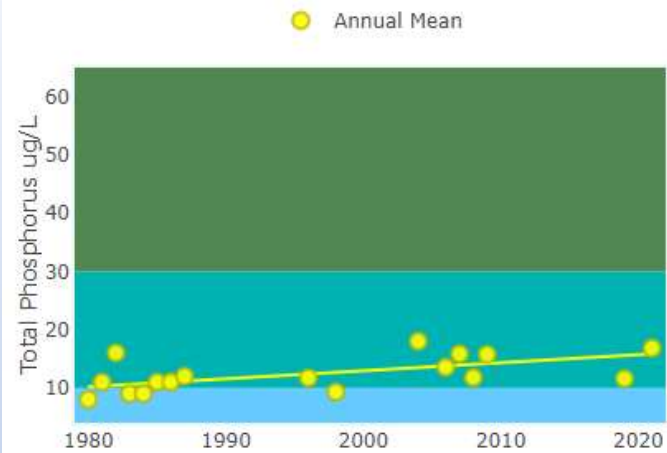
- Good Conditions (Blue)
- Fair Conditions (Yellow)
- Poor Conditions (Red)
- Insufficient Data (White)

[Learn How Lakes Are Scored](#)



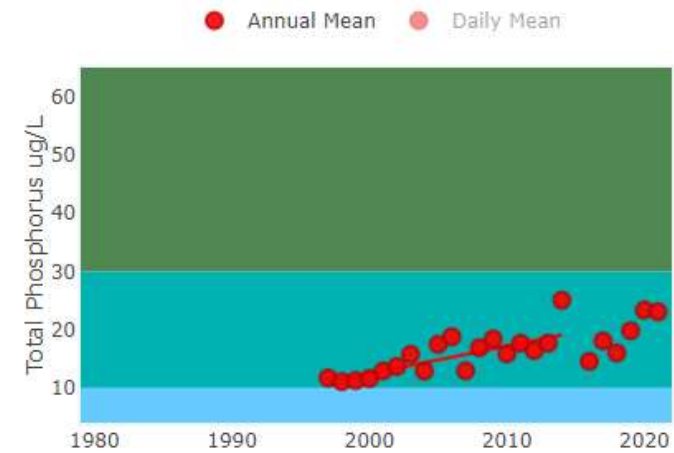
### Spring Phosphorus

Trend: Significantly Increasing (p-value=0.0131)



### Summer Phosphorus

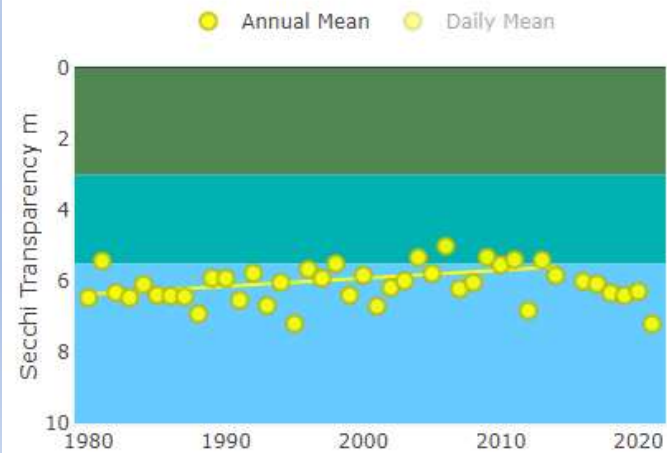
Trend: Highly Significantly Increasing (p-value=1e-04)



## LAKE FAIRLEE SCORE CARD WATER QUALITY TRENDS

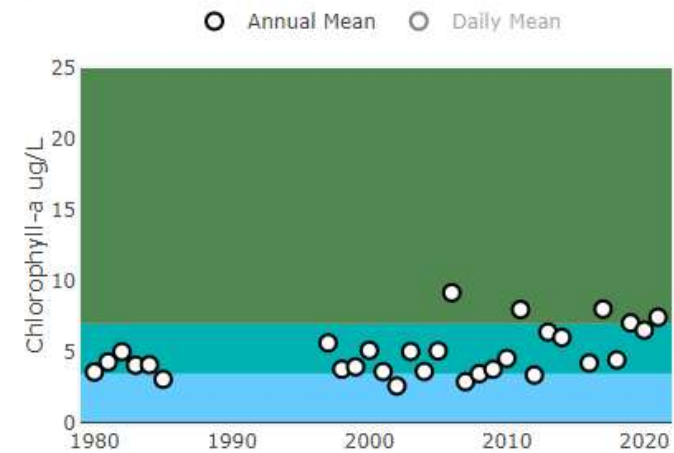
### Summer Secchi

Trend: Significantly Decreasing (p-value=0.0198)



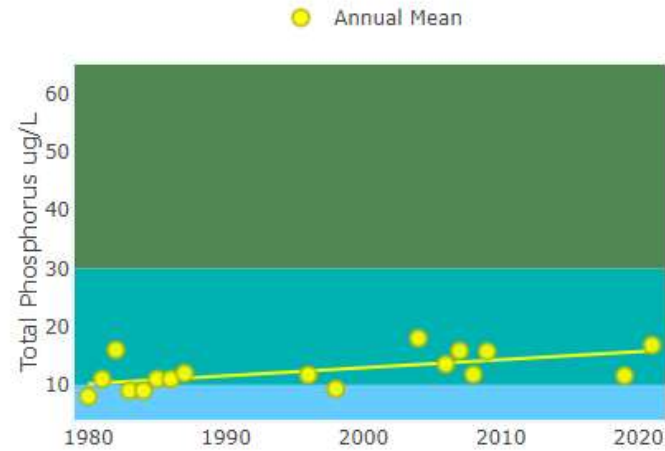
### Summer Chlorophyll-a

Trend: Stable (p-value=0.4273)



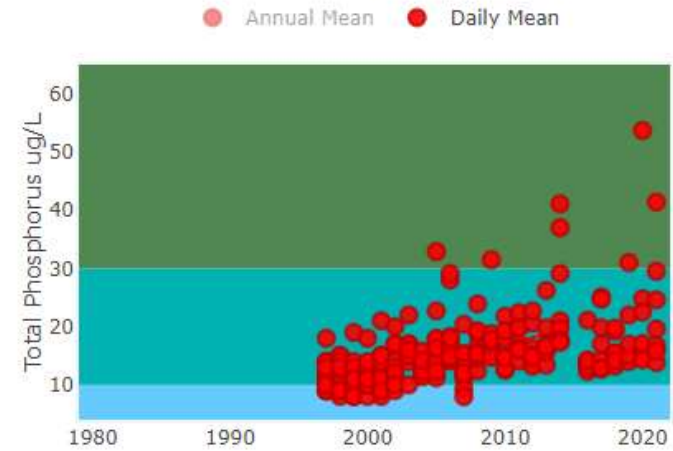
### Spring Phosphorus

Trend: Significantly Increasing (p-value=0.0131)



### Summer Phosphorus

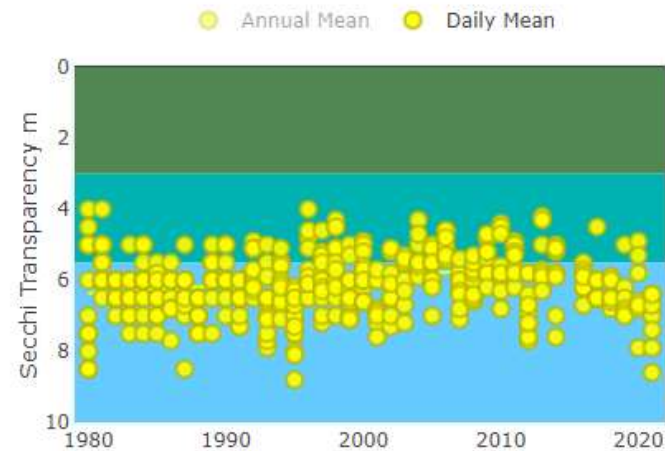
Trend: Highly Significantly Increasing (p-value=1e-04)



## LAKE FAIRLEE SCORE CARD WATER QUALITY TRENDS

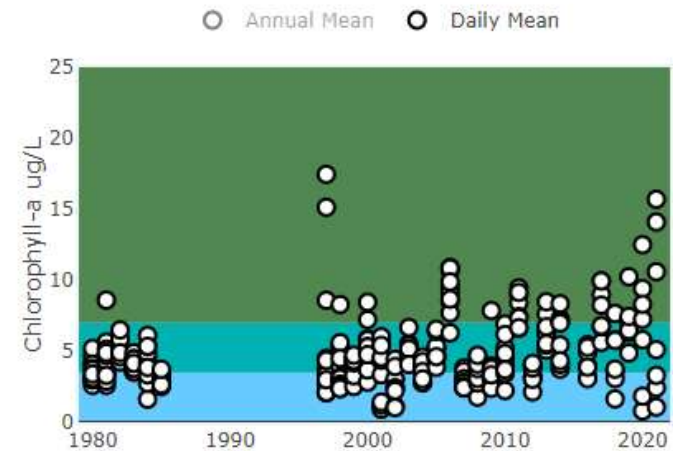
### Summer Secchi

Trend: Significantly Decreasing (p-value=0.0198)

