LAKE WINNIPESAUKEE ASSOCIATION

Clear Waters Ahead: Directing Action for the Health of Paugus Bay

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Conservation Program Manager
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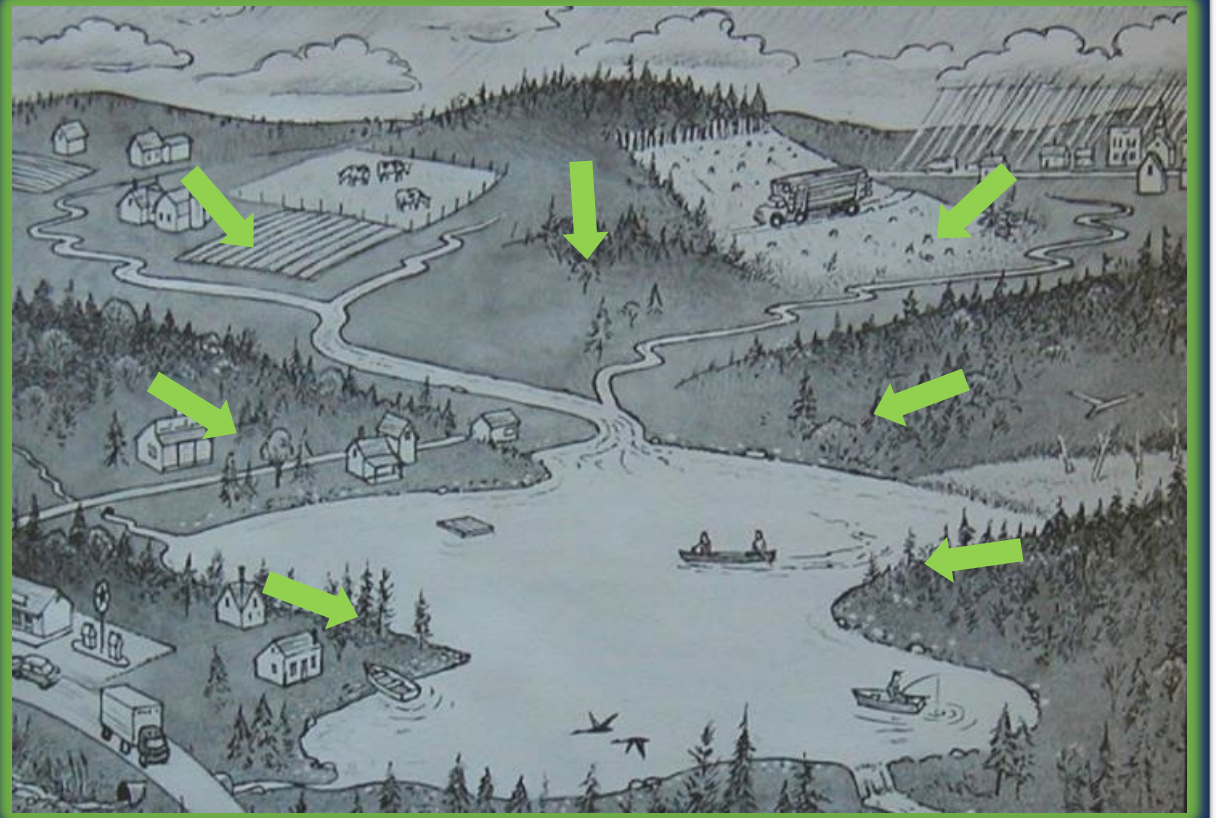
What is a Watershed?

A watershed is **an area of land that channels rainfall, snowmelt, and runoff into a common body of** water.



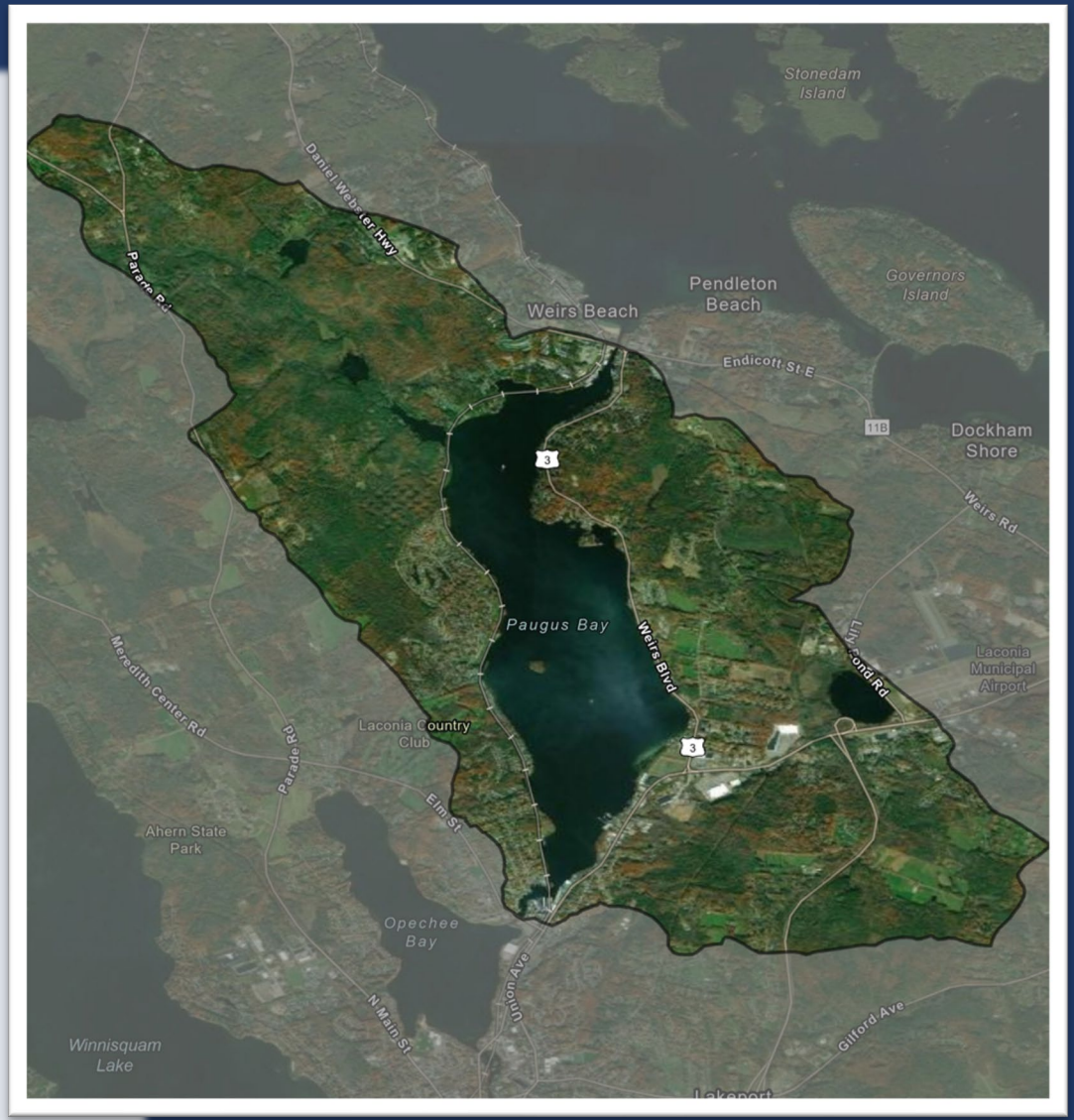
What we do on the land impacts the lake's water quality.

Paugus Bay

Geographical Overview

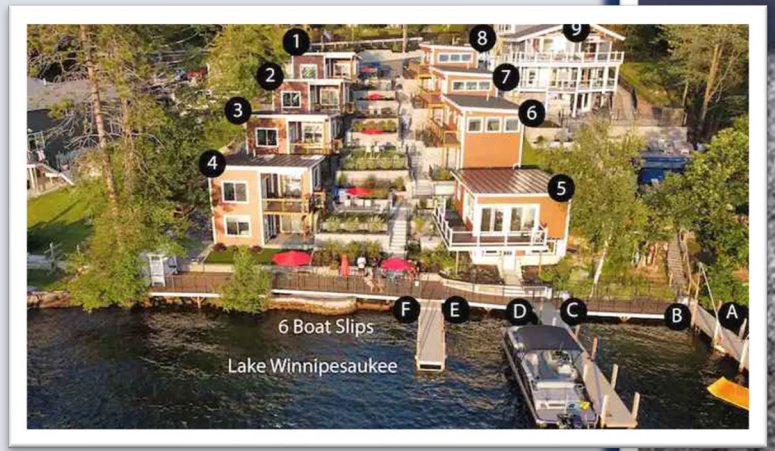
- Paugus Watershed (6,230 acres)
- Bay Area (1,234 acres)
- Begins at the Weirs Channel and outlets to Lake Opechee via Lakeport Dam
- **All of Winnipesaukee drains into Paugus**

