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# Silver Lake 2022 Runoff Evaluation

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Restorative Lake Sciences



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# Silver Lake Impairments

1. Low water clarity (high TSS)
2. Elevated cyanobacteria blooms
3. Low submersed aquatic  
vegetation
4. Elevated nutrients



*Cladophora glomerata*  
along shoreline





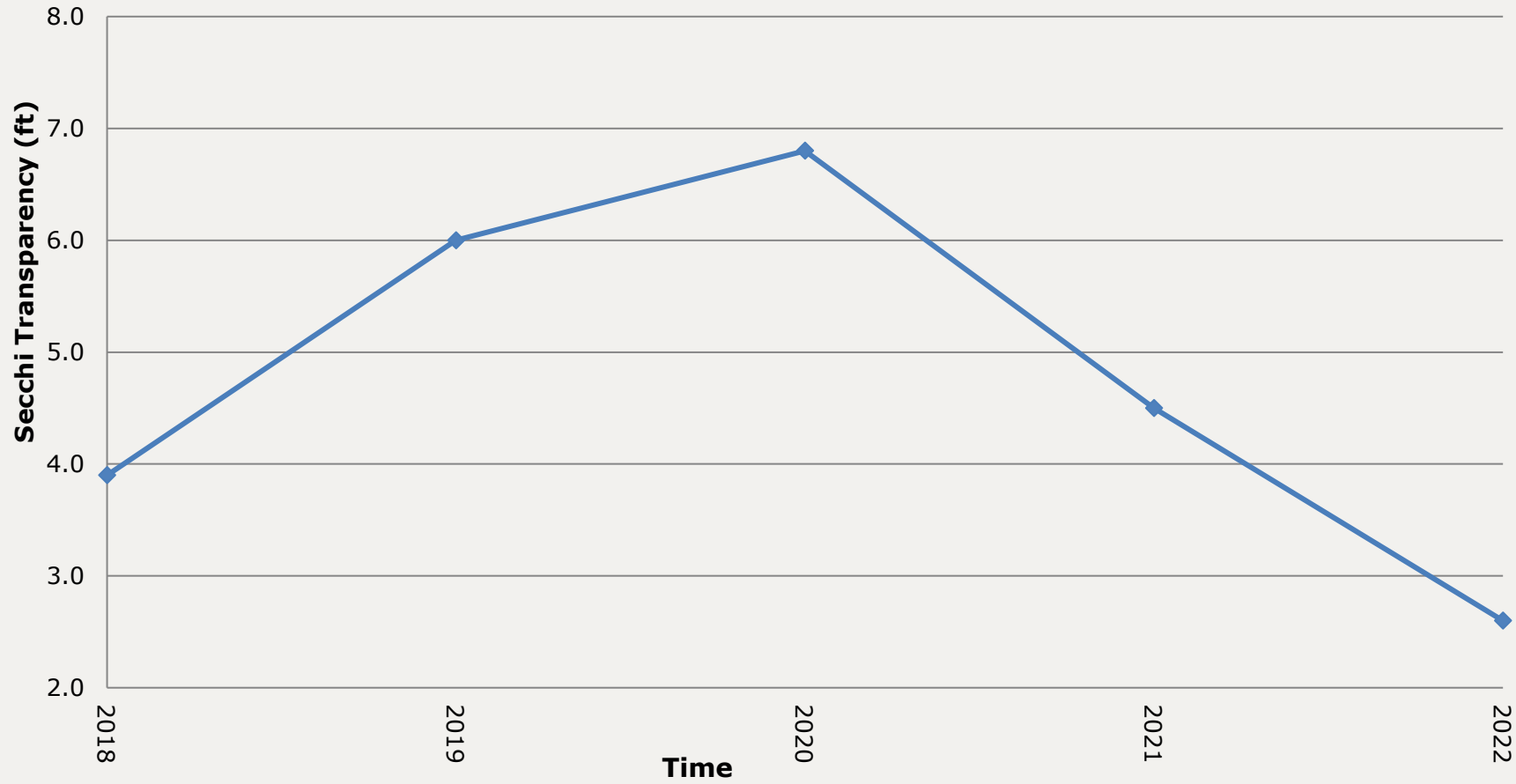






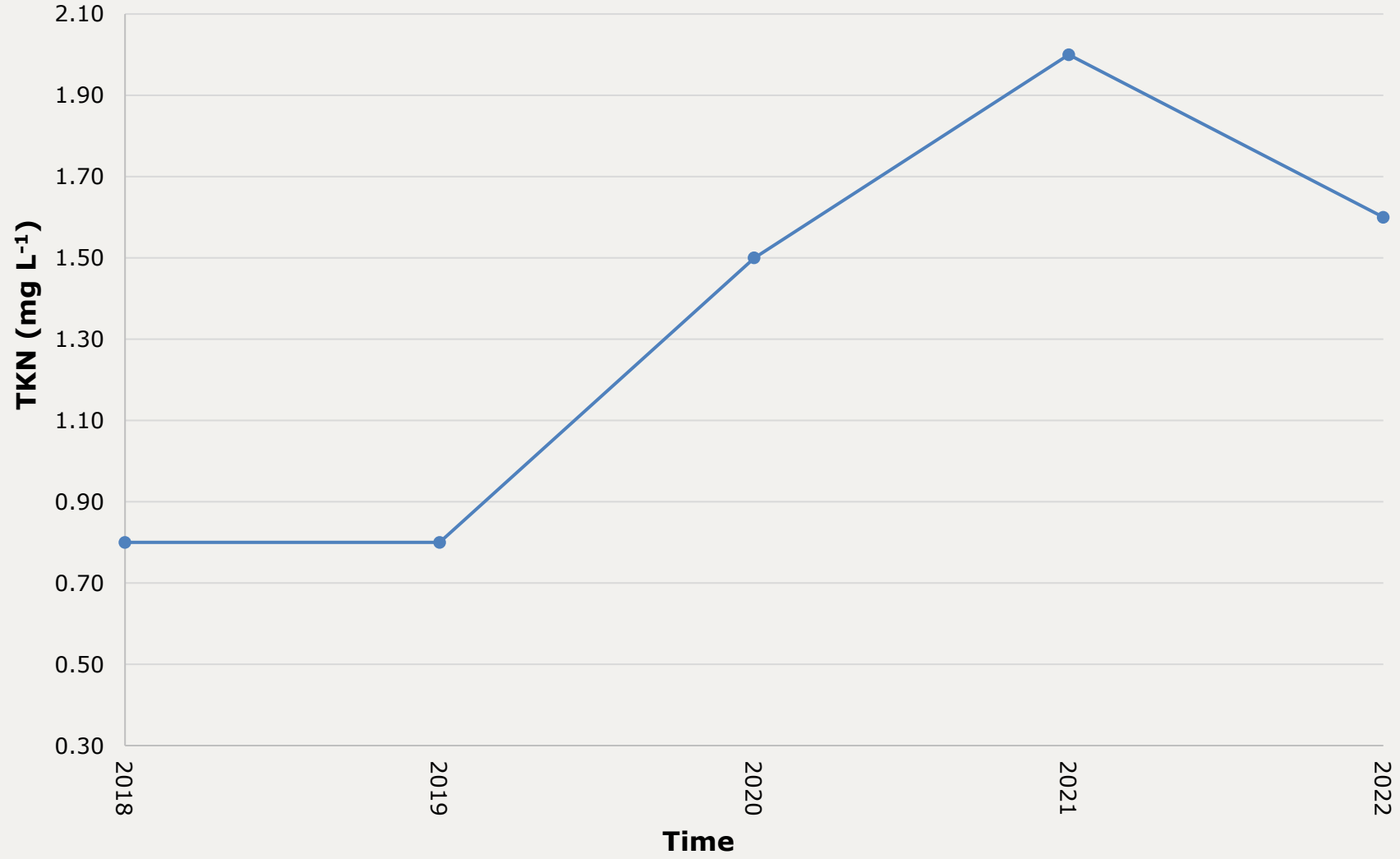