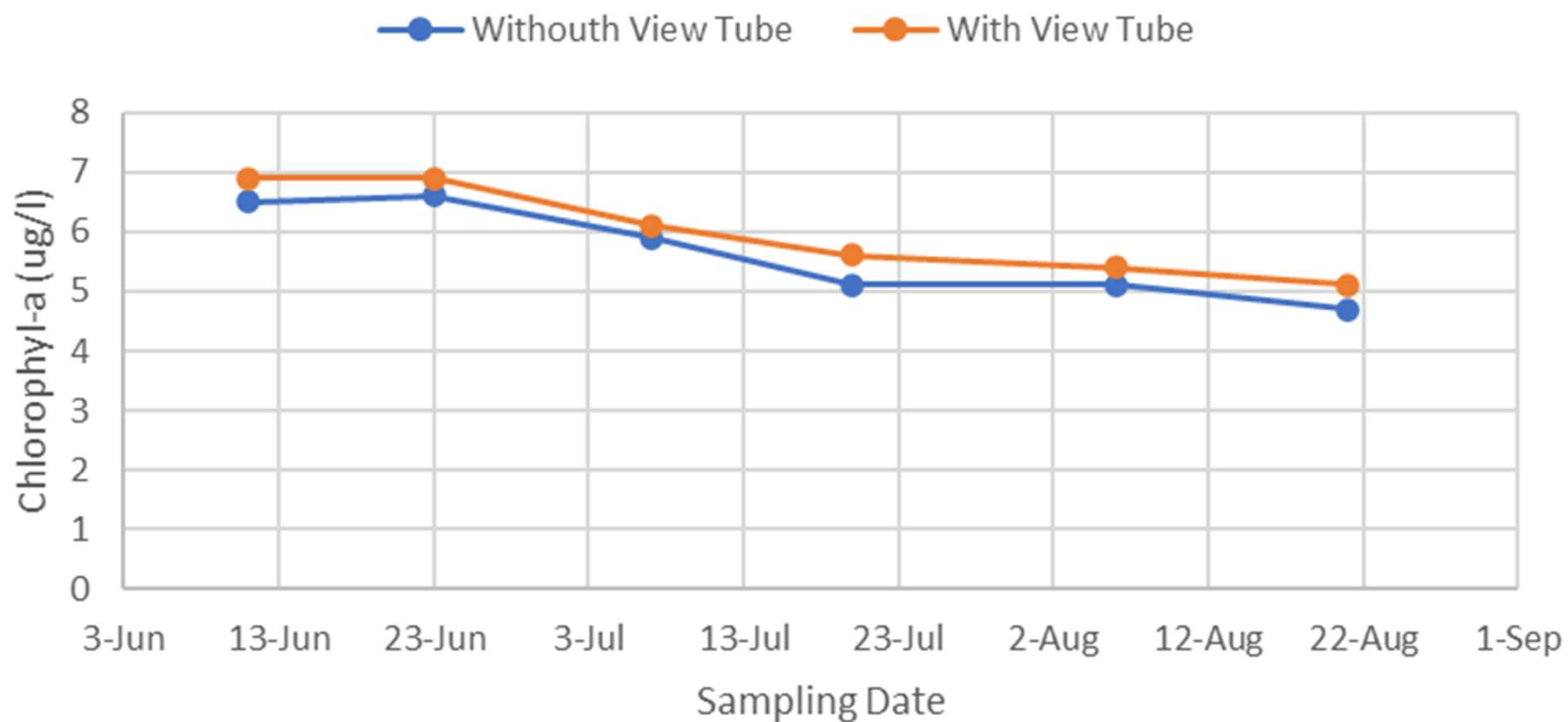


### Summer Chlorophyll-a

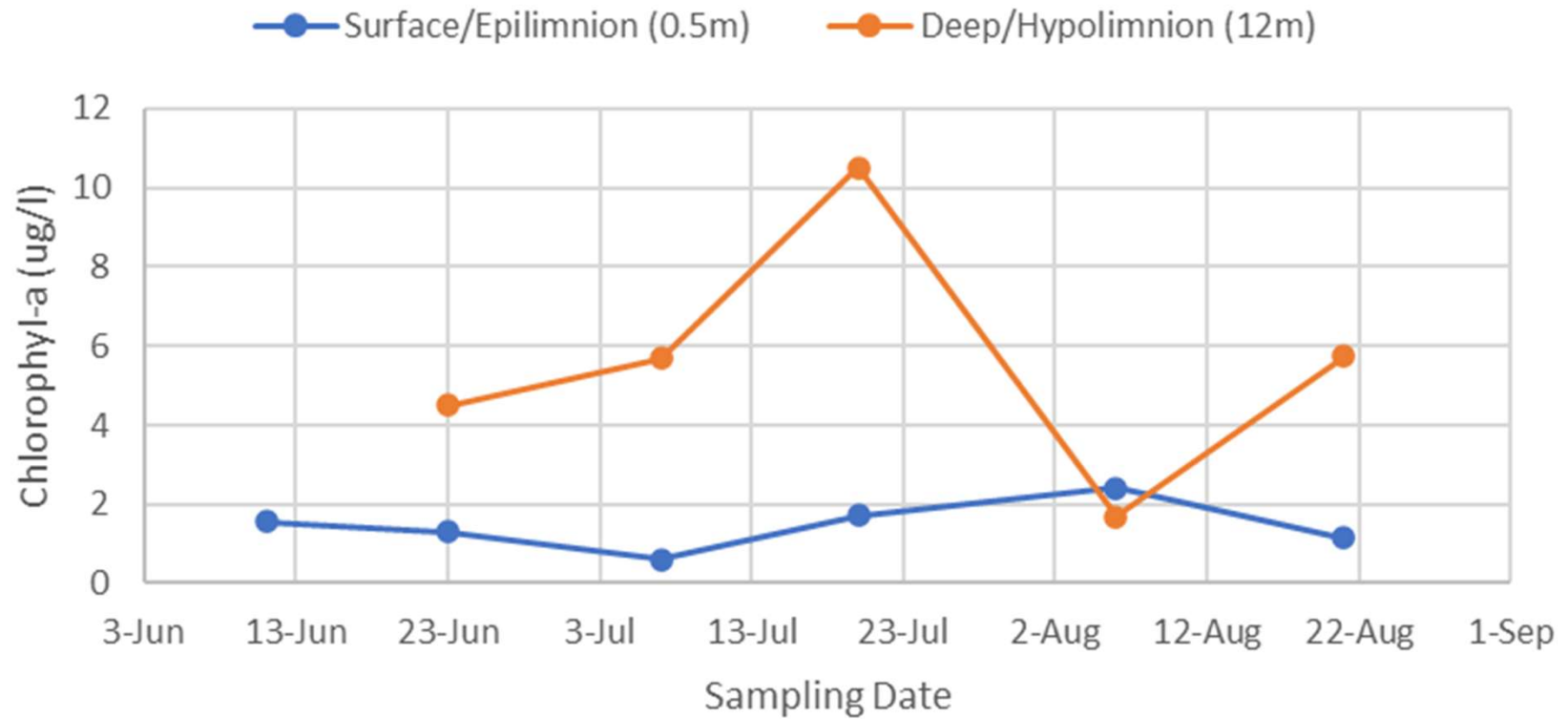
Trend: Stable (p-value=0.4273)