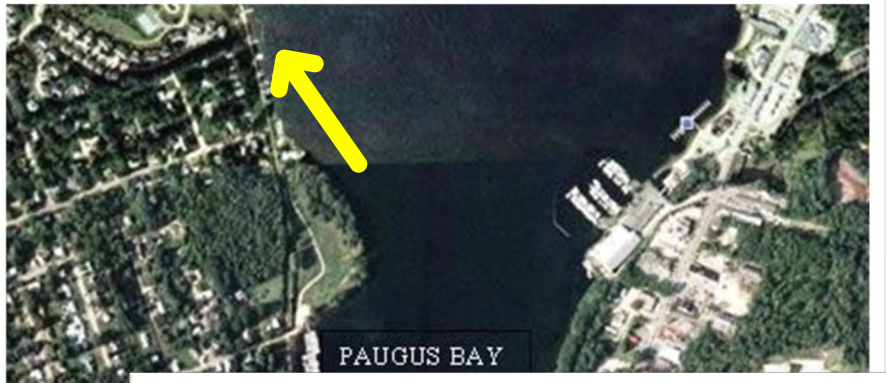
- Flushing Rate = 10.6 times/year
- Narrow, NW to SE Axis
- Drinking Water Source for the City of Laconia



Paugus Bay Issues

- Primary Drinking Water Source
- Recent Uptick in Cyanobacteria Blooms
- Increased Development





Forested Watershed

- Natural Filter
- Stabilizes Soil
- Mitigate Flooding Risk
- Biodiversity

Developed Watershed

5-10 TIMES THE AMOUNT OF PHOSPHORUS IN RUNOFF

- Increased Runoff
- Water Pollution
- Fragmentation
- Altered Hydrology

THEN

2015

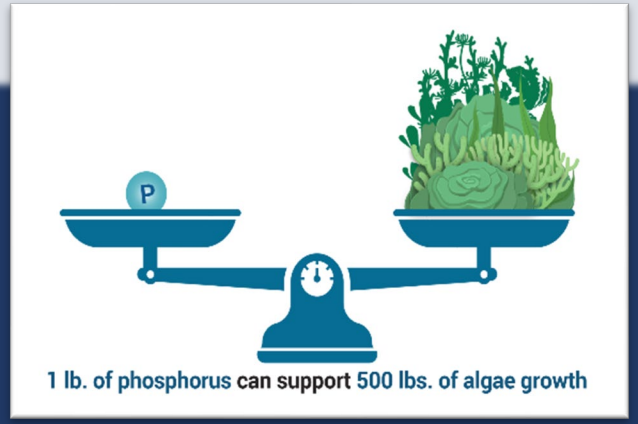
1906

NOW

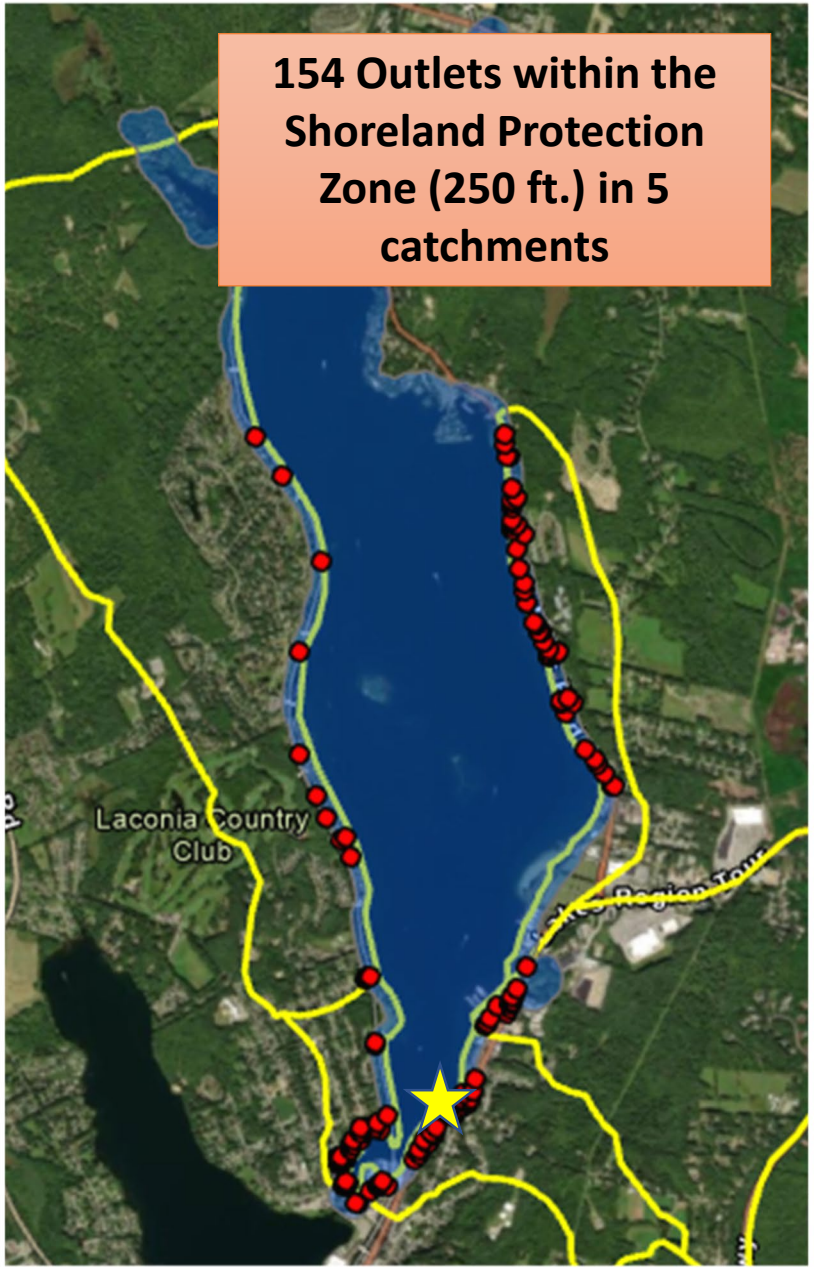
The Main Threat: Phosphorus

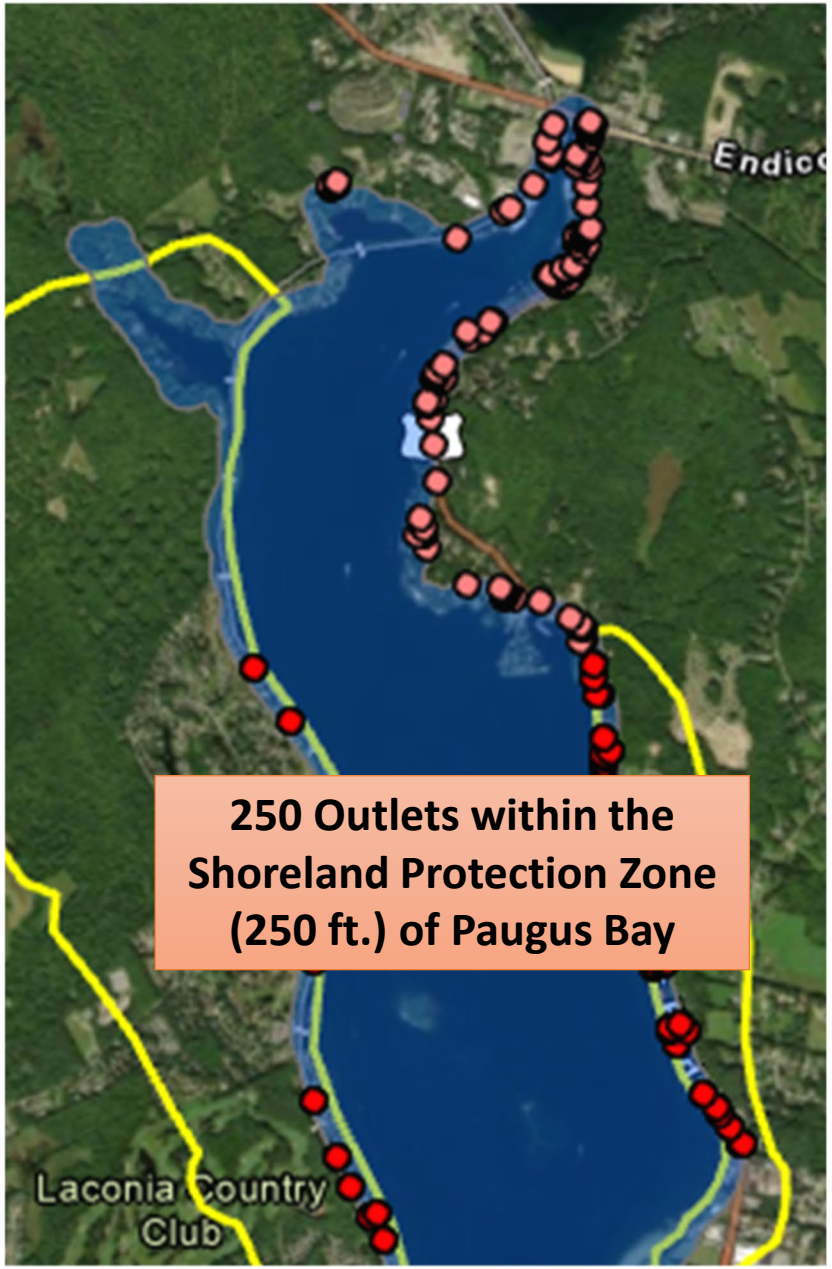
Excessive Nutrient Loading

- Polluted Stormwater Runoff
- Failing Septic Systems
- Erosion
- Recreational Pressures
- Increased Development
- Invasive Plants and Animals