### Trend in Mean Secchi Transparency in Silver Lake



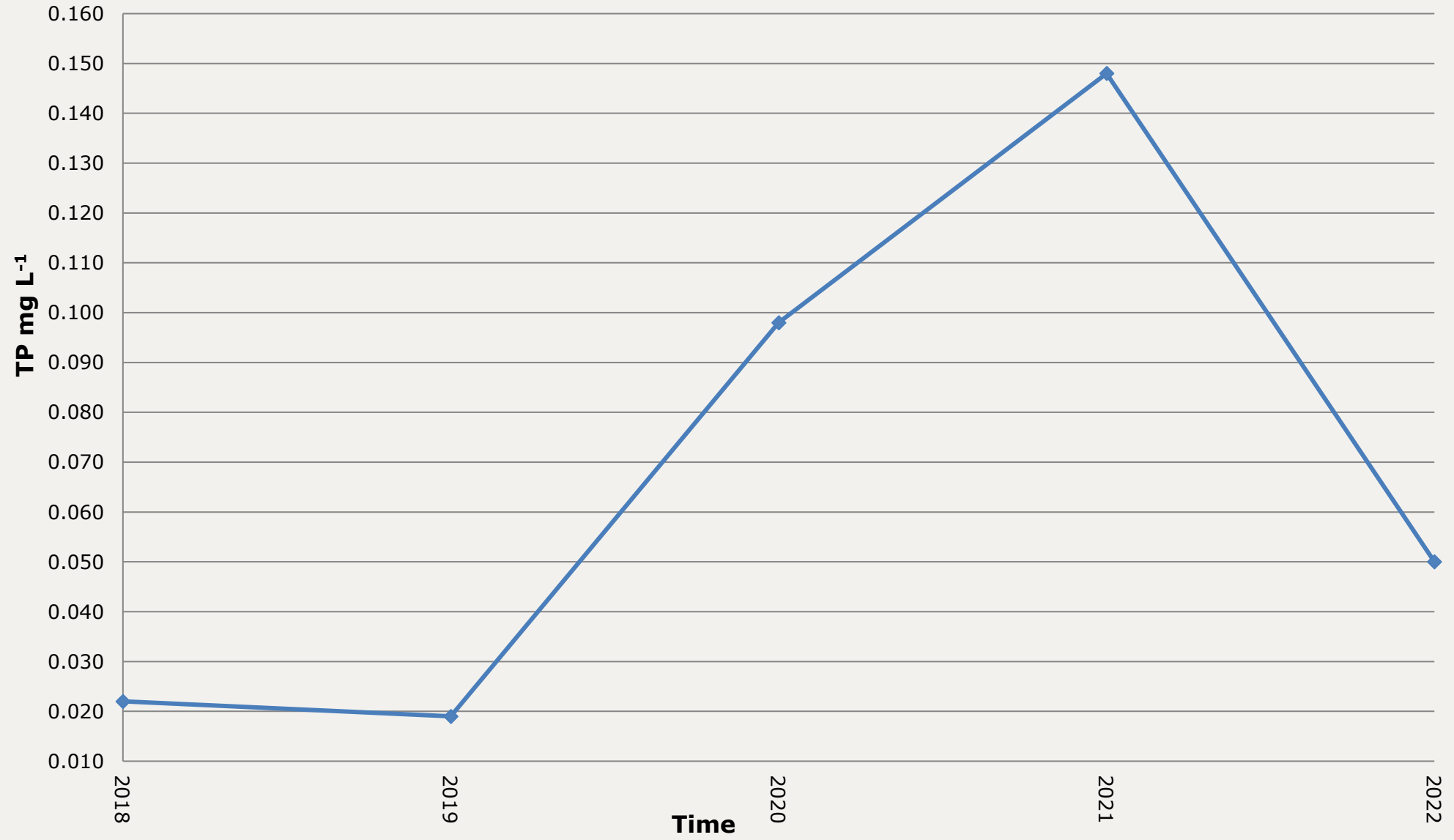


**Trend in Mean TKN in Silver Lake**



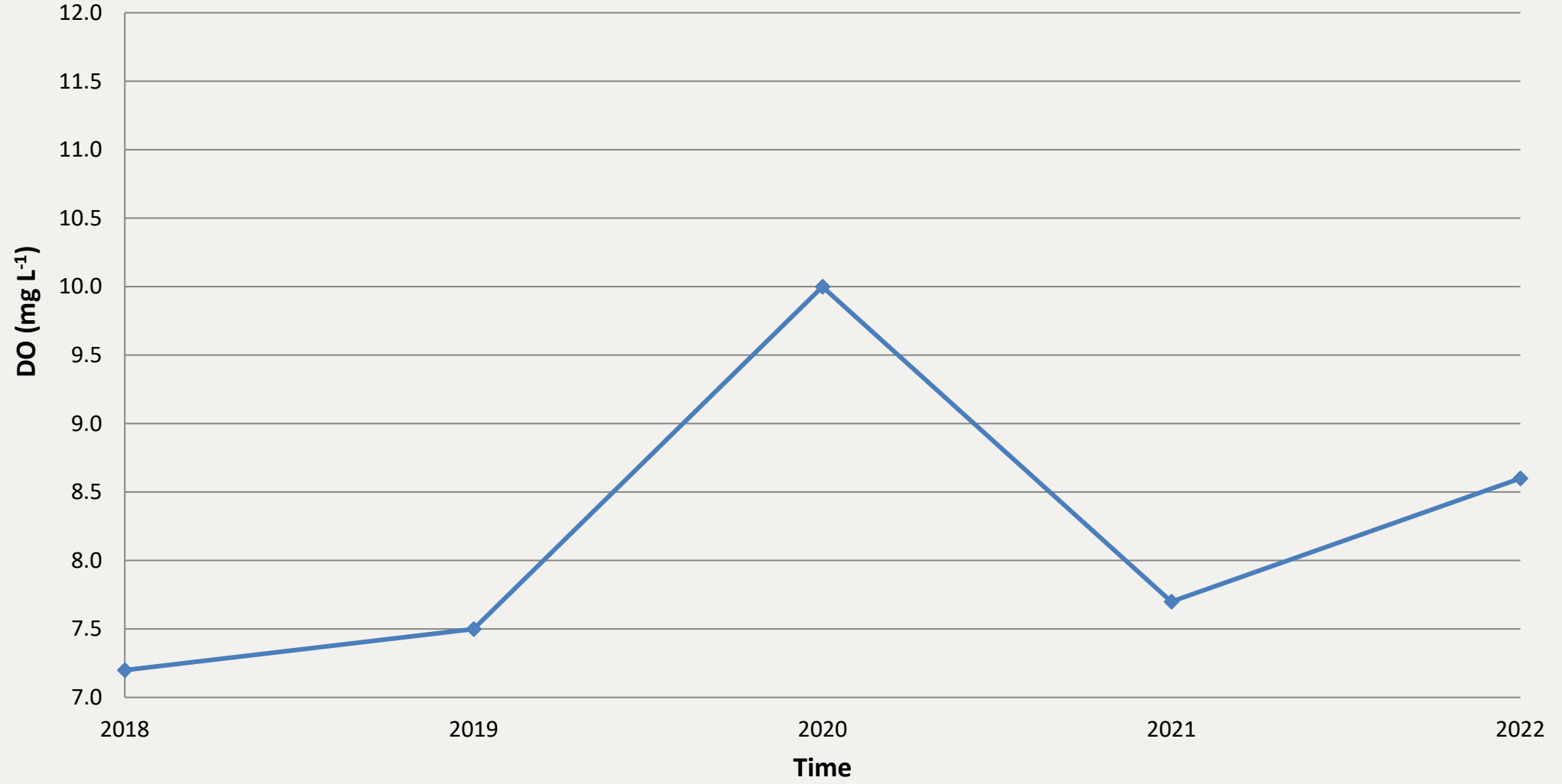


**Trend in Mean TP in Silver Lake**

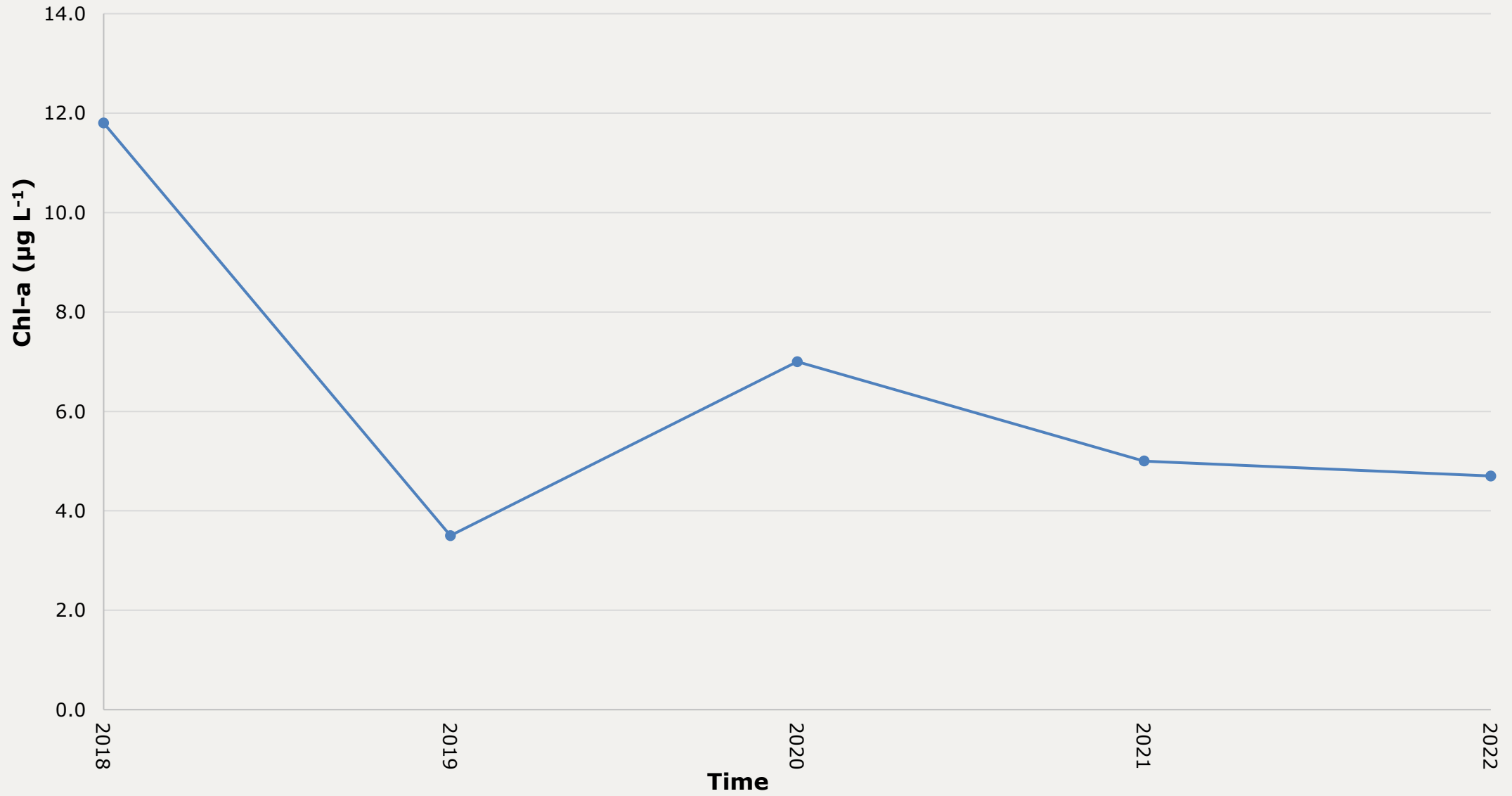




### Trend in Mean DO in Silver Lake



**Trend in Mean Chlorophyll-a in Silver Lake**





# A Watershed



watershed divide

tributaries

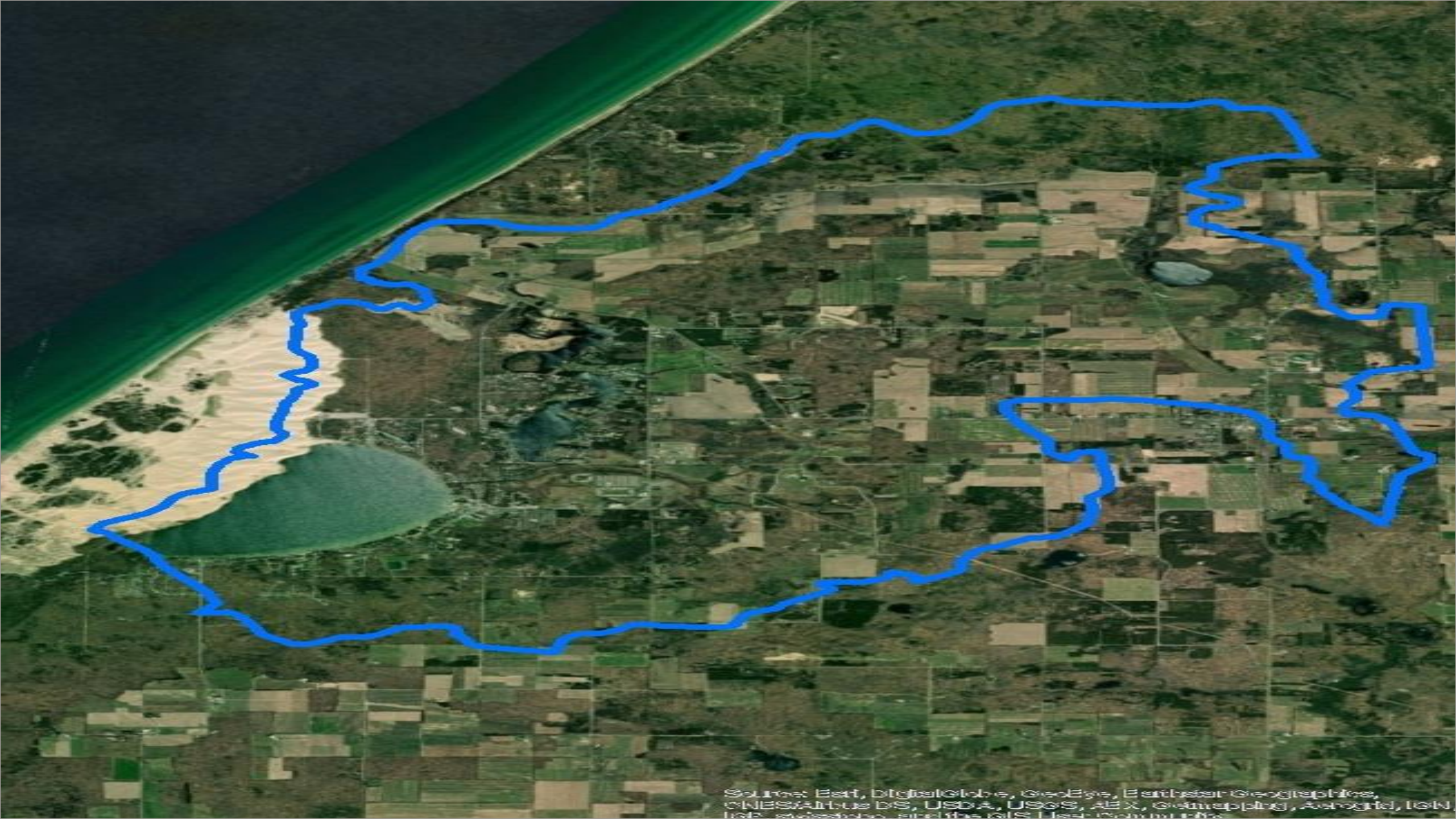
watershed divide

percolation

percolation

groundwater  
(aquifer)





Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroX, Geomapping, AeroGRID, IGN, ICB, GEBCO, and the GIS User Community



# Silver Lake Runoff Sampling Locations

# Silver Lake

Oceana County, MI  
Sampling Location Map

## Legend

● Tributary Sampling Location



24th Ave

Taylor & N Shore Dr

Hunter Creek

Silver Lake

Lolligagin' House

State Park

Dunes Vista Tube

22nd Ave Launch

18th Ave Launch

Silver Lake Rd

N-22nd

N-18th Ave Dr

N-Ridge Rd

N-Shore Dr

N-Raven St

W-Hazel Rd





# 18<sup>th</sup> Ave Ramp





22nd Ave Ramp





# Taylor Road Ramp





24<sup>th</sup> Ave  
Ramp/Tube

NO SWIMMING  
BY STATE W.  
PUBLIC ACCESS





24<sup>th</sup> Ave





State Park





# Lollygagging Cabin





Hunter Creek

NO WAKE  
ZONE

NO OUTLET





# Plume from Hunter Creek





Dunes Vista Tube





# Gully Erosion





# Gully Erosion





# Silver Lake Runoff Location Flow Paths



# Silver Lake

Oceana County, MI  
CSA Flow Map

## Legend

- 18th Ave Ramp Watercourse
- Dunes Vista Tube
- Edgewood Rd
- Feature 1
- Hunter Creek
- Lolligagin Cabin
- State Park