## 2023 Lake Fairlee Lay Monitoring Secchi Transparency

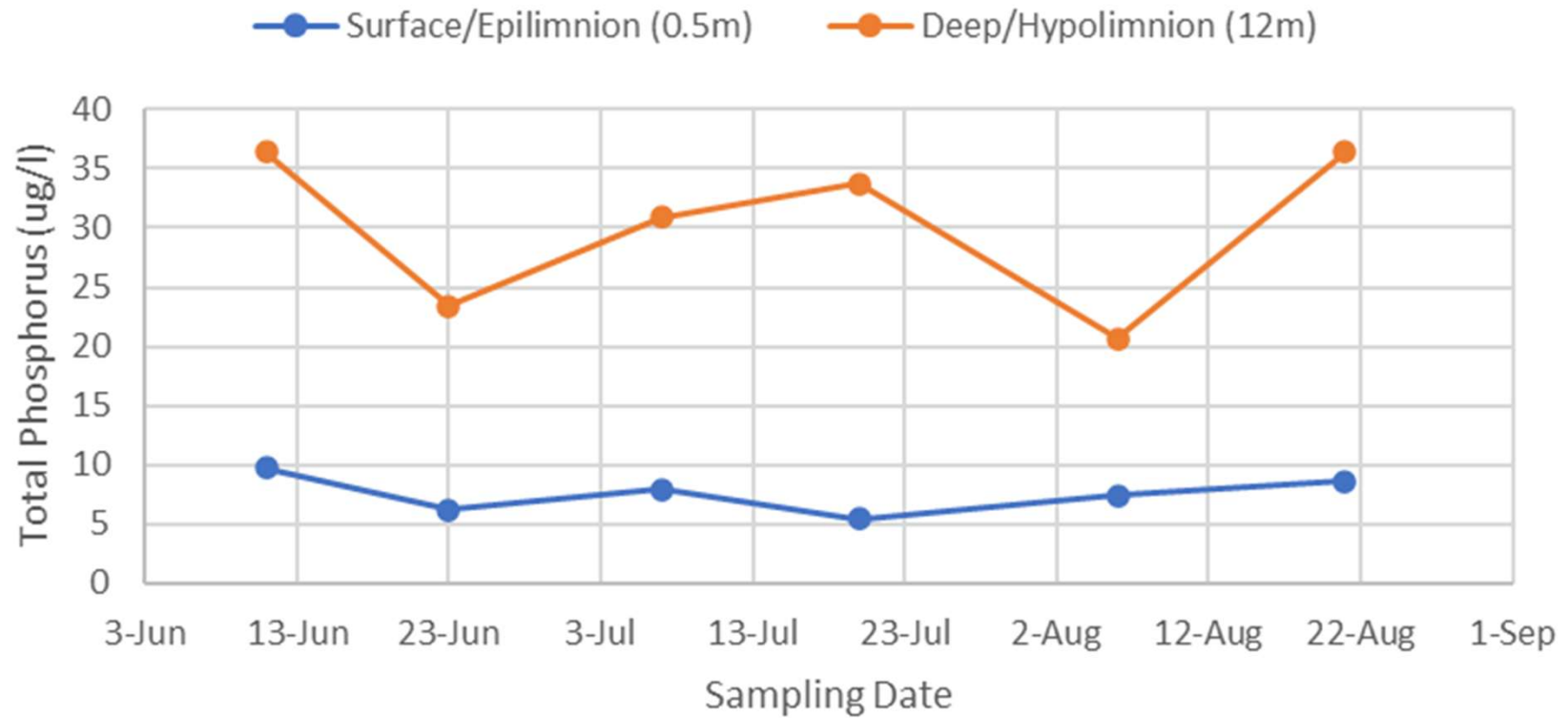


## 2023 Lake Fairlee Lay Monitoring Chlorophyll-a

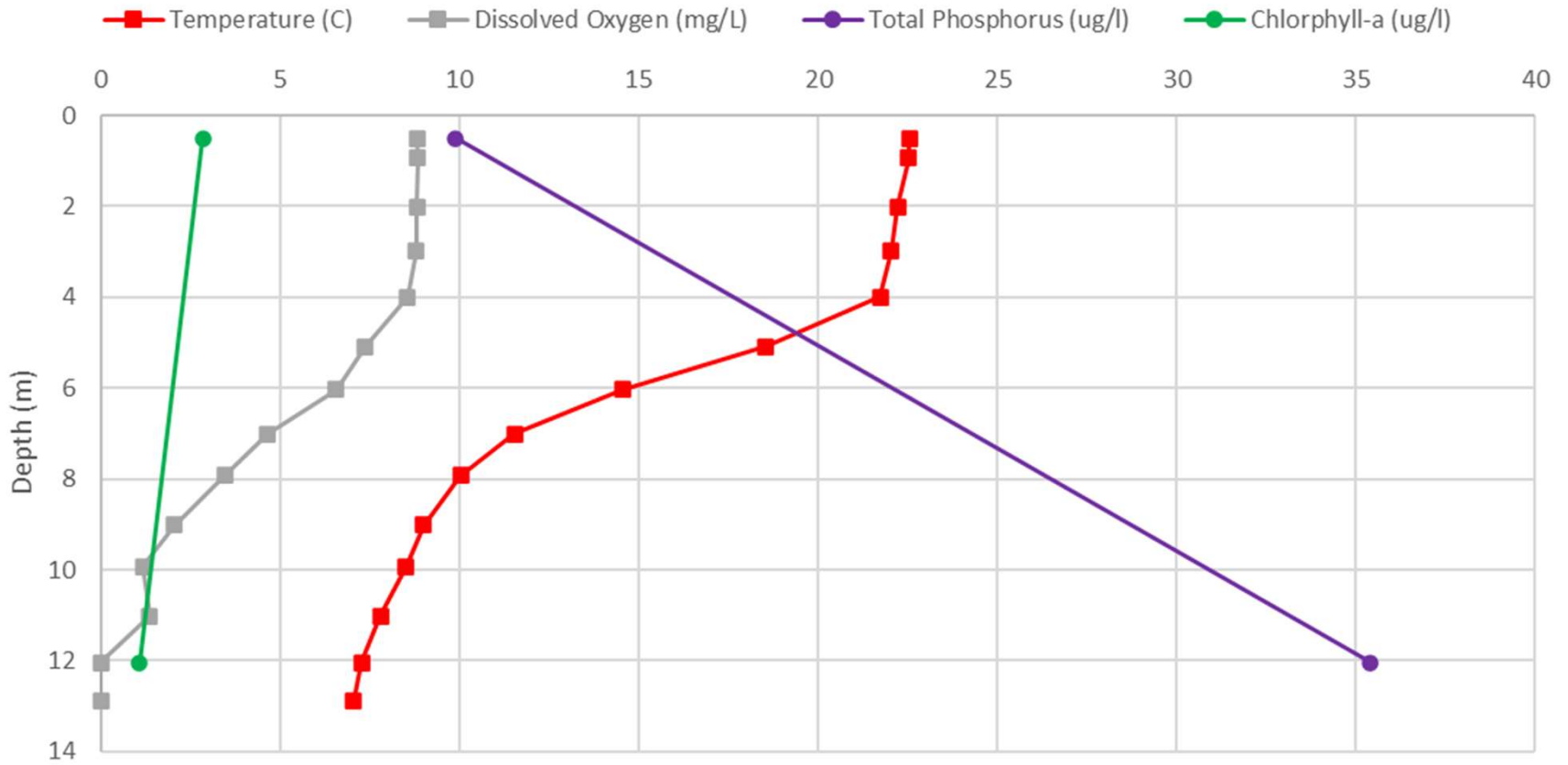




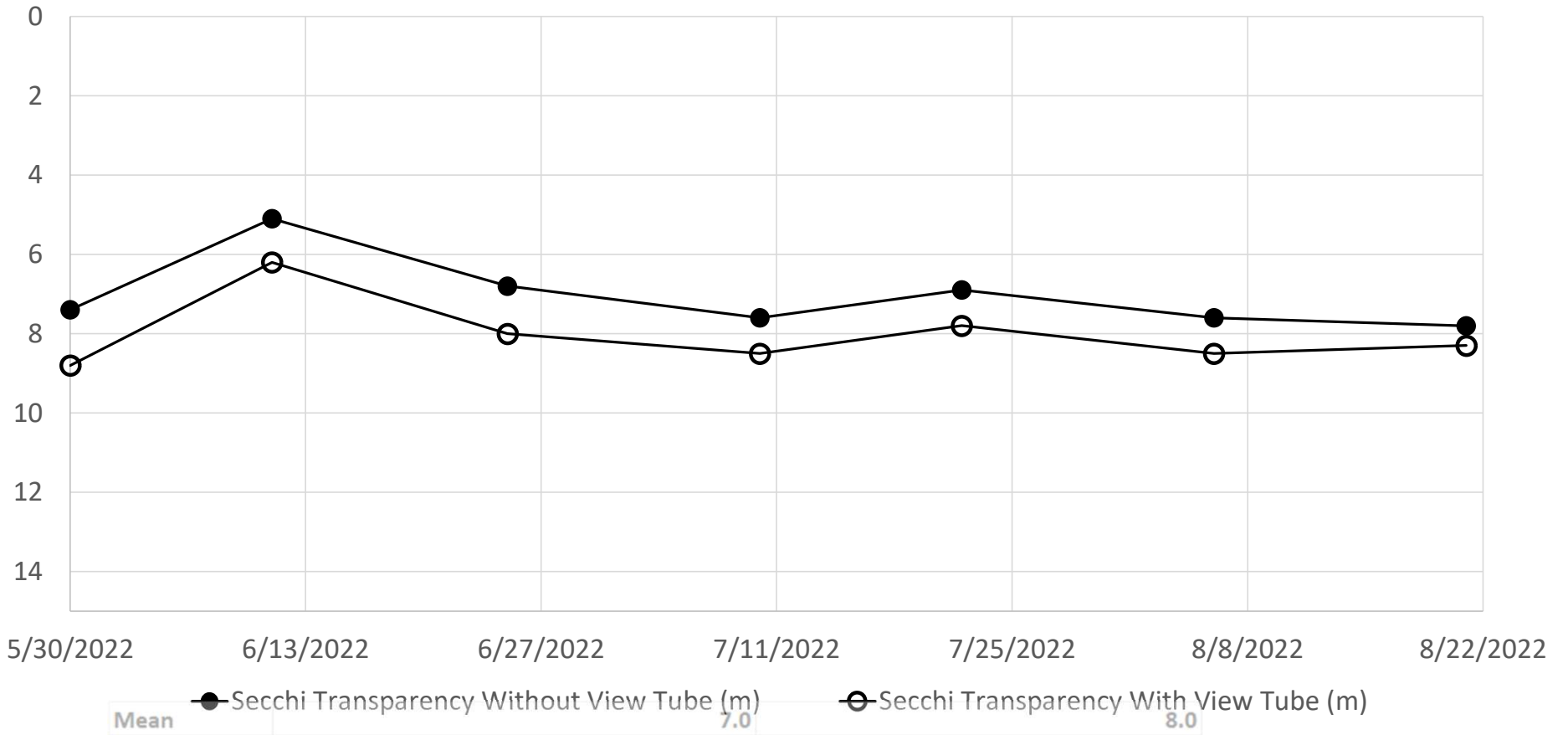
## 2023 Lake Fairlee Lay Monitoring Total Phosphorus



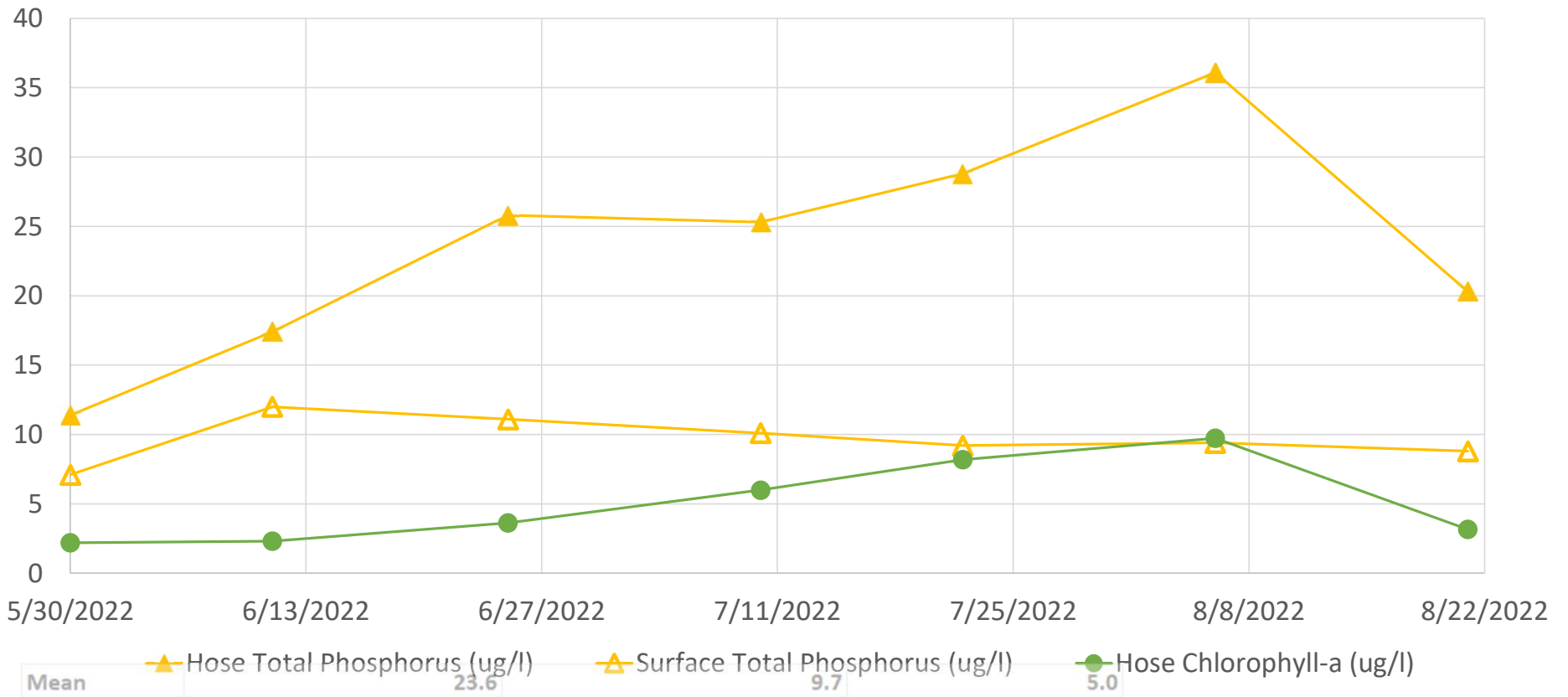
### Lake Fairlee Water Quality Vertical Profile 8/21/2023