Stormwater Outlets



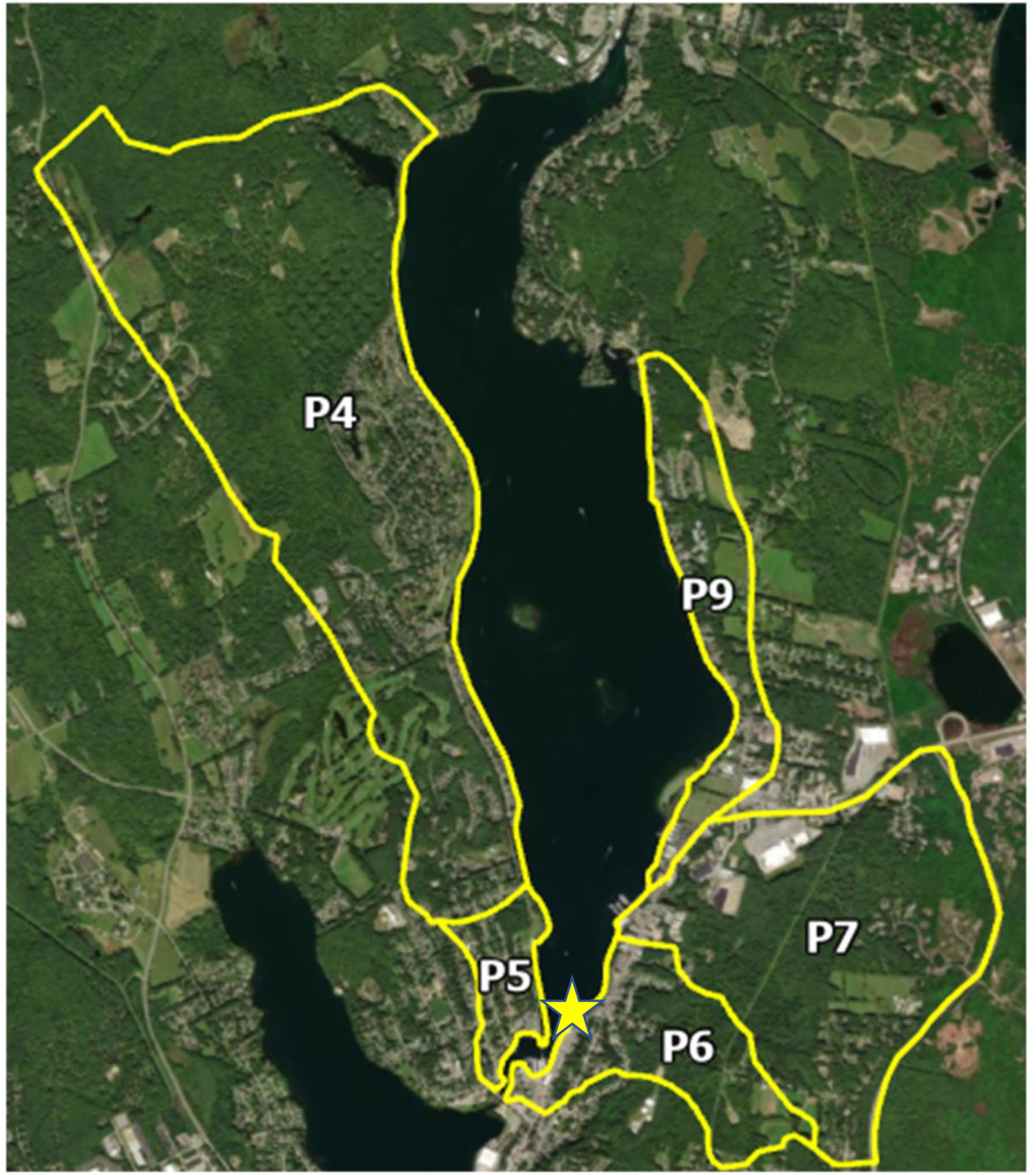


Cyanobacteria

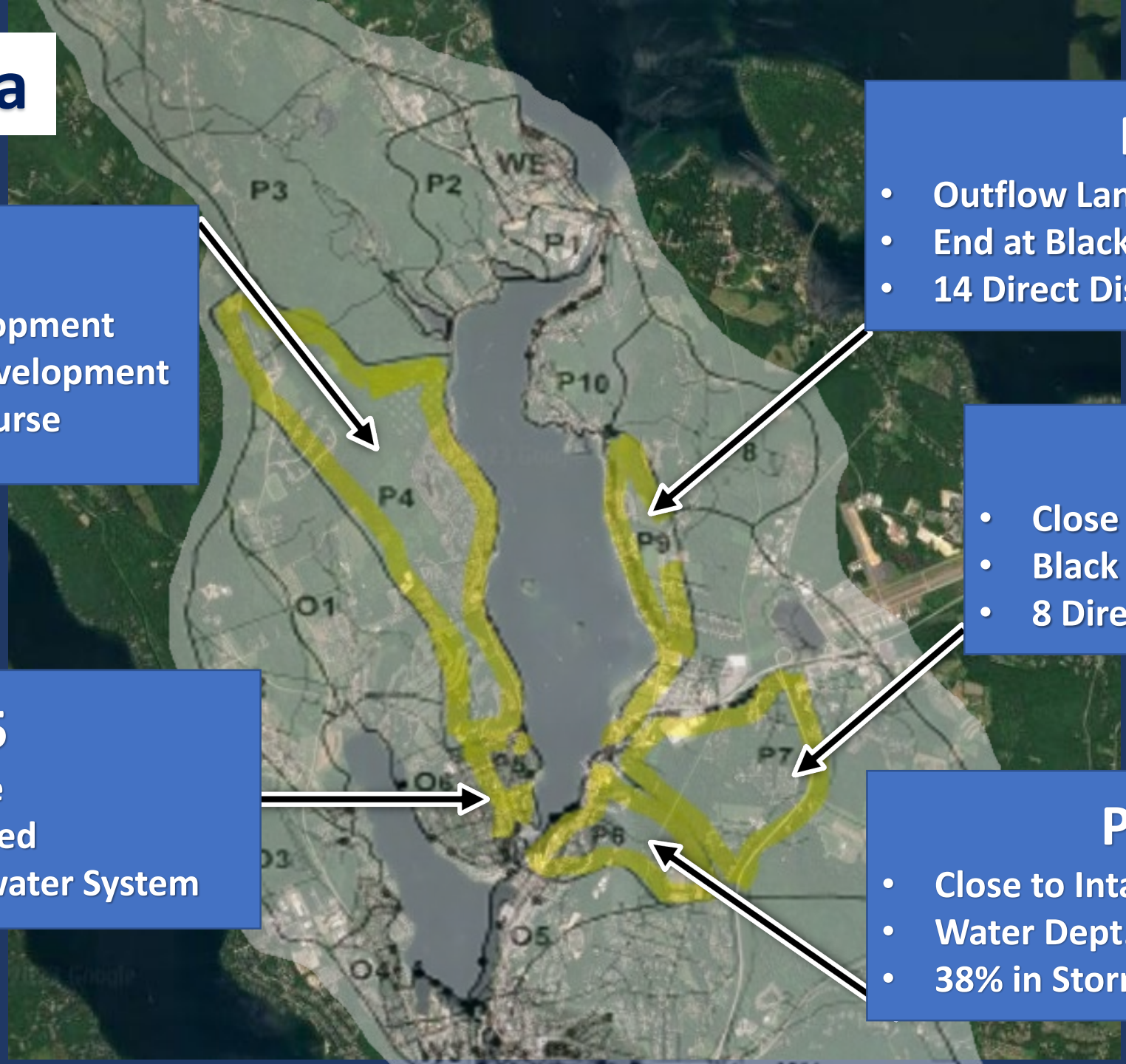
- 3.4 Billion Years Old
- Photosynthetic
- Key Role in Ecosystem
- Can proliferate rapidly and form dense populations aka “blooms”
- Blooms have negative ecological and human health impacts
- Nutrients fuel blooms
- Cyanotoxin Risk

Project Goals

- Inventory and prioritize sites contributing excessive sediment and nutrient loading in 5 catchments
- Develop an action plan of structural and non-structural recommendations
- Continue monitoring the health of the bay
- **Implement the recommendations in the action plan to reduce and mitigate pollutant loading to the bay**



Study Area



P4

- Long Bay Development
- South Down Development
- Laconia Golf Course

P9

- Outflow Langley Brook
- End at Black Brook Outlet
- 14 Direct Discharges into Bay