# Silver Lake

Oceana County, MI  
18th Ave Ramp Watercourse

**Legend**  
18th Ave Ramp Watercourse





# Silver Lake

Oceana County, MI  
Dunse Vista Tube Tributary Watercourse

**Legend**

-  Dunse Vista Tube Watercourse




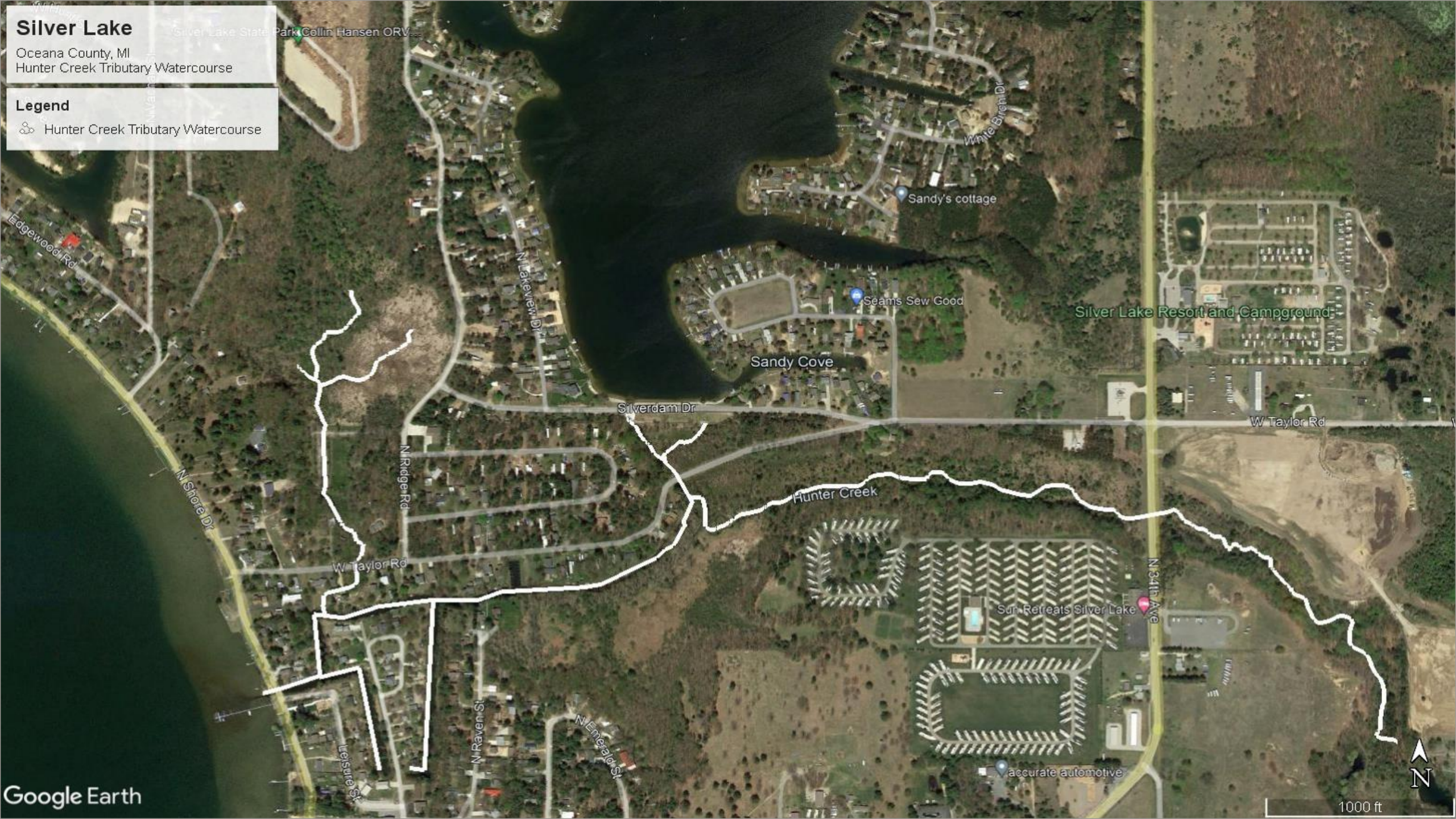


# Silver Lake

Oceana County, MI  
Hunter Creek Tributary Watercourse

## Legend

 Hunter Creek Tributary Watercourse



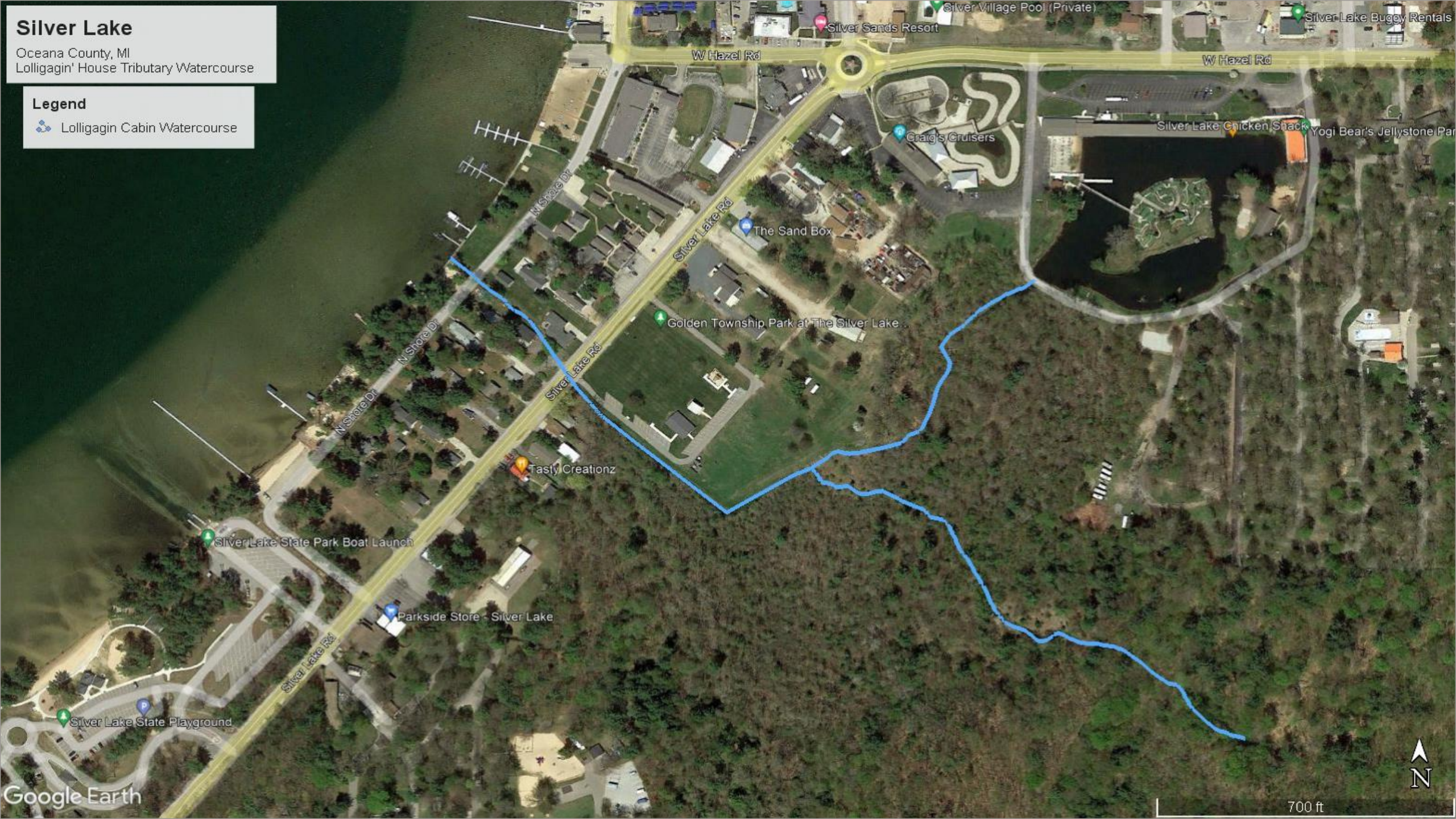


# Silver Lake

Oceana County, MI  
Lolligagin' House Tributary Watercourse

**Legend**

-  Lolligagin Cabin Watercourse




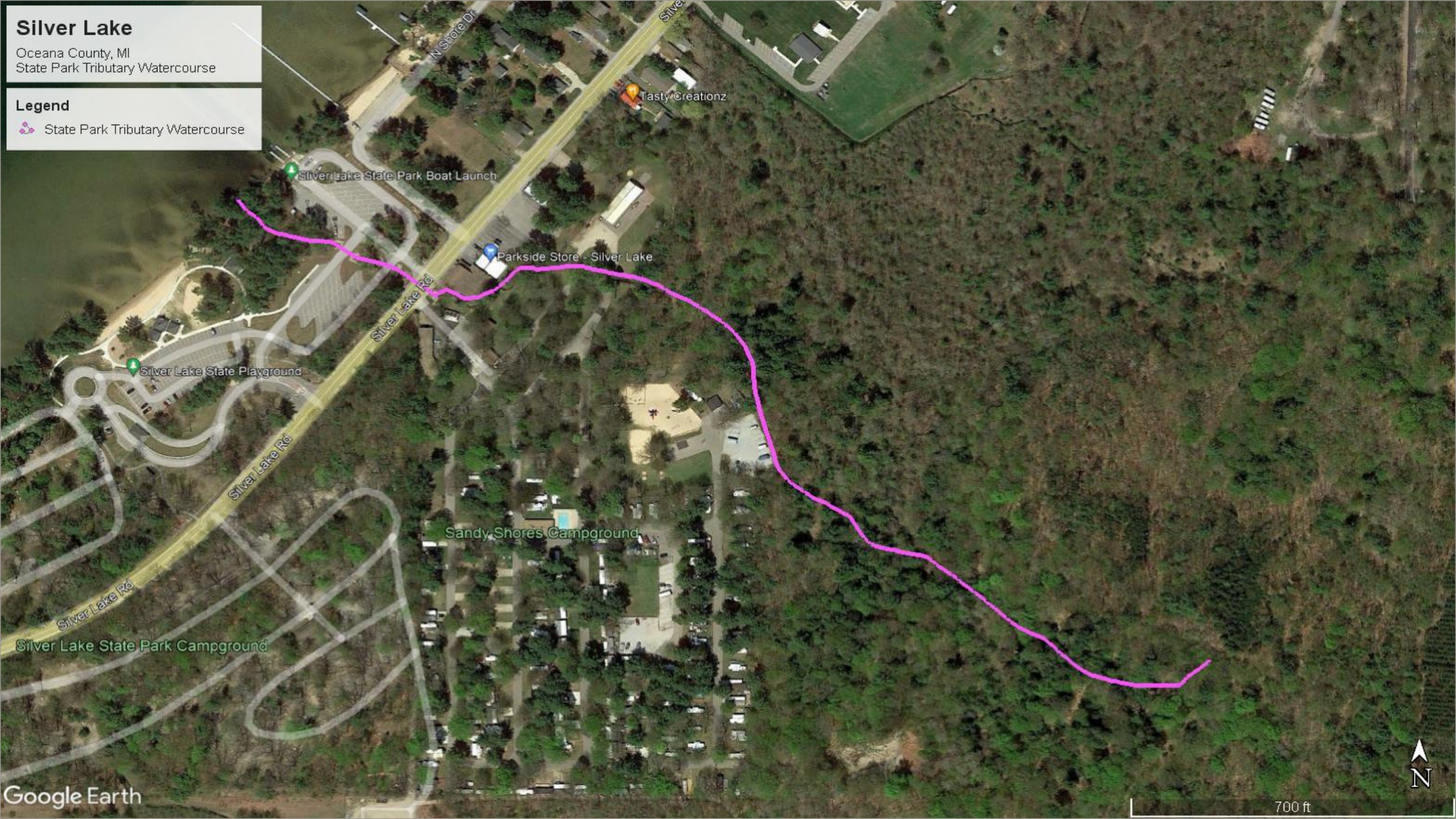


# Silver Lake

Oceana County, MI  
State Park Tributary Watercourse

## Legend

 State Park Tributary Watercourse