### 2022 Lake Fairlee Lay Monitoring Secchi Transparency Results



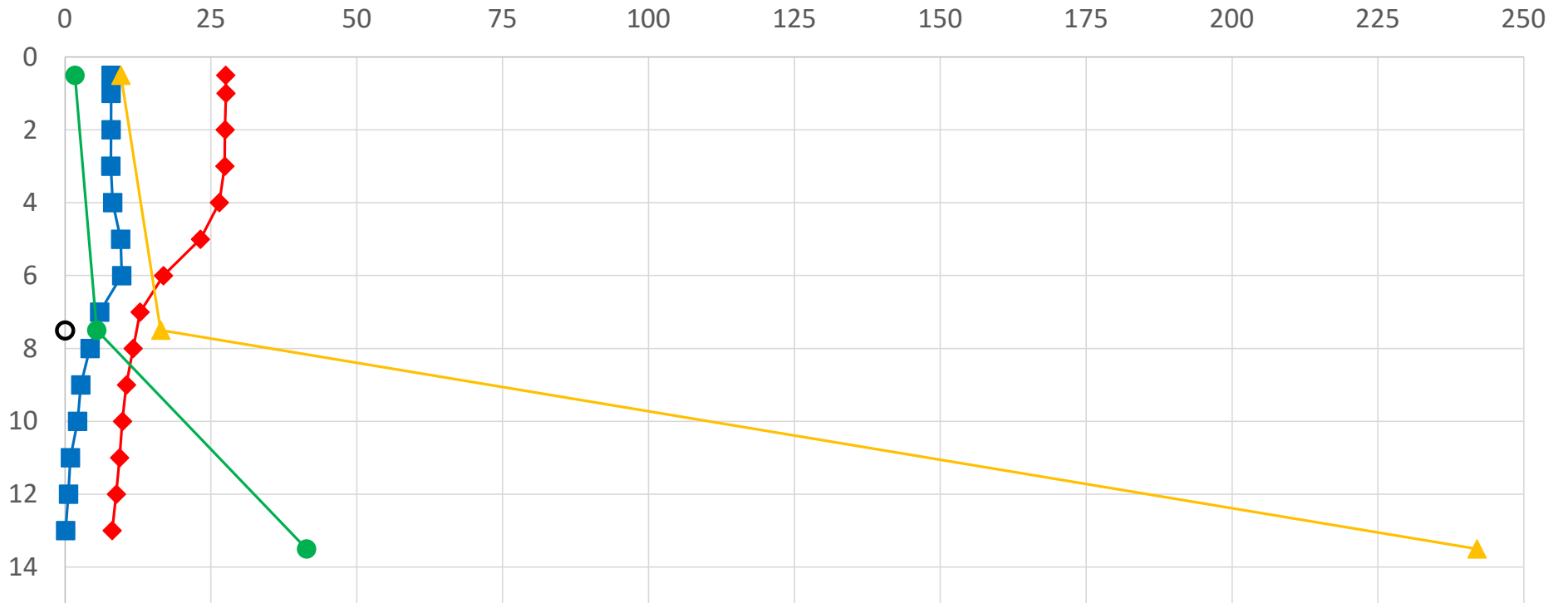
### 2022 Lake Fairlee Lay Monitoring Total Phosphorus and Chlorophyll-a Results (Note: Integrated Hose Sample Depth ~ 13.5 m; Surface Grab Sample Depth ~ 0.5 m)





### 8/8/2022 Lake Fairlee Water Quality Vertical Profile

- ◆ Temperature (C)
- Dissolved Oxygen (mg/l)
- Secchi Depth (m)
- Chlorophyll-a (ug/l)
- ▲ Total Phosphorus (ug/l)





# LaRosa Partnership Program (LPP) Tributary Sampling Overview

- Since 2021, sampled biweekly from April/May to July/August
- Blood Brook Sites (total phosphorus 2021-2022)
  - King Hill: inlet to lake
  - Marsh Hill (2022): bracketing of agriculture
  - Godfrey: bracketing of agriculture
  - Brushwood: baseline near headwaters (also chloride)
- Middle Brook Sites (total phosphorus 2021-2022)
  - Route 244: inlet to lake (also chloride)
  - Lower Middle Brook Pond (2022): bracketing of agriculture
  - Upper Middle Brook Pond (2022): bracketing of agriculture
  - Scrutton Hill: baseline near headwaters (also chloride)

<https://dec.vermont.gov/watershed/map/monitor/larosa>

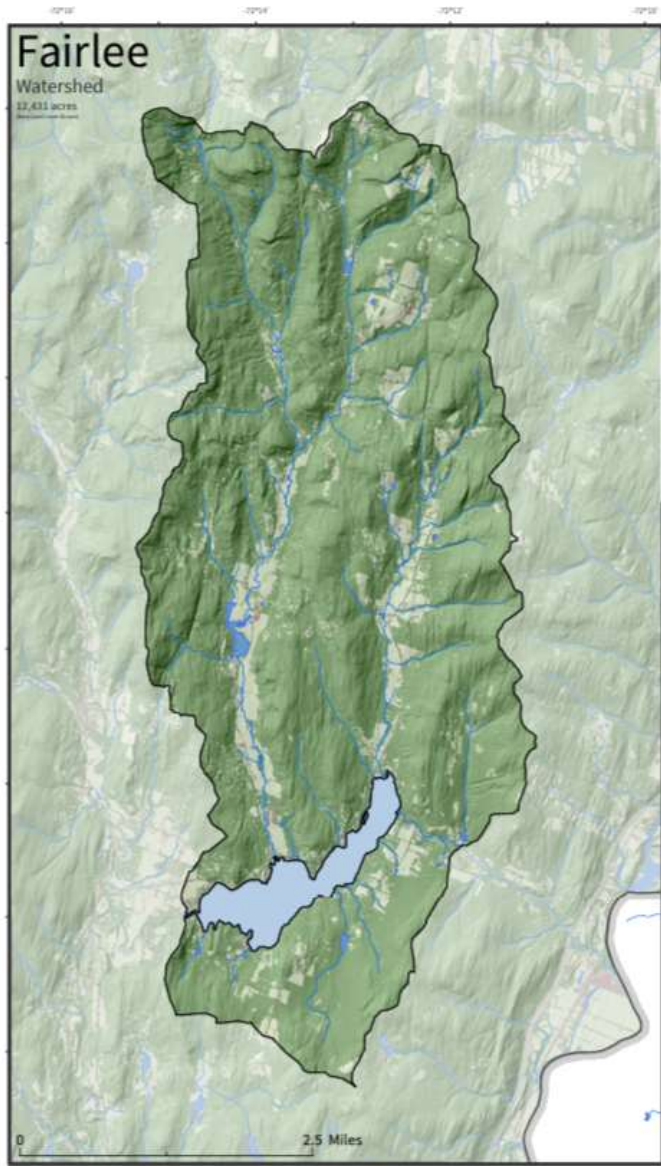
# LPP Sample Parameters Overview: Total Phosphorus & Chloride

## Total Phosphorus

- Sources
  - Developed land runoff, roads, driveways
  - Fertilizers – lawns and agriculture
- Impacts
  - Feeds plants, algae and cyanobacteria
  - Aesthetics, Recreation, Aquatic Life Uses
- Vermont Water Quality Standards Nutrient Criteria for Aquatic Life Use
  - Not to be exceeded at low median monthly flow (baseflow) during June through October
  - 12 ug/L for small high gradient streams (SHG)
  - 15 ug/L for medium high gradient streams (MHG)
  - 27 ug/L for warm-water medium gradient streams and rivers (WWMG)

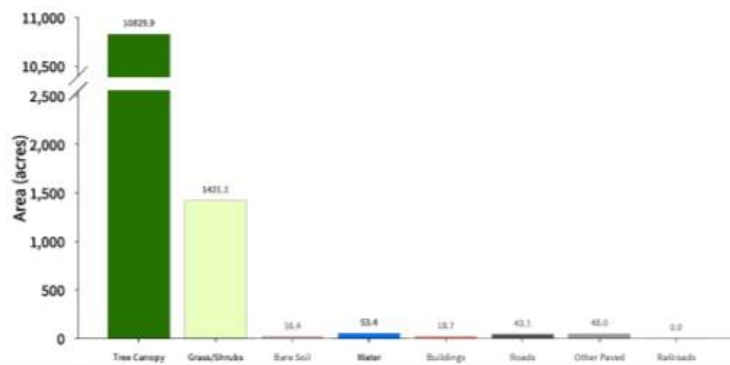
## Total Chloride

- Sources
  - Road salt
  - Wastewater, water softeners
- Impacts
  - Affects chemical processes of biological organisms
  - Aquatic Life Use
- Vermont Water Quality Standards Chloride Criteria for Aquatic Life Use
  - 860 mg/L maximum (acute)
  - 230 mg/L average (chronic)
  - Studies show chloride can impact organisms at lower concentrations



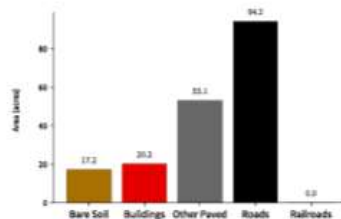
## High-Resolution Land Cover Summary

### Base Land Cover (Top-Down\*)

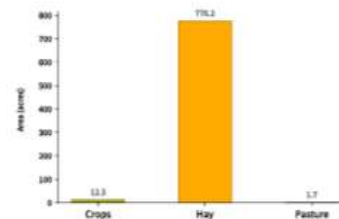


### Supplemental Land Cover

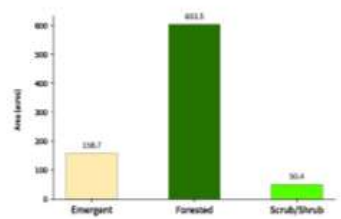
#### Impervious Surfaces (184.64 acres - 1.5% of total) (Bottom-Up\*\*)