P7

- Close to Intake
- Black Brook
- 8 Direct Discharges

P5

- Close to Intake
- Highly urbanized
- 96% in Stormwater System

P6

- Close to Intake
- Water Dept. Location
- 38% in Stormwater System

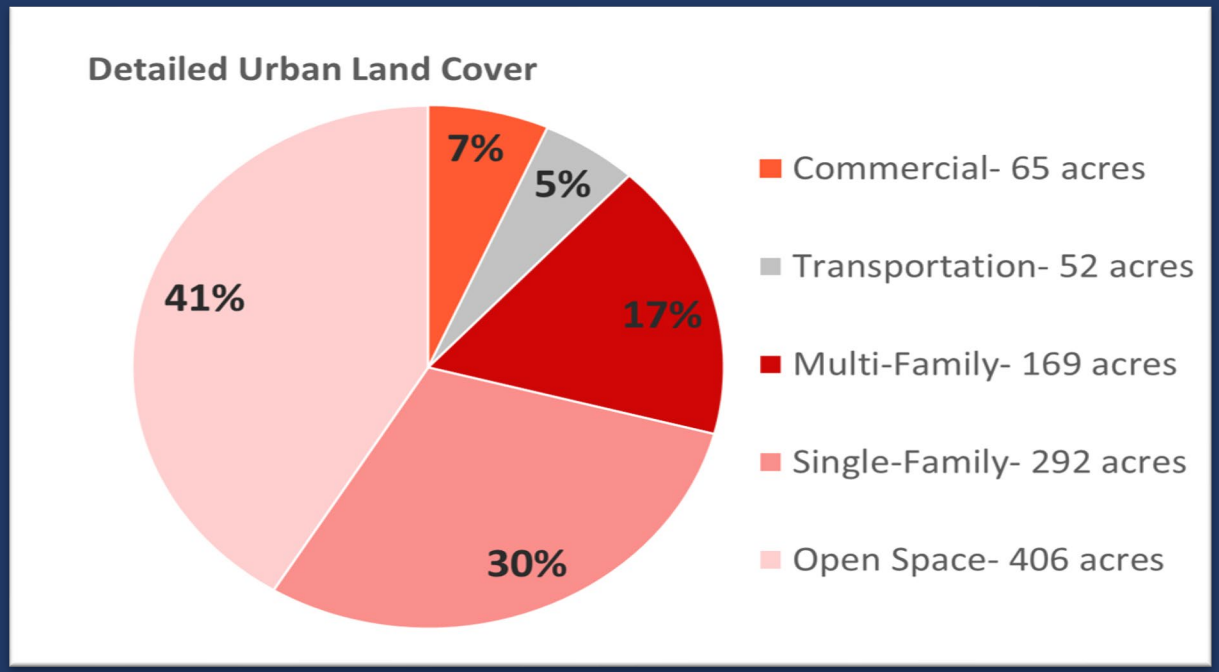
Paugus Bay Assessment Tasks and Timeline

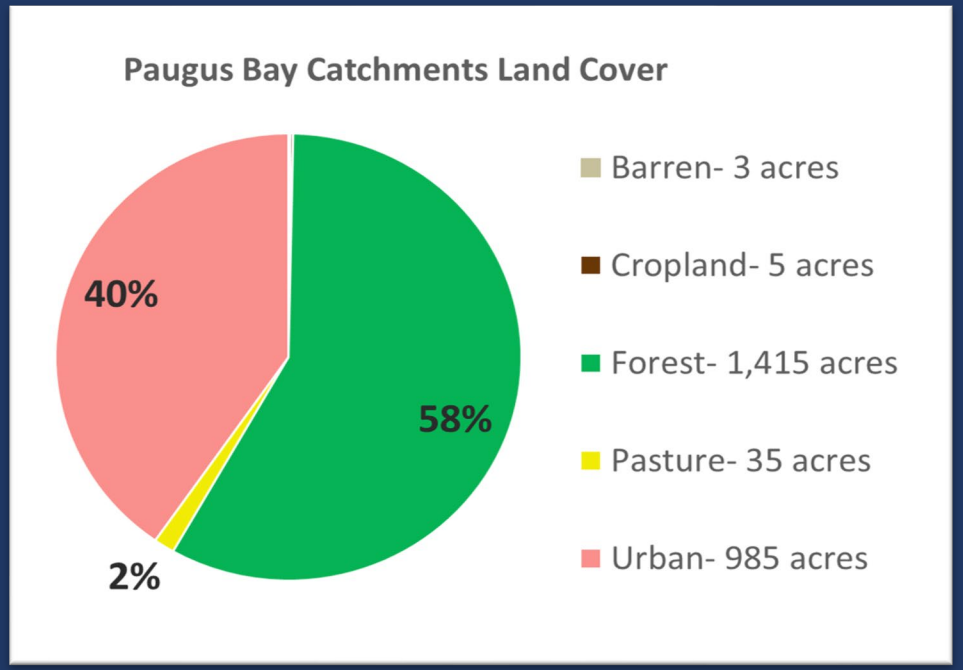
Pollutant Load Modeling

Local Inputs

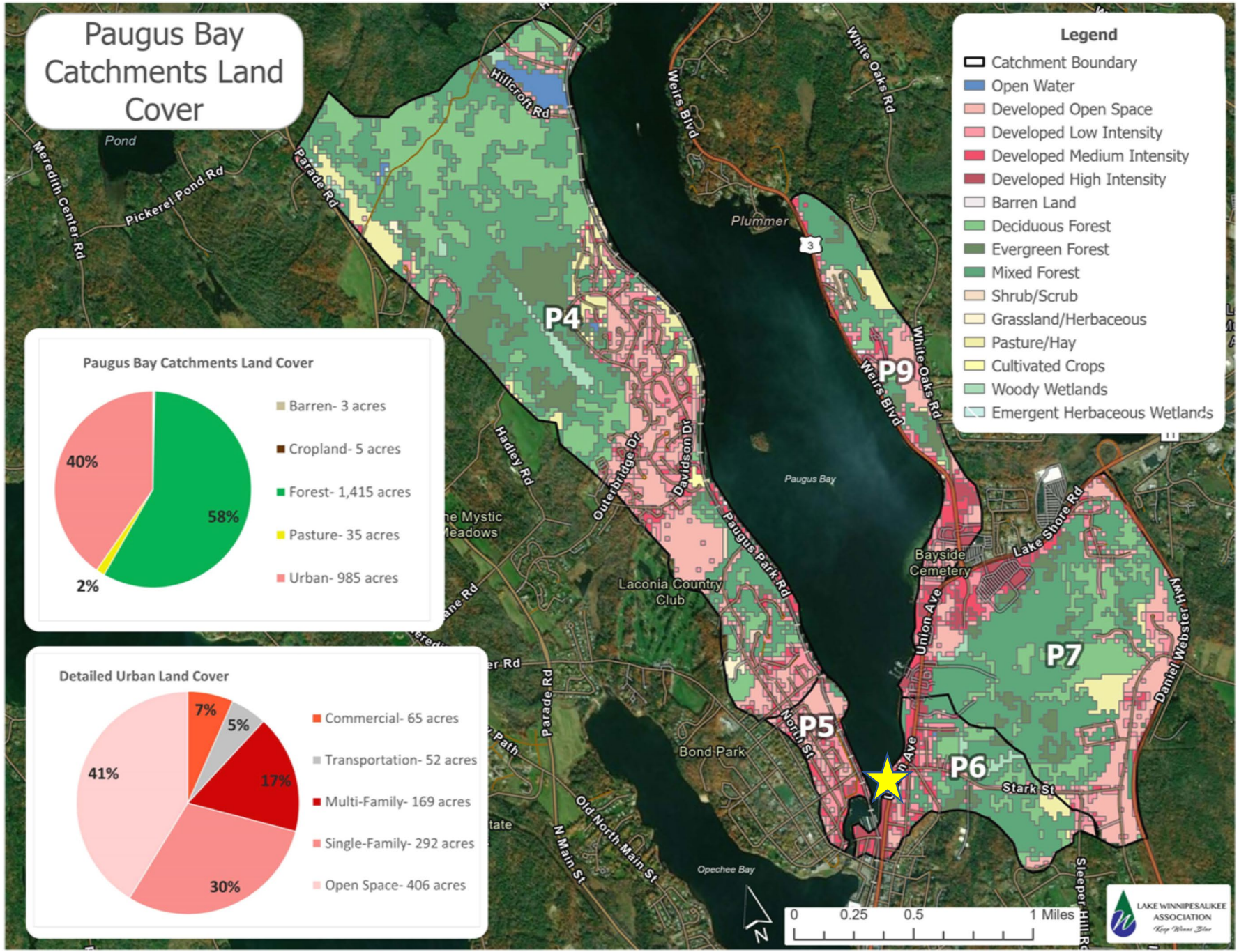
- Weather
- Soil Type
- Septic Systems
- Land Cover Data