# Silver Lake Runoff Data



**Table 8. Silver Lake mean physical water quality data (April-September, 2022).**

<i>Silver Lake</i>	<i>Water</i>	<i>DO</i>	<i>pH</i>	<i>TDS</i>	<i>Conduct.</i>
<i>Runoff Sampling Site</i>	<i>Temp (°C)</i>	<i>(mg L<sup>-1</sup>)</i>	<i>(S.U)</i>	<i>(mg L<sup>-1</sup>)</i>	<i>mS cm<sup>-1</sup></i>
18 <sup>th</sup> Ave Ramp	17.6±3.6	9.4±0.6	8.1±0.1	37.0±30.0	105.0±21.0
22 <sup>nd</sup> Ave Ramp (Dunes Vista)	17.9	9.0	7.8	213.0	290.0
Dunes Vista Tube	15.0±3.7	9.9±1.0	7.9±0.1	198.0±65.0	308±99.0
State Park	14.1±3.1	9.9±1.0	7.9±0.1	225.0±80.0	352.0±125
Lollygagging Cabin	17.8±5.2	9.3±1.4	7.6±0.1	190.0±68.0	299.0±106
Hunter Creek	17.6±5.2	9.2±1.6	7.8±0.4	218.0±77.0	341±120.0
Taylor Road Tube	18.6±6.8	9.1±1.1	7.9±0.2	132.0±73.0	207±115.0
24 <sup>th</sup> Ave Ramp Tube	16.7±4.4	8.3±1.1	7.4±0.2	207±110	324±171