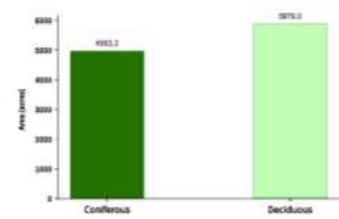
#### Agriculture (790.23 acres - 6.4% of total)



#### Wetlands (822.01 acres - 6.5% of total)

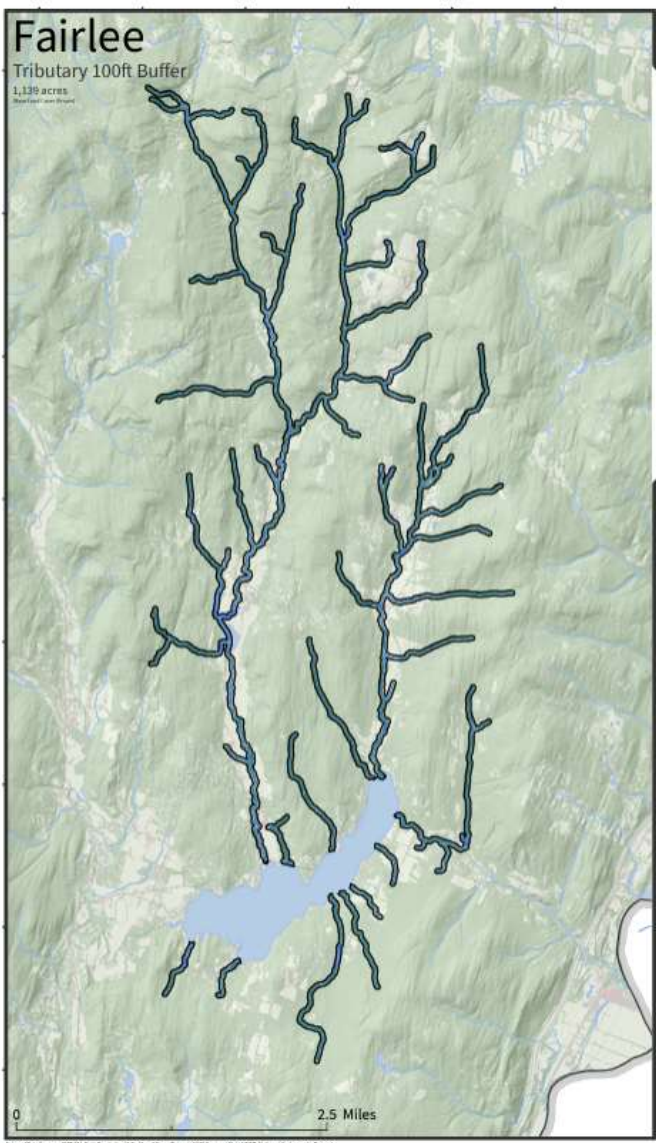


#### Tree Canopy (10,828.16 acres - 87.2% of total)

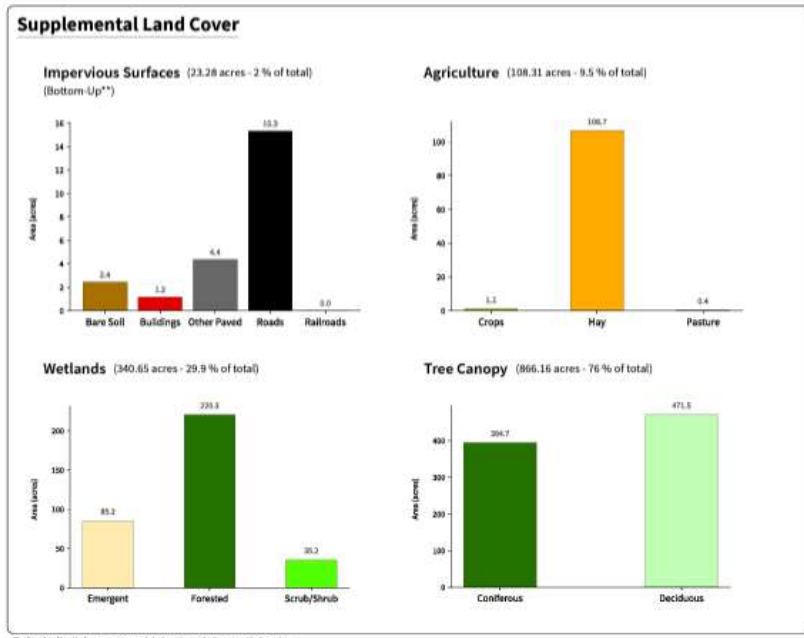
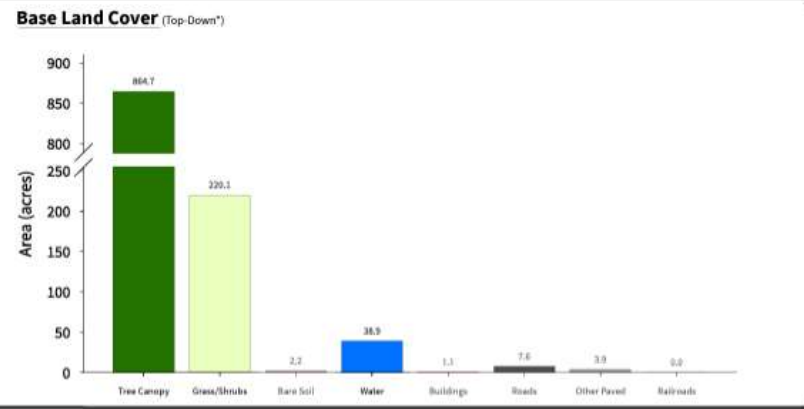


\*Top-Down: Total land cover area by category. Total area is reported for regional land cover.  
 \*\*Bottom-Up: Total land cover area by category. Total area is reported for regional land cover.  
 \*Note: The total area of the Fairlee Watershed is 17,433 acres. The total area of the supplemental land cover is 1,816.87 acres (10.4% of total). The total area of the base land cover is 15,616.13 acres (89.6% of total). The total area of the tree canopy is 10,828.16 acres (62.1% of total). The total area of the agriculture is 790.23 acres (4.5% of total). The total area of the wetlands is 822.01 acres (4.7% of total). The total area of the impervious surfaces is 184.64 acres (1.1% of total). The total area of the bare soil is 16.4 acres (0.1% of total). The total area of the water is 53.4 acres (0.3% of total). The total area of the buildings is 13.7 acres (0.1% of total). The total area of the roads is 43.1 acres (0.2% of total). The total area of the other paved is 45.0 acres (0.3% of total). The total area of the railroads is 0.0 acres (0.0% of total).