Photo Credit: Frank Roche





Paugus Bay Catchments Land Cover



Land Cover by Catchment

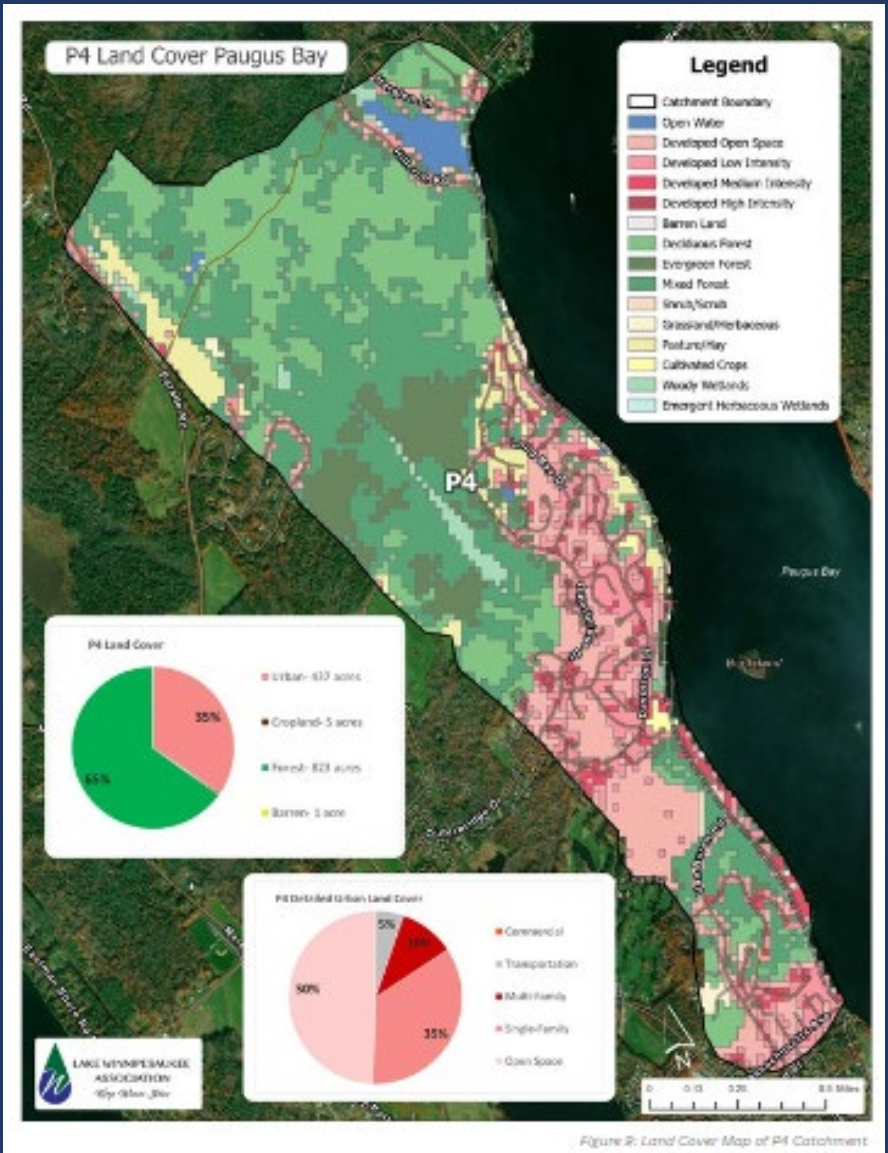


Figure 8: Land Cover Map of P4 Catchment

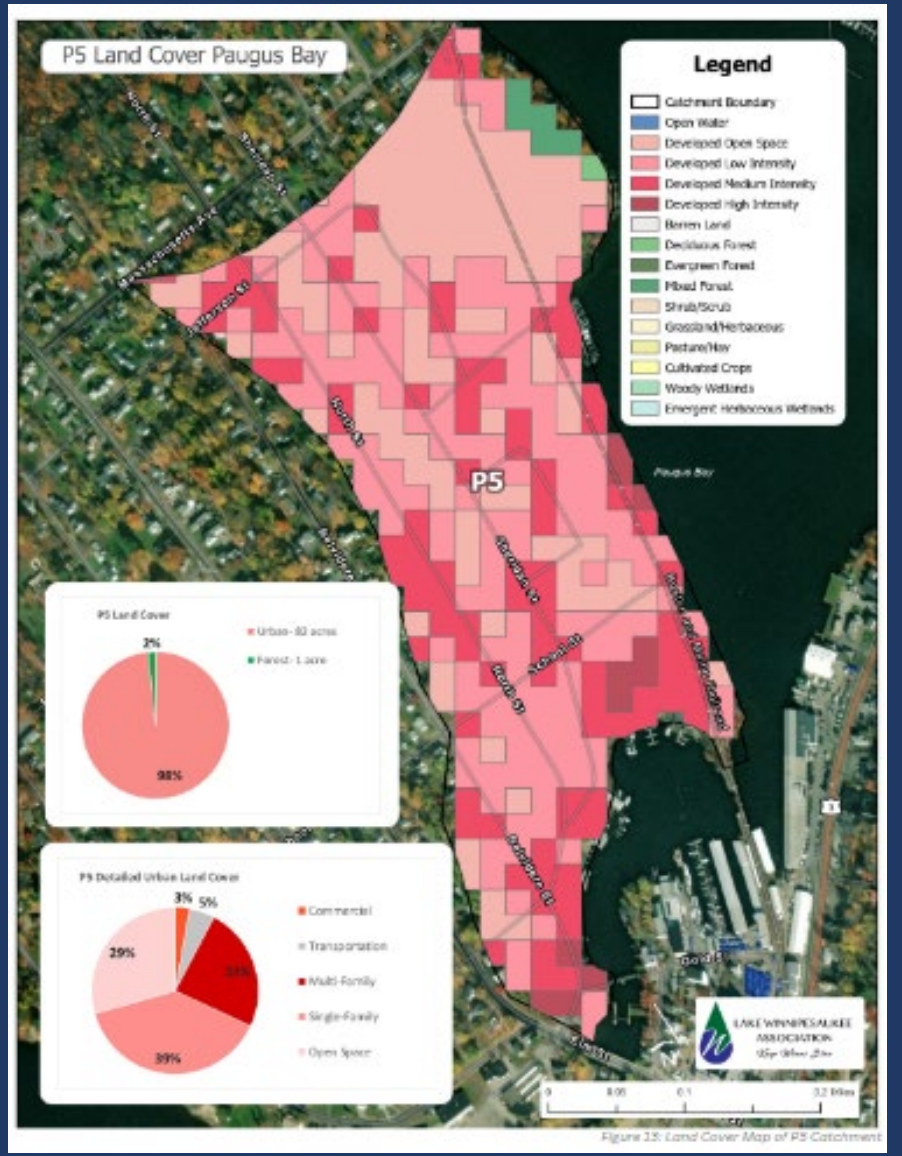
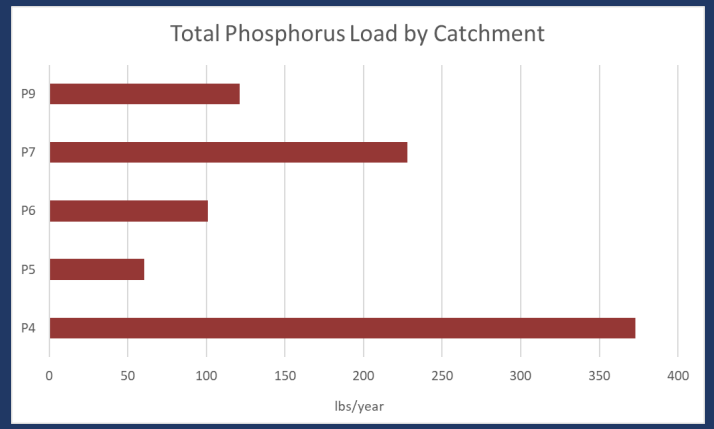


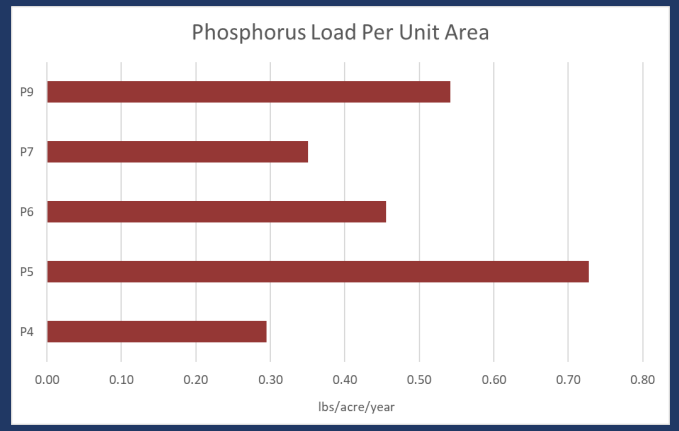
Figure 15: Land Cover Map of P5 Catchment

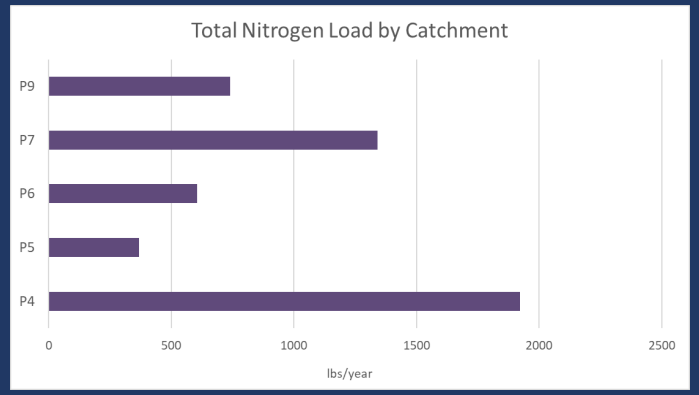
Nutrient Loading by Catchment

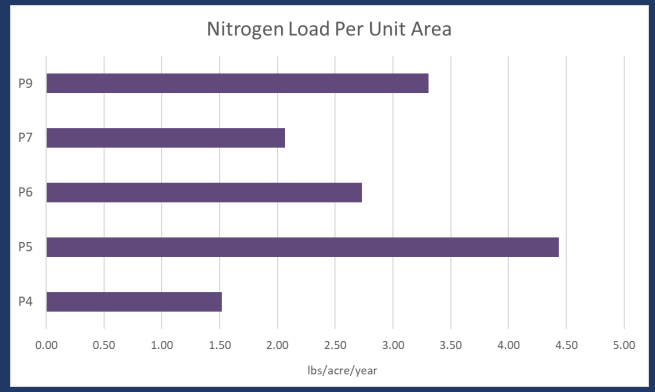
- Load by Catchment
  - Phosphorus
  - Nitrogen
  - Sediment
- Load per Unit Area
  - Based on catchment size