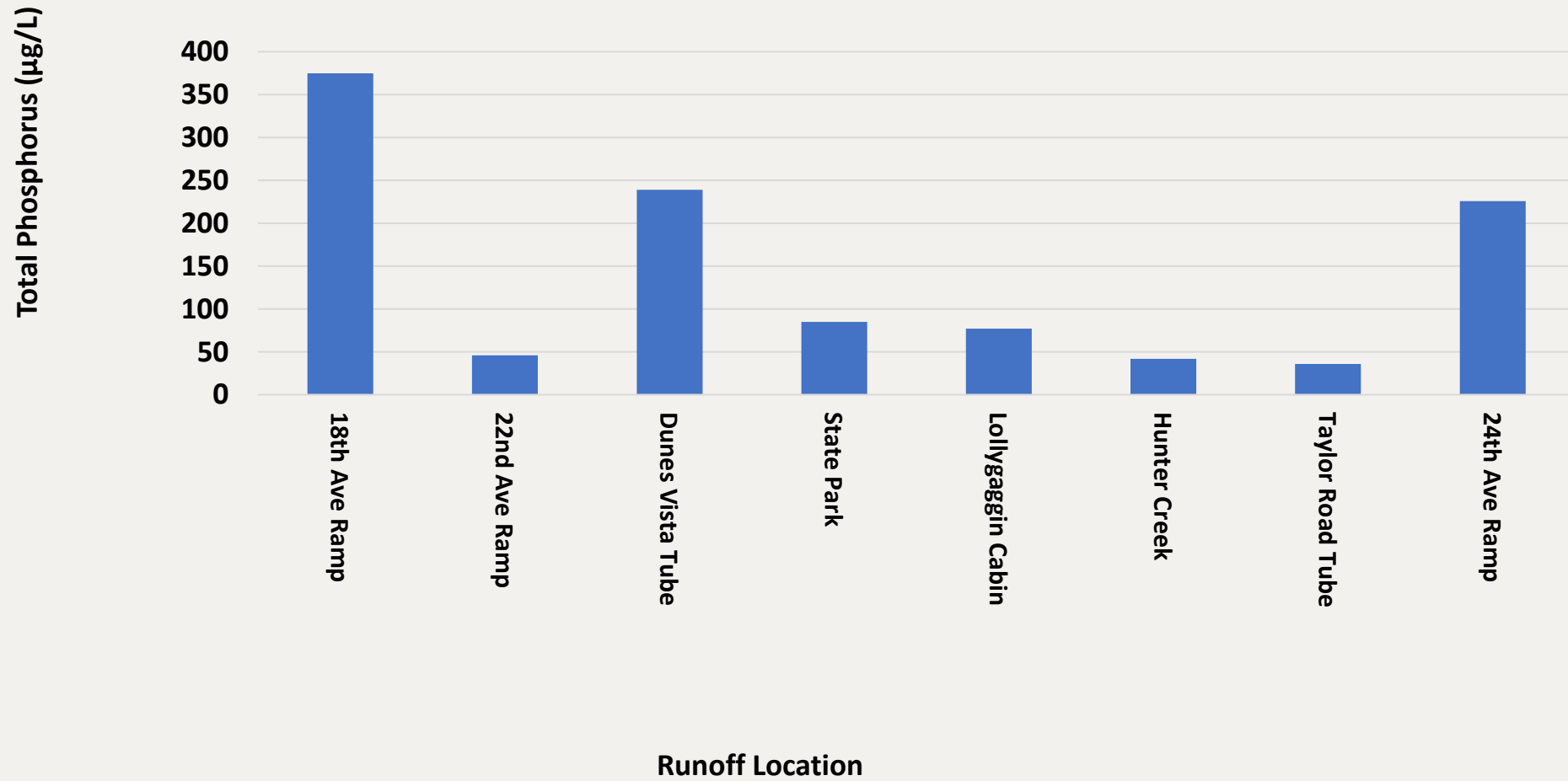


**Table 9. Silver Lake mean chemical water quality data (April-September, 2022).**

<i>Silver Lake</i>	<i>TSS</i>	<i>TP</i>	<i>TIN</i>	<i>Cl-</i>	<i>NO3</i>	<i>NH3-</i>
<i>Runoff Sampling Site</i>	<i>(mg L<sup>-1</sup>)</i>	<i>(mg L<sup>-1</sup>)</i>	<i>(mg L<sup>-1</sup>)</i>	<i>(mg L<sup>-1</sup>)</i>	<i>mg L<sup>-1</sup></i>	<i>mg L<sup>-1</sup></i>
18 <sup>th</sup> Ave Ramp	245±35	0.375±0.0	0.950±0.6	13.5±4.9	0.360±0.1	0.550±0.594
22 <sup>nd</sup> Ave Ramp (Dunes Vista)	14	0.046	0.100	10.0	0	0.100
Dunes Vista Tube	83±68	0.239±0.2	0.654±0.2	11.8±4.0	0.596±0.2	0.061±0.0
State Park	69±32	0.085±0.1	0.764±0.3	10.0±0.0	0.726±0.3	0.040±0.0
Lollygagging Cabin	21±15	0.077±0.1	0.184±0.1	10.0±0.0	0.154±0.1	0.036±0.0
Hunter Creek	23±11	0.042±0.0	0.622±0.4	11.4±3.1	0.564±0.4	0.060±0.045
Taylor Road Tube	18±14	0.036±0.0	0.646±0.6	10.0±0.0	0.432±0.5	0.199±0.2
24 <sup>th</sup> Ave Ramp Tube	64±72	0.226±0.2	0.368±0.2	18.2±16	0.210±0.1	0.186±0.2