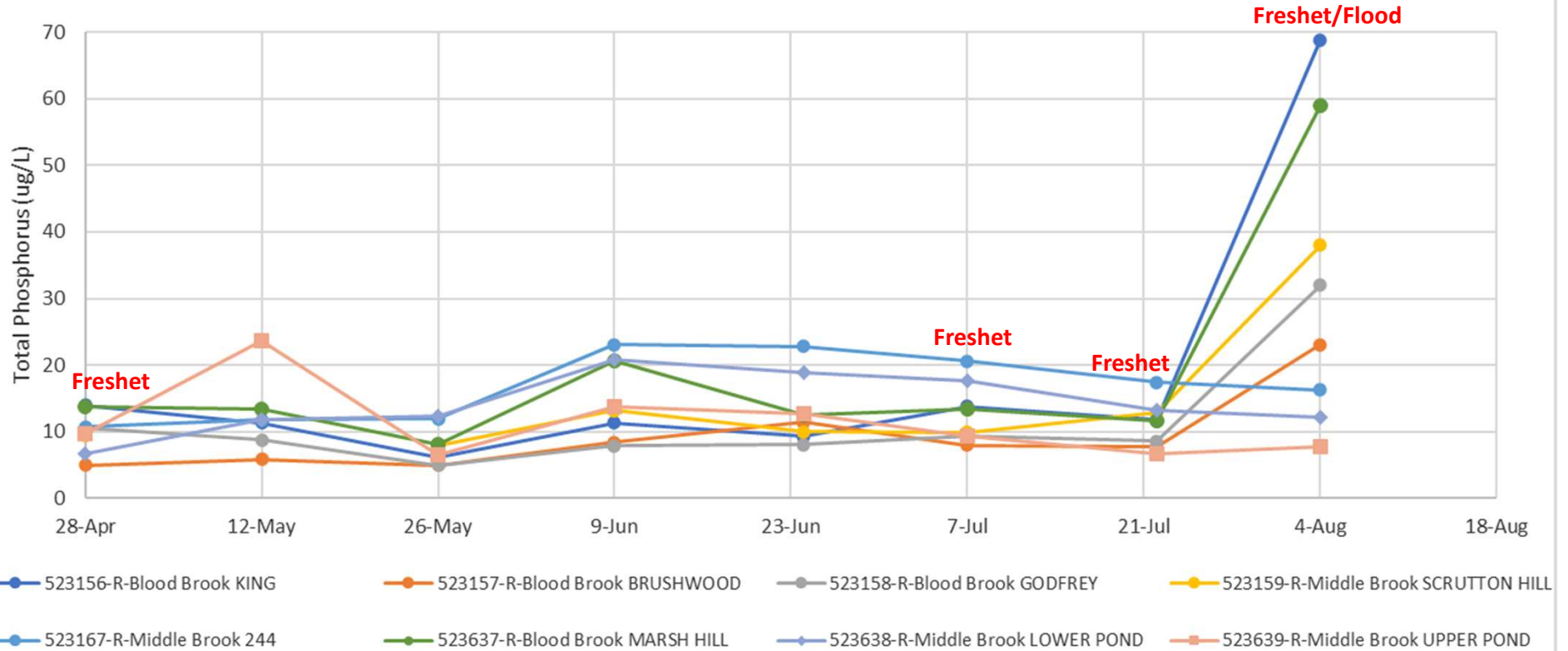


### High-Resolution Land Cover Summary

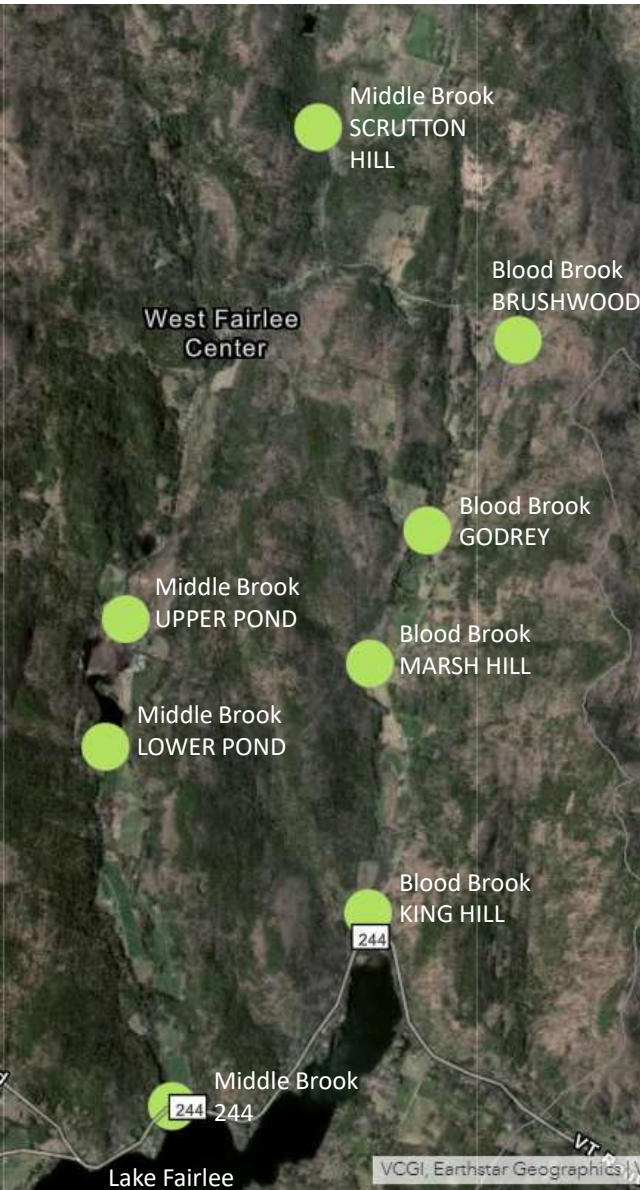


\*Top-Down: A satellite or aerial imagery approach. Land cover is mapped to the regional land cover data.  
 \*\*Bottom-Up: Aerial imagery approach. Land cover is mapped to local governmental data layers. This approach results in improved mapping of boundaries and details not captured by other methods.  
 See USFWS High Resolution LandCover 2012 Project for more detail.

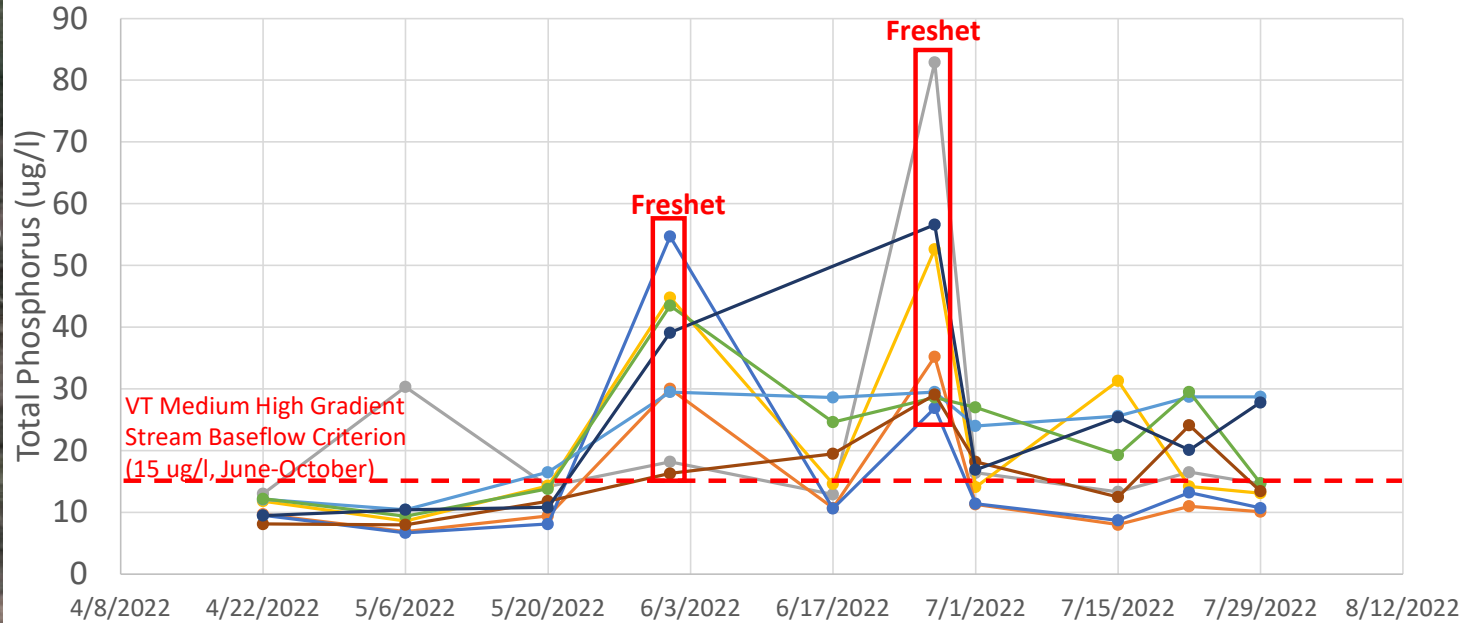
## 2023 Lake Fairlee Tributary Total Phosphorus Monitoring



Site	LocID	# Samplin	Mean CI	Max CI	Min CI	Mean TP	Max TP	Min TP
523157-R-Blood Brook BRUSHWOOD	523157	8				9.31	23.10	5.00
523158-R-Blood Brook GODFREY	523158	8				11.30	32.00	5.00
523156-R-Blood Brook KING	523156	8				18.30	68.80	6.10
523637-R-Blood Brook MARSH HILL	523637	8				19.08	58.90	8.20
523167-R-Middle Brook 244	523167	8	10.11	14.50	6.60	16.84	23.10	10.70
523638-R-Middle Brook LOWER POND	523638	8				14.24	20.90	6.70
523159-R-Middle Brook SCRUTTON HILL	523159	8	2.48	5.80	2.00	14.49	38.00	8.00
523639-R-Middle Brook UPPER POND	523639	8				11.26	23.60	6.50



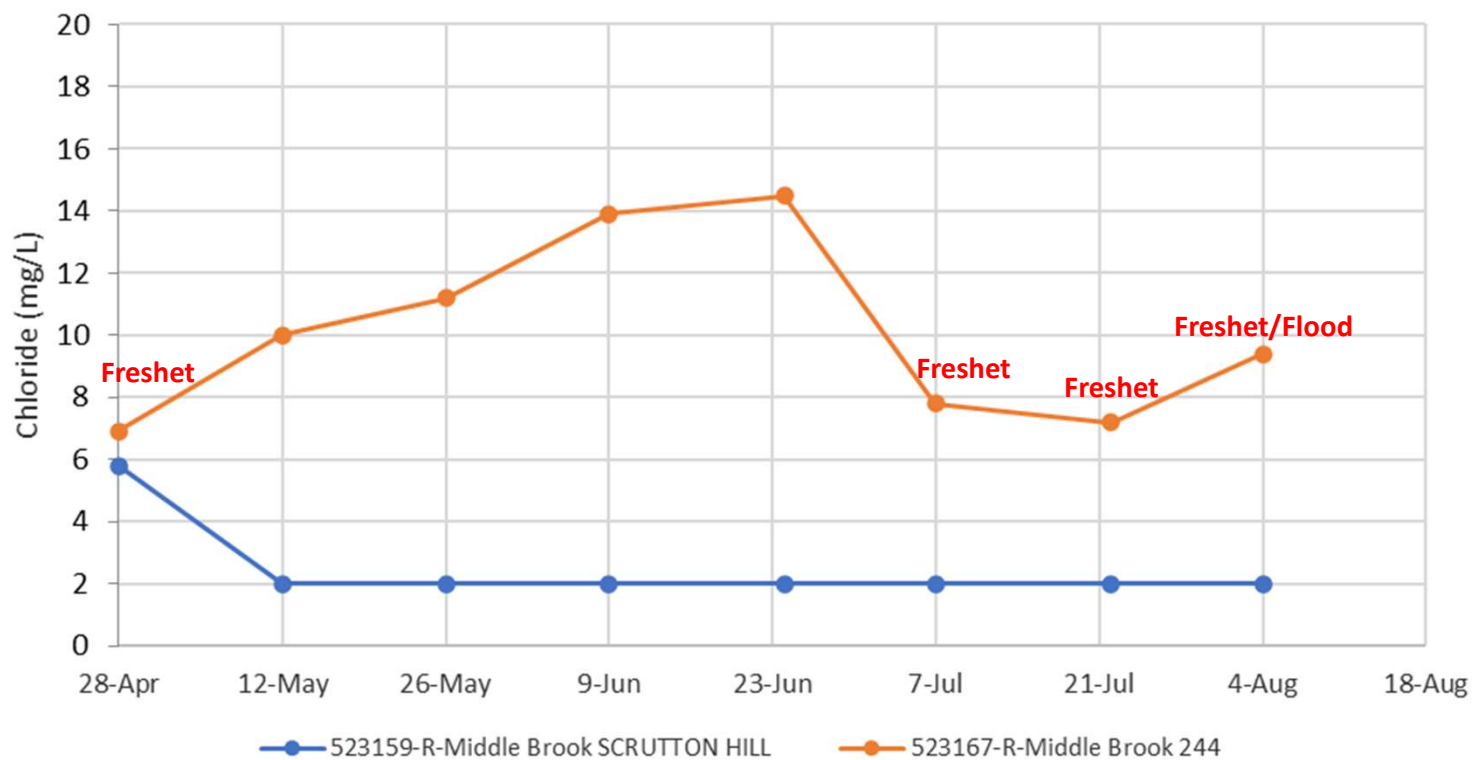
2022 Lake Fairlee LaRosa Tributary Monitoring Total Phosphorus Results