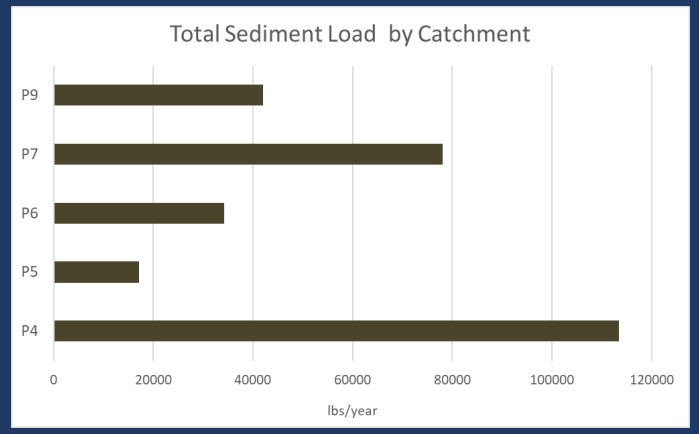
Even though P5 is the smallest catchment at just over 80 acres, it has the highest per-acre pollution load for Phosphorus, Nitrogen, and Sediment

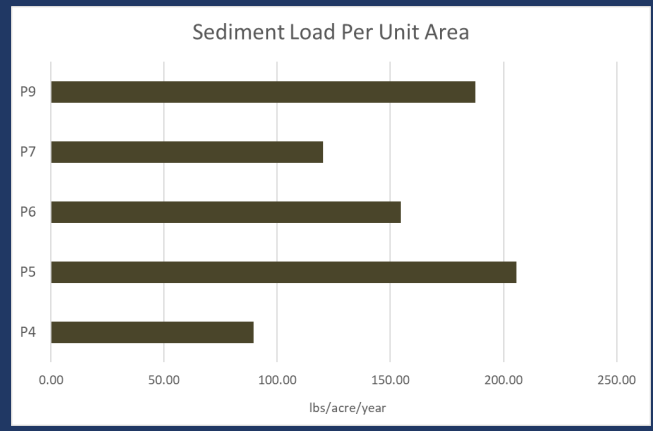


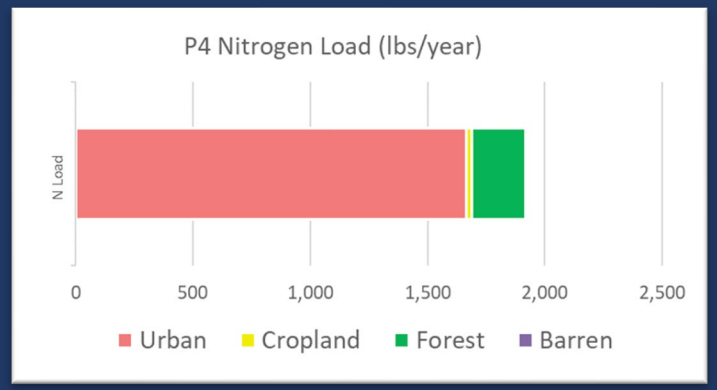


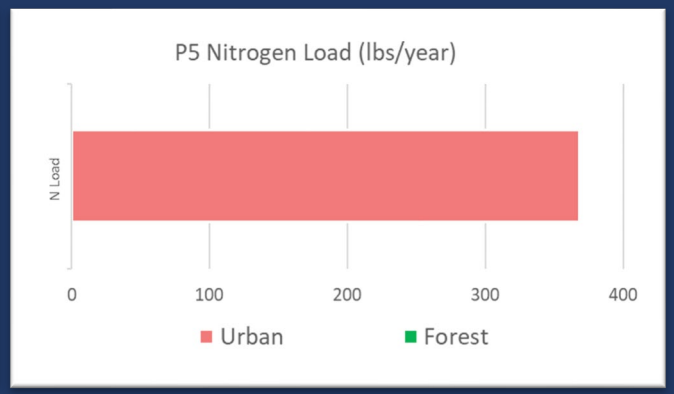


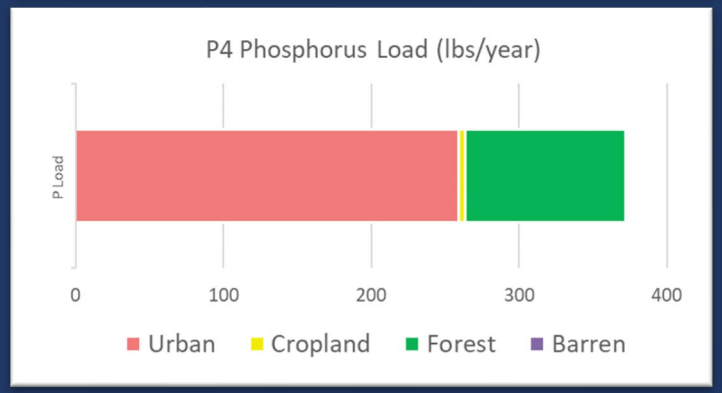


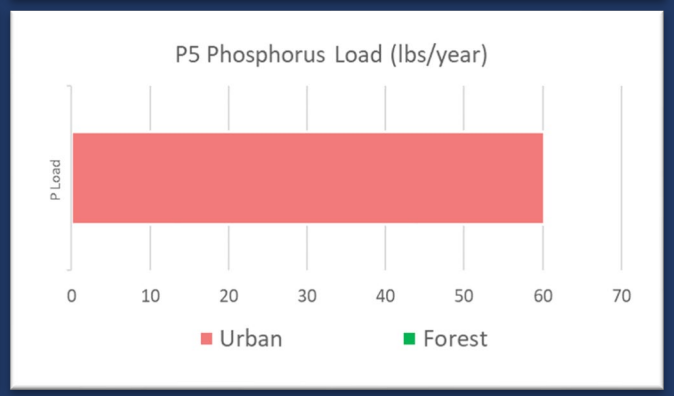


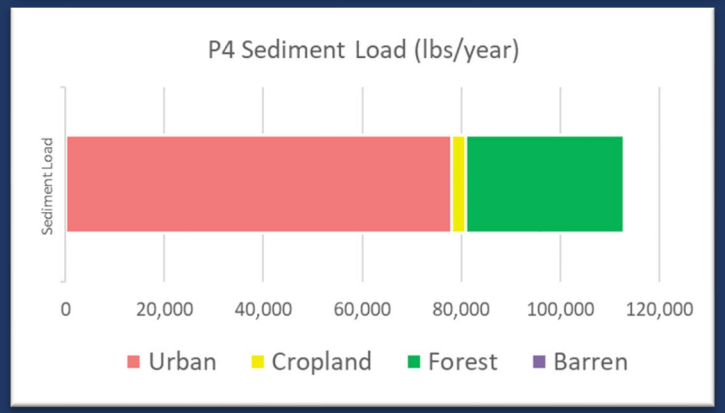


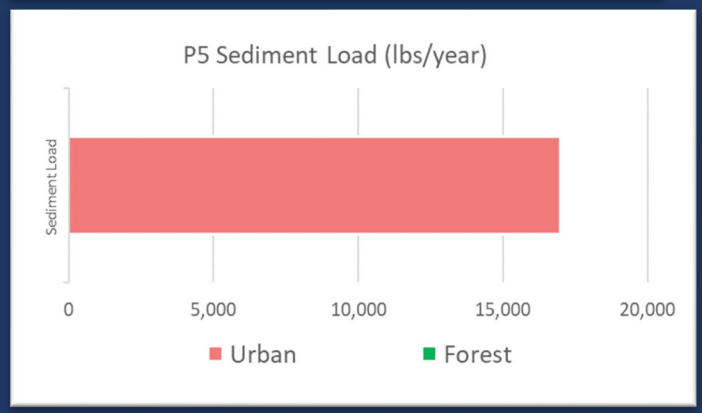












Loading by Land Cover

- Developed = 40%
  - Open Space (45%)
  - Single Family (22%)
  - Multi Family (17%)
  - Commercial (7%)
  - Roads (5%)
- Forested = 58%
- Increasing Development