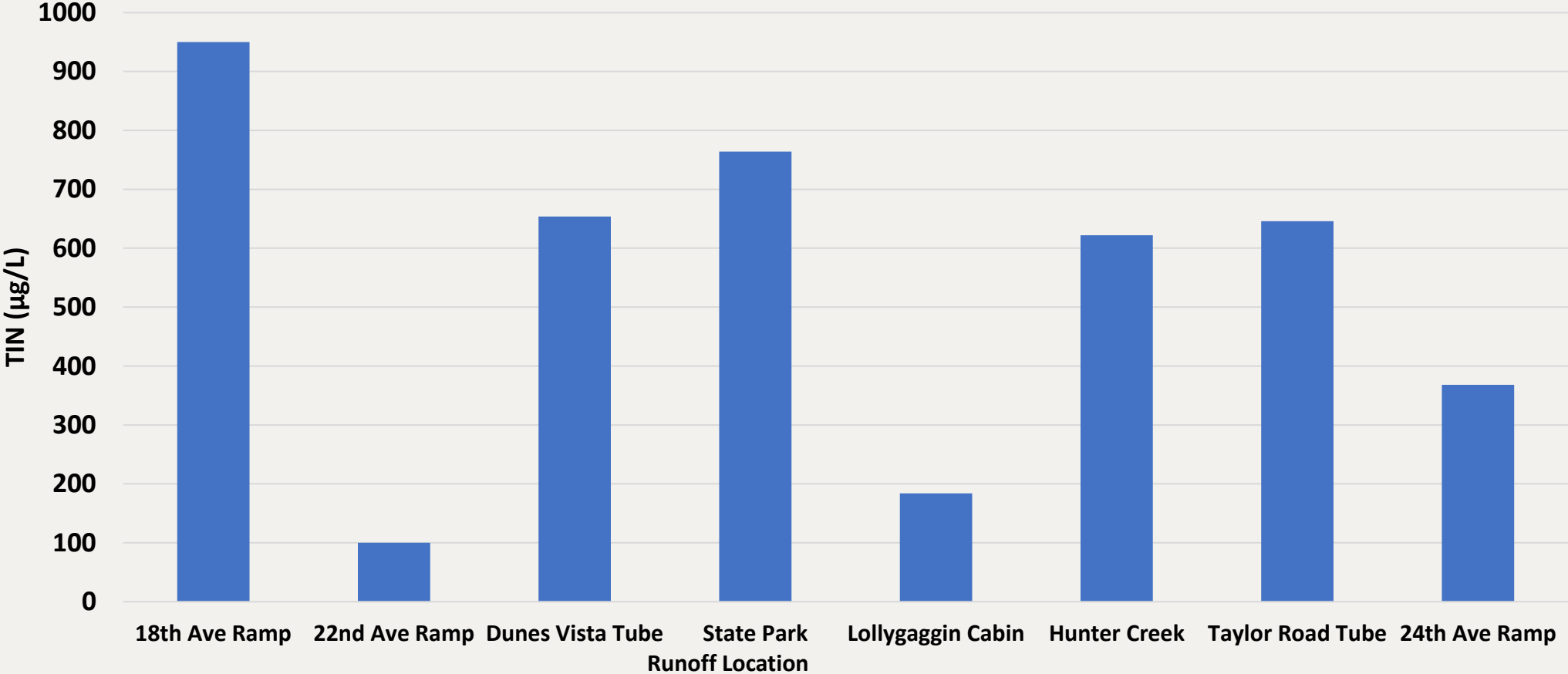


Silver Lake Runoff Locations and Mean TP Contributions  
April-September, 2022



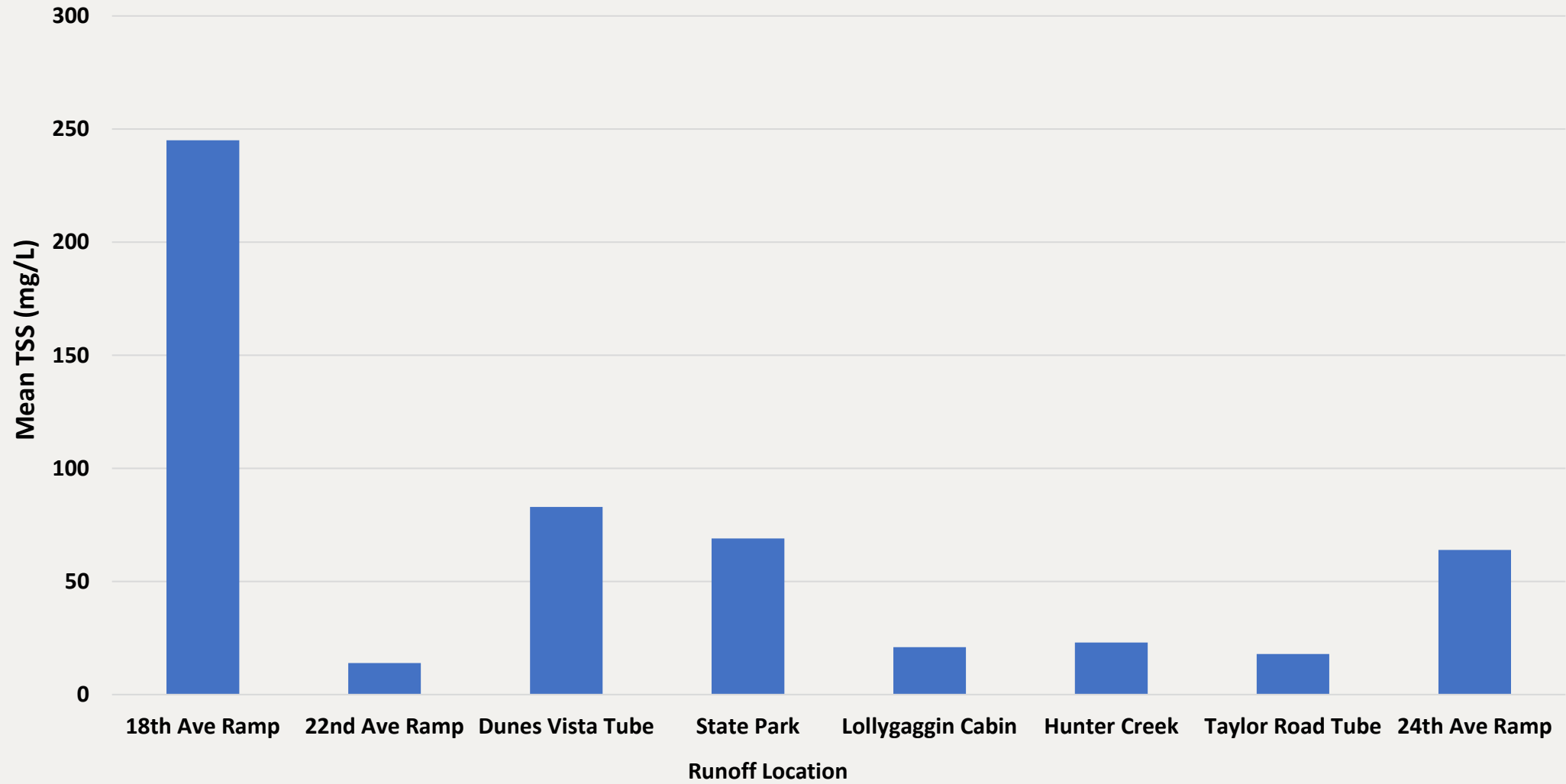


Silver Lake Runoff Locations and Mean TIN Contributions (April-September, 2022)





**Silver Lake Runoff Locations and Mean TSS Contributions (April-September, 2022)**





**Table 10. Silver Lake runoff locations with prioritization based on measured impairments for recommended mitigation methods.**

<b>Runoff Location</b>	<b>Priority</b>	<b>Key Recommendations</b>
<b>18<sup>th</sup> Ave Ramp</b>	VERY HIGH (gully erosion)	Keep free of debris; Sweep; Consider settling basin upland to reduce solids and nutrients
<b>22<sup>nd</sup> Ave Ramp</b>	LOW	Keep free of debris; Sweep
<b>Dunes Vista Tube</b>	VERY HIGH Biochar	Need stormwater inventory map to determine precise sources draining into Tube
<b>State Park</b>	HIGH	Need to settle out dark organic fines prior to lake entry; nutrient reduction
<b>Lollygagging Cabin</b>	HIGH Biochar	Nutrient inactivation in upstream ponds; possible settling basin for solids
<b>Hunter Creek</b>	LOW	Upstream BMP/Riparian Education
<b>Taylor Road Tube</b>	LOW	Upstream BMP/Riparian Education
<b>24<sup>th</sup> Ave Ramp Tube</b>	VERY HIGH (gully erosion)	Re-slope and reduce gully erosion



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# Additional Recommendations

1. Possible stormwater inventory map (for diffuse origins)
2. Sample Little Silver Lake outflow during rain events in 2023
3. Determine nutrient concentrations from Craigs Cruisers pond (and evaluate possible need for nutrient inactivation)
4. Settling basins for State Park and Hunter Creek?
5. Biochar custom retrofitted filters for the two tubes entering Silver Lake (RLS to work with SludgeHammer<sup>®</sup> and EGLE)
6. Convince all riparians to invest in SludgeHammer<sup>®</sup> or IMET<sup>®</sup> technology in absence of sewer system