- Blood Brook KING
- Blood Brook MARSH HILL
- Blood Brook GODFREY
- Blood Brook BRUSHWOOD
- Middle Brook 244
- Middle Brook LOWER POND
- Middle Brook UPPER POND
- Middle Brook SCRUTTON HILL

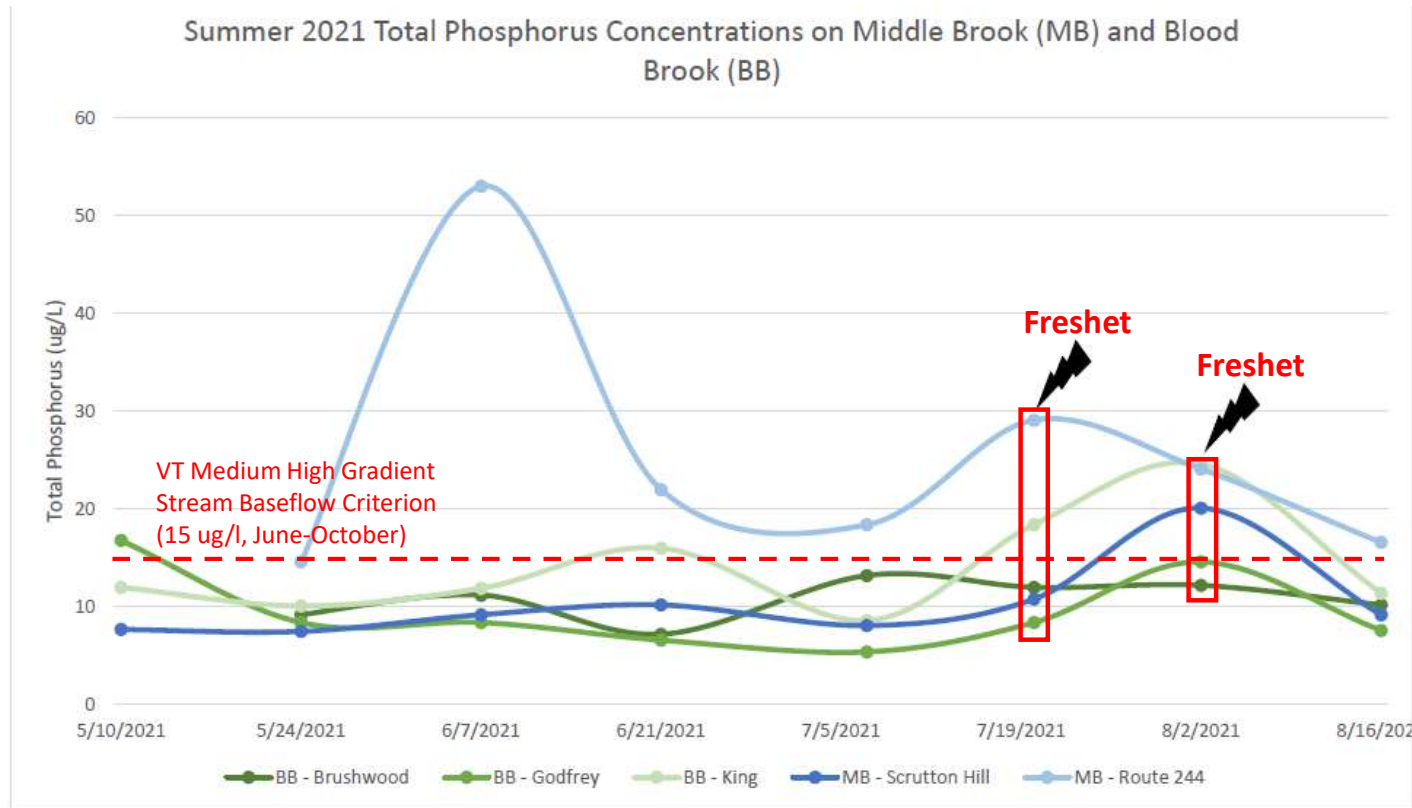
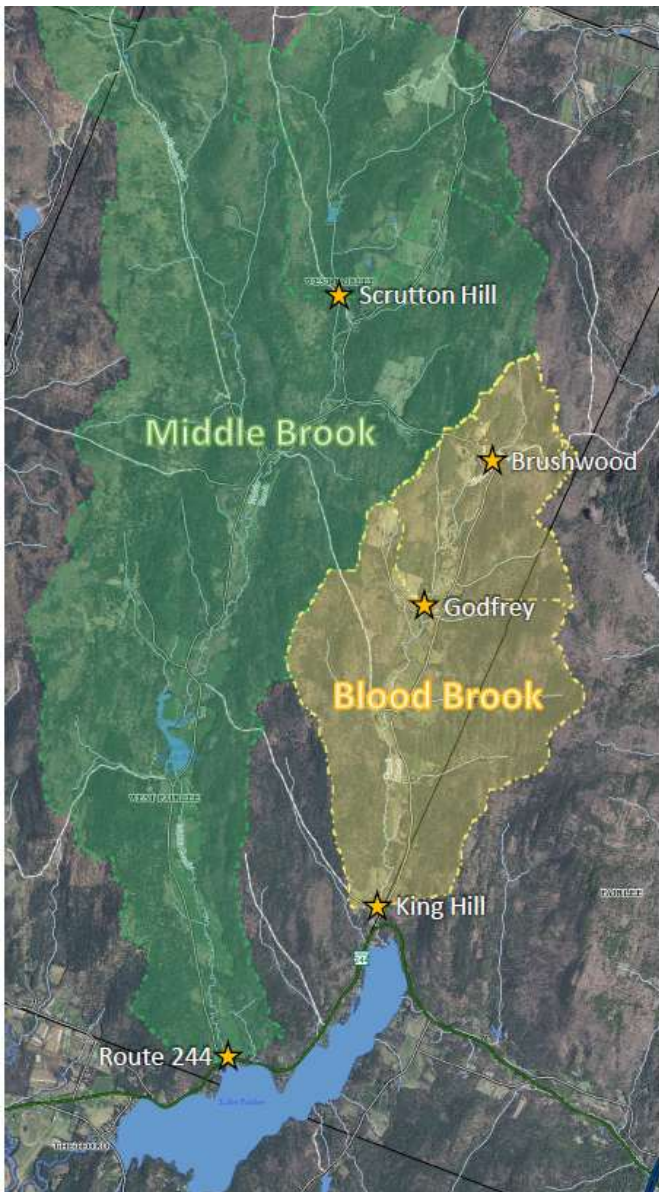
Tributary Site	Minimum TP (ug/l)		Average Baseflow TP (ug/l)		Maximum TP (ug/l)	
	2022	2021	2022	2021	2022	2021
Blood Brook KING HILL	12.9	7.4	16.4	11.1	82.9	24.6
Blood Brook MARSH HILL	8.6	NA	15.3	NA	52.6	NA
Blood Brook GODFREY	6.9	5.4	9.6	8.9	35.2	16.8
Blood Brook BRUSHWOOD	6.7	7.2	9.9	10.2	54.7	13.2
Middle Brook 244	10.4	10.8	21.8	22.6	29.5	53
Middle Brook LOWER POND	9.4	NA	18.8	NA	43.5	NA
Middle Brook UPPER POND	8.0	NA	14.5	NA	29.1	NA
Middle Brook SCRUTTON HILL	9.5	7.5	17.3	8.7	56.6	20.1

## 2023 Lake Fairlee Tributary Chloride Monitoring



Site	LocID	# Samplin	Mean Cl	Max Cl	Min Cl	Mean TP	Max TP	Min TP
523157-R-Blood Brook BRUSHWOOD	523157	8				9.31	23.10	5.00
523158-R-Blood Brook GODFREY	523158	8				11.30	32.00	5.00
523156-R-Blood Brook KING	523156	8				18.30	68.80	6.10
523637-R-Blood Brook MARSH HILL	523637	8				19.08	58.90	8.20
523167-R-Middle Brook 244	523167	8	10.11	14.50	6.60	16.84	23.10	10.70
523638-R-Middle Brook LOWER POND	523638	8				14.24	20.90	6.70
523159-R-Middle Brook SCRUTTON HILL	523159	8	2.48	5.80	2.00	14.49	38.00	8.00
523639-R-Middle Brook UPPER POND	523639	8				11.26	23.60	6.50