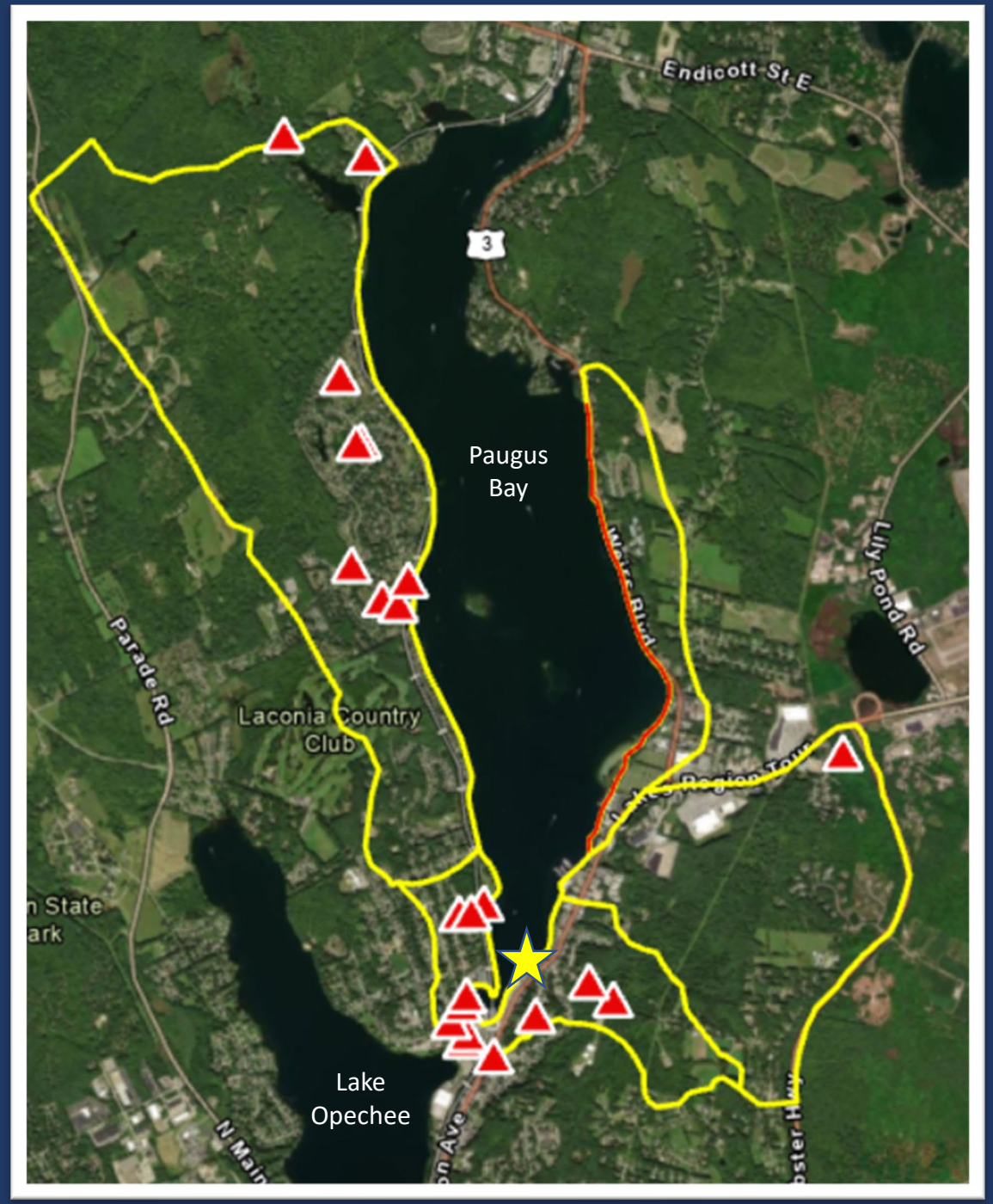
Land Cover	Acreage	Percentage
Barren	3	0%
Cropland	5	0%
Forest	1,415	58%
Pasture	35	1%
Urban	985	40%
Total	**2443**	**100%**
Detailed Urban		
Commercial	65	*7%*
Transportation	52	*5%*
Multi-Family	169	*17%*
Single-Family	292	*30%*
Open Space	406	*41%*
Total	985	*100%*

Table 1: Land Cover for P4, P5, P6, P7 and P8.

Watershed Survey

- Ground truthing GIS data
- Identified and characterized sites contributing excessive pollutants
- 23 sites
- Highly Urbanized

- Roads/Crossings
- Residential Properties
- Commercial Properties
- Municipal Land
- Forestry Activities
- Agriculture
- Recreational Areas



Nonpoint Source Sites

1. Water Access Points
2. Road Surfaces and Shoulders
3. General Erosion
4. Downtown/Urban Areas

Increasing development on top of aging infrastructure has consequences.

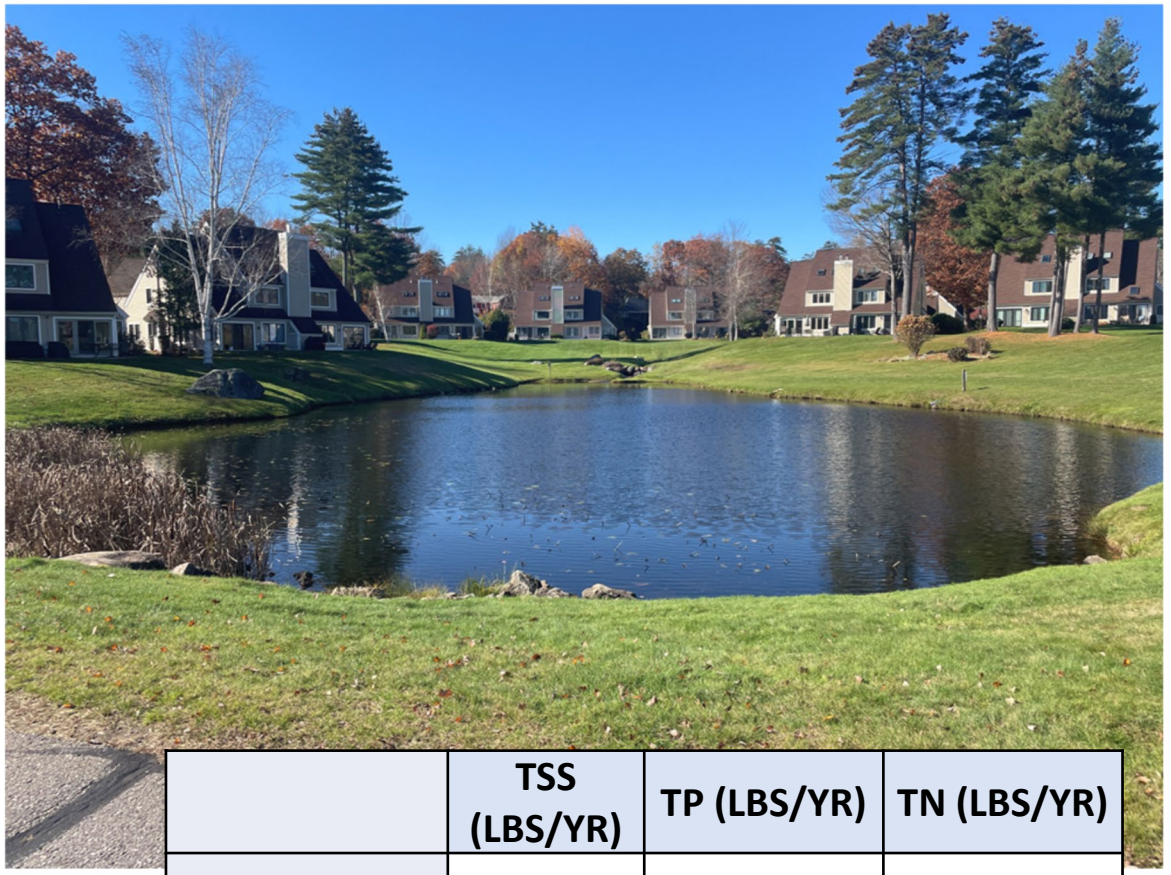
BMP Example

Site ID: PB-P4-08

Impact: High

Observations: This detention pond captures a majority of the drainage from a large residential development and drains through a culvert into another detention pond before it outlets to Paugus Bay. The lack of vegetated buffer is causing areas within the bank to collapse, and the expansive grassy areas often have geese present.