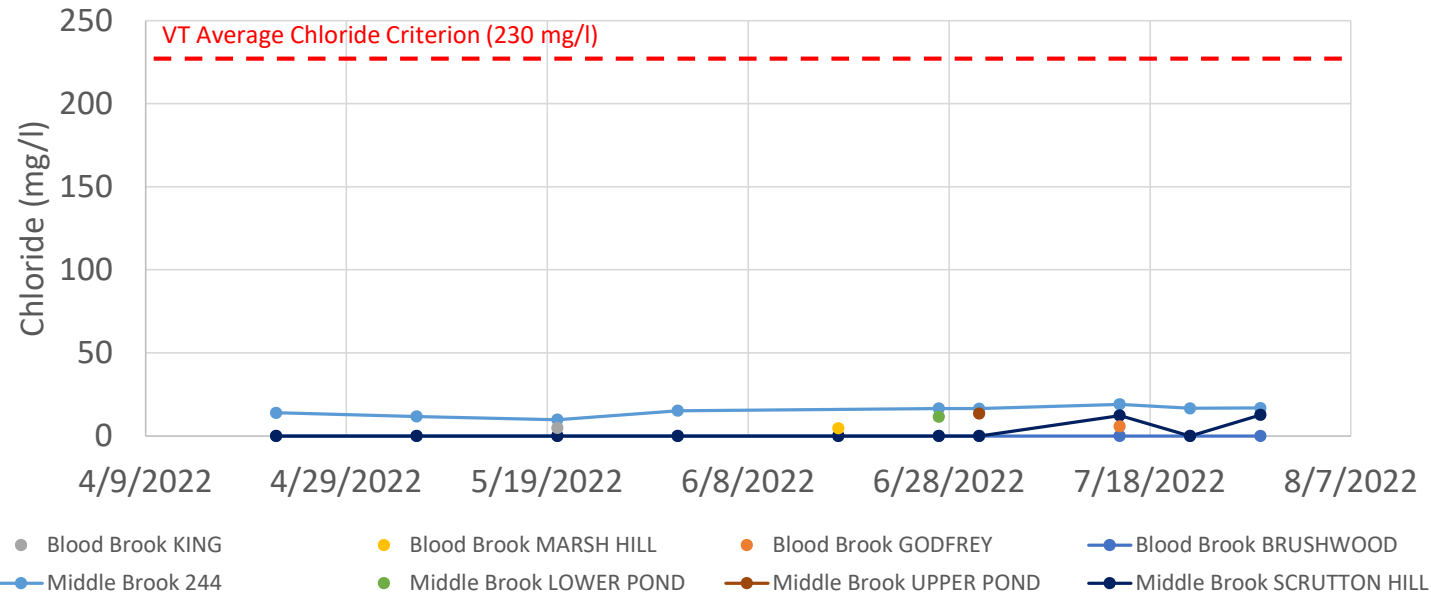


Location	Range	Median	Average	Geomean
Blood Brook - Brushwood	7.2 - 13.2	11.2	10.7	10.6
Blood Brook - Godfrey	5.4 - 16.8	8.4	9.3	8.7
Blood Brook - King	8.6 - 24.6	12.0	14.0	13.3
Middle Brook - Scrutton Hill - Upstream	7.5 - 20.1	9.2	10.4	9.9
Middle Brook - 244 - Downstream	14.6 - 53	20.2	24.5	22.5

Pattern of TP increase upstream to downstream, except from Brushwood to Godfrey

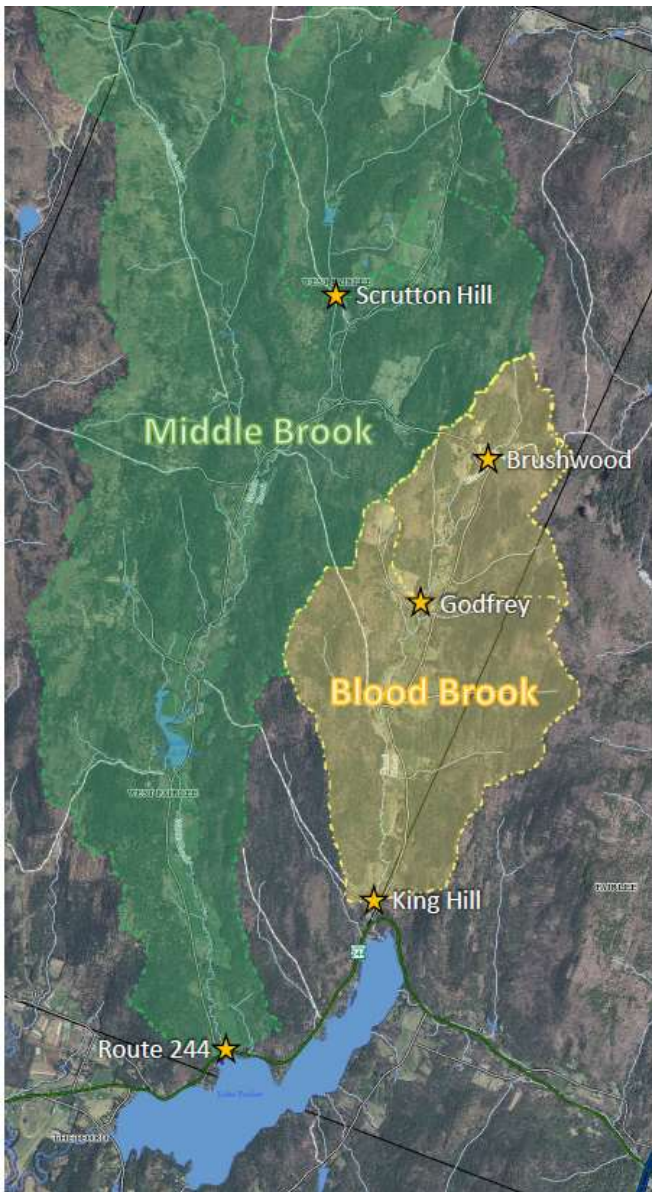


### 2022 Lake Fairlee LaRosa Tributary Monitoring Chloride Results

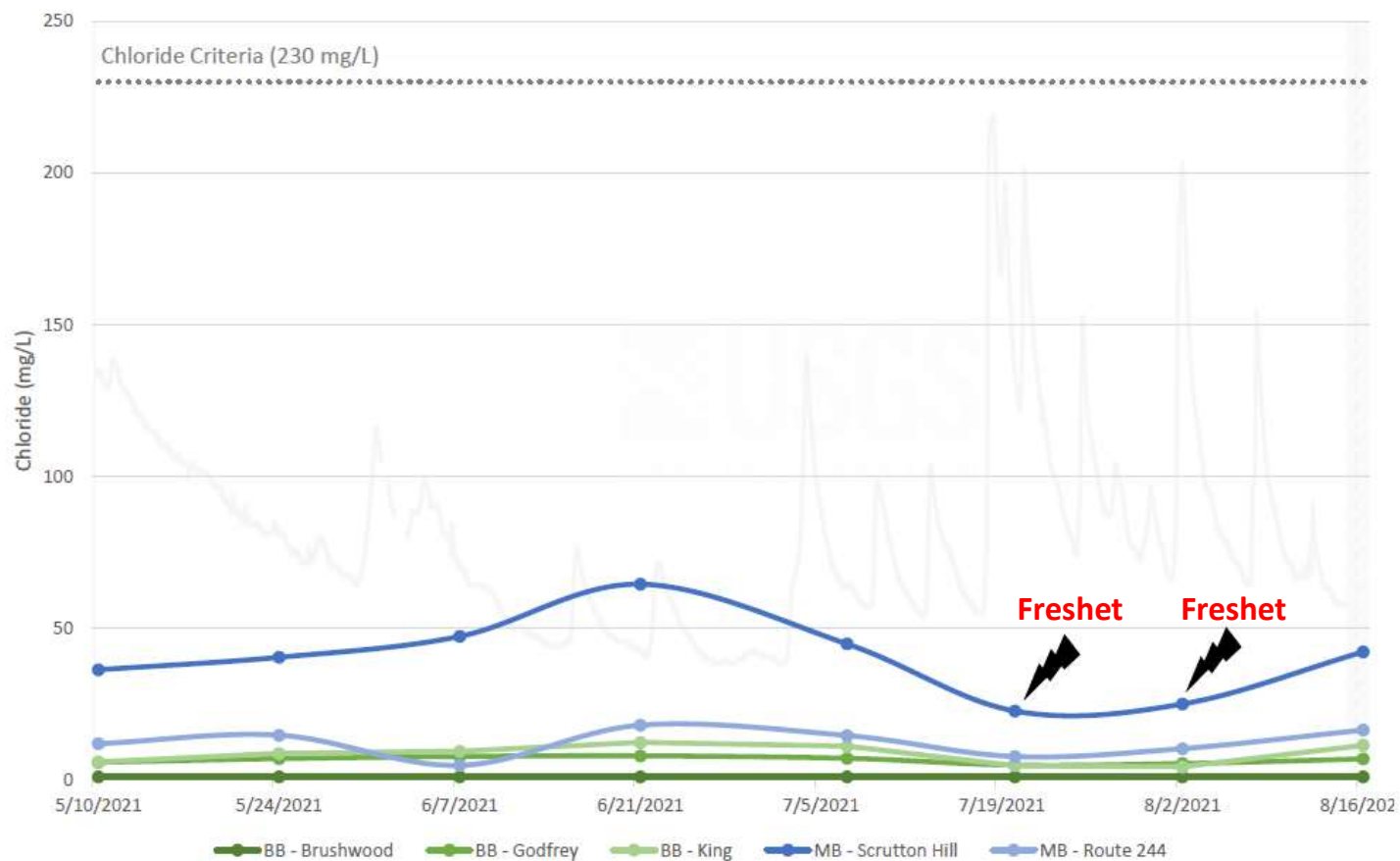


Tributary Site	Minimum Chloride (mg/l)		Average Chloride (mg/l)		Maximum Chloride (mg/l)	
	2022	2021	2022	2021	2022	2021
Blood Brook KING	4.7	4.3	NA	8.4	4.7	12.3
Blood Brook MARSH HILL	4.6	NA	NA	NA	4.6	NA
Blood Brook GODFREY	5.8	4.9	NA	6.6	5.8	7.9
Blood Brook BRUSHWOOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Middle Brook 244	9.8	4.8	15.1	13.4	19.0	22.5
Middle Brook LOWER POND	11.5	NA	NA	NA	11.5	NA
Middle Brook UPPER POND	13.5	NA	NA	NA	13.5	NA
Middle Brook SCRUTTON HILL	12.3	22.7	NA	40.4	12.6	64.5





### Summer 2021 Total Chloride Concentrations on Middle Brook (MB) and Blood Brook (BB)



All sample results were below nutrient criteria values for chloride. Levels were slightly elevated on Scrutton Hill Road, potentially from road salts.

# 2023 Monitoring Summary & 2024 Next Steps



- Lay Monitoring Program (LMP)
  - 2023 Summary: Secchi transparency started high and gradually decreased slightly through the summer. Total phosphorus and chlorophyll-a concentrations were low in the epilimnion and elevated in the hypolimnion due to internal loading from anoxic sediment.
  - 2024 Next Steps: LMP volunteer continues collecting biweekly epilimnetic (0.5 m) and hypolimnetic (20 m) samples. Caffeine testing will also continue at a lower lab reporting limit ( $\leq 0.1$  ug/L). LMP staff collects duplicate samples, vertical profile data, and additional metalimnetic sample during annual visit.
- LaRosa Partnership Program (LPP)
  - 2023 Summary: High total phosphorus in Blood Brook downstream sites during August 4<sup>th</sup> flood; slightly elevated chloride in Middle Brook 244 site
  - 2024 Next Steps: LPP volunteer continues collecting biweekly samples June through August (align with LMP)