Recommendations: This is a large opportunity to improve upon stormwater controls at the site and provide benefits to the community and the environment



	TSS (LBS/YR)	TP (LBS/YR)	TN (LBS/YR)
Pre-Development Nutrient Loads	1453	6	32
Post-Development Loads (With BMPs)	392	3	20
Reduction Due to BMPs	1061	2.6	13
Difference	73%	45%	40%

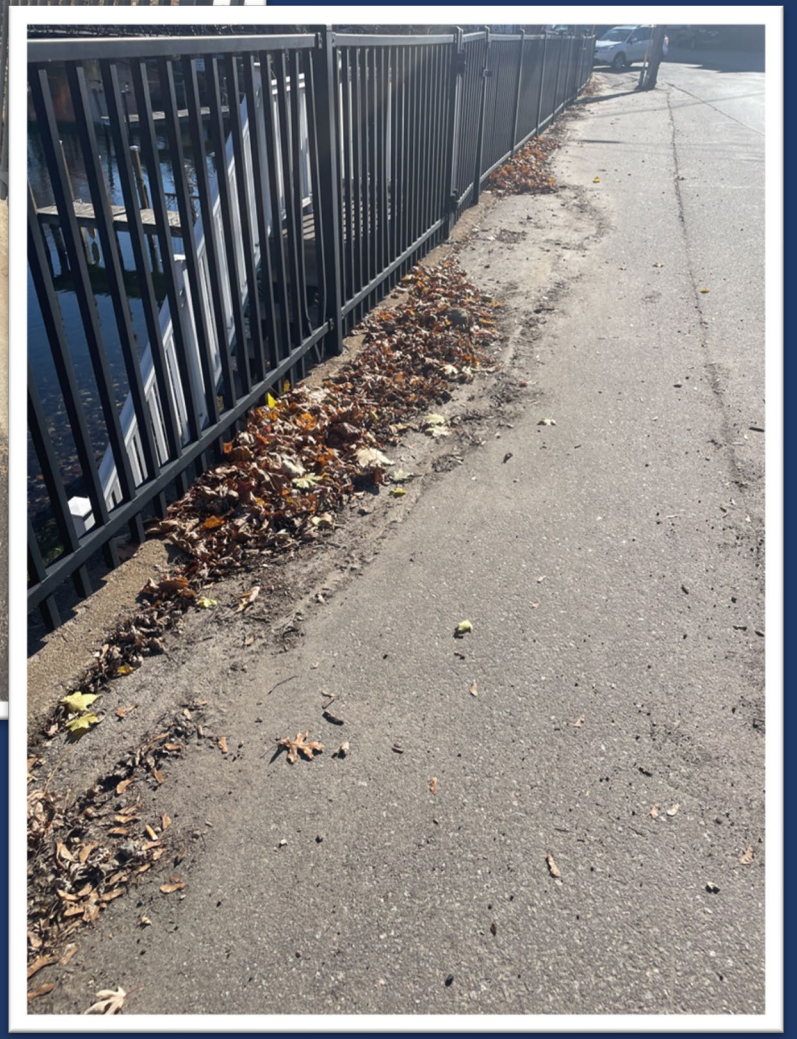
Estimated Project Reductions

Site ID: PB-P5-01
Impact: High

Observations: Belvidere Rd is a steeply sloping impervious surface the generates and deposits storm water runoff in an area with inadequate drainage less than 20 feet to the Bay.

Recommendations: We recommend installing an underground chamber filtration system to capture sediment and filter out pollutants.

	TSS (LBS/YR)	TP (LBS/YR)	TN (LBS/YR)
Pre-Development Nutrient Loads	5427	27	197.7
Post-Development Loads (With BMPs)	543	24	69.2
Reduction Due to BMPs	4885	3	128.5
Difference	90%	10%	65%



Project Types

Different types of BMPs target different remediation efforts.

- Vegetated Buffer
- Vegetated Swale
- Armoring Culverts
- Culvert Maintenance
- Filtration Systems (Above or Underground)
- Infiltration Trench
- Road Maintenace
- Recrown/Reshape Road
- Remove pavement
- Bioretention

Project Type	Count
Vegetated Buffer/Swale	14
Culvert Repair and Maintenance	3
Filtration Systems	3
Road Repair and Maintenance	3

Sometimes, these BMPs are able to be combined to be even more effective.

Step One: Address Problem Above → Unpaved dirt road creating erosion and sedimentation a road over.

Step Two: Address Issue Itself → Bare soil is being deposited into the waterbody.

Step Three: Provide additional measures to protect water quality → Add native vegetation to shoreline.

Shoreline Survey

- Identify potential land use impacts on Paugus Bay
- Access to public property only, shoreline survey gives us a general idea from the water
- Score based on
  - Buffer Width
  - Bare Soil
  - Shoreline Erosion
  - Structure Setback Distance
- 141 Parcels

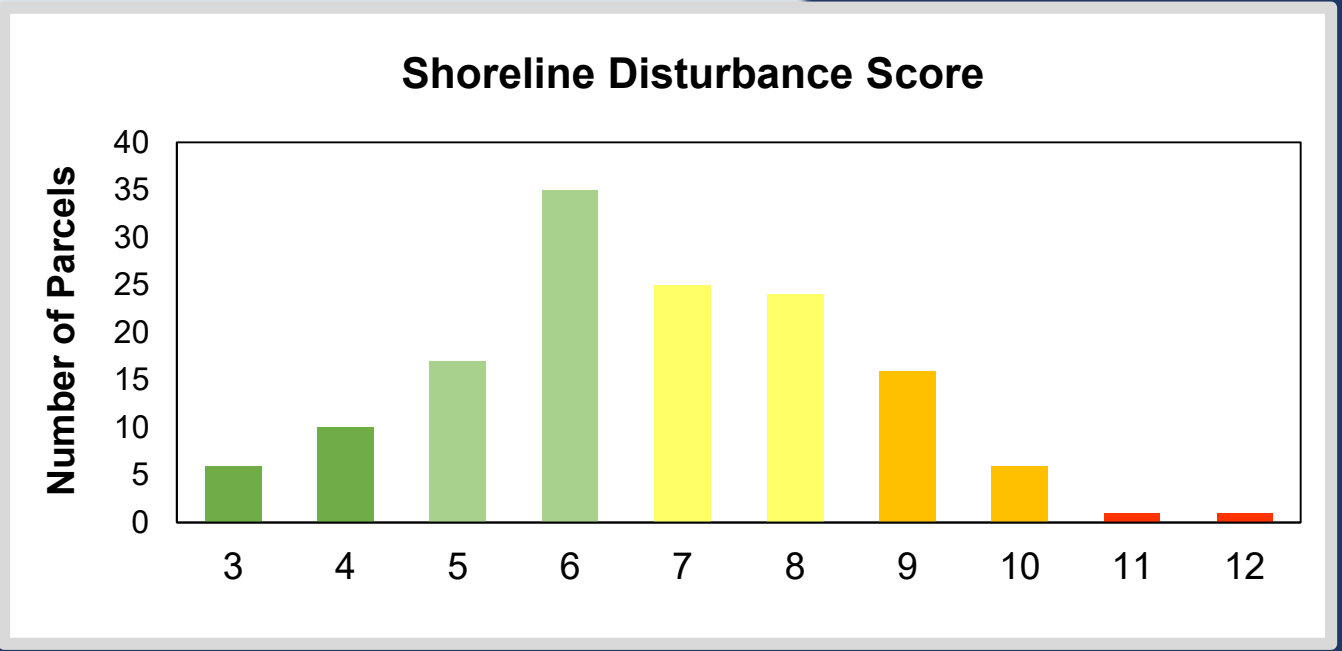
Shoreline Disturbance Score

Low Disturbance	0 - 4
Moderate	5 - 6
High	7 - 8
Very High	9 - 10
Extreme	11 - 12

Excellent

Poor

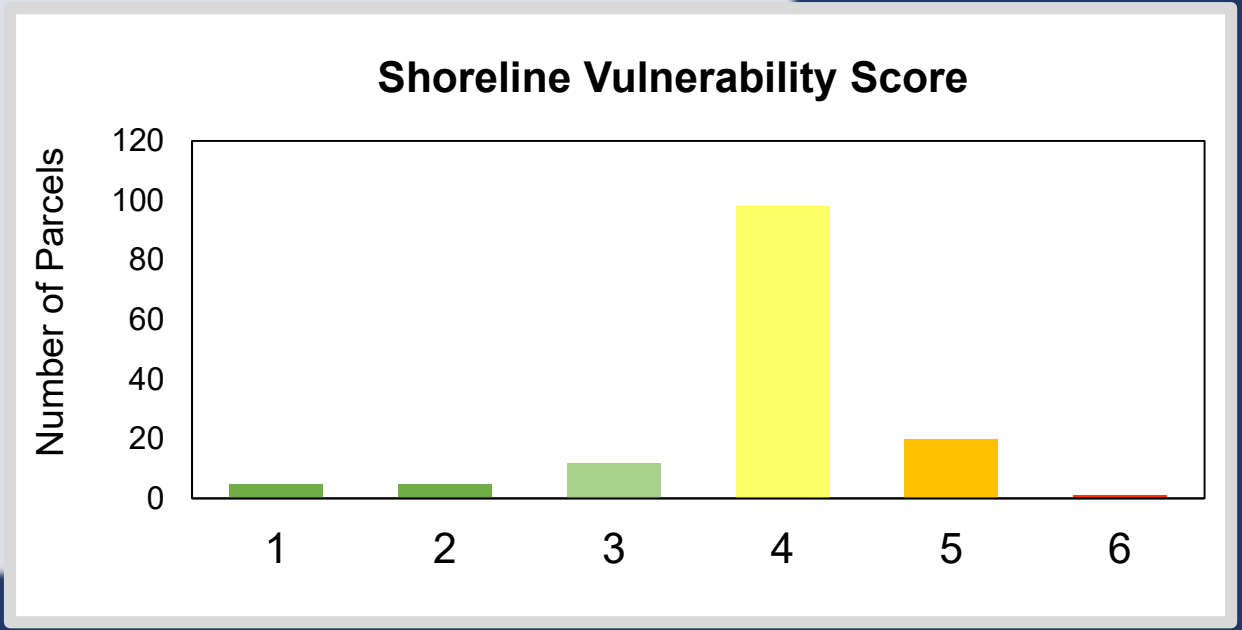
Evaluated Condition	Average Score
Buffer (1-5)	3.8
Bare Soil (1-4)	1.7
Shoreline Erosion (1-3)	1.3
Shoreline Disturbance Score (3-12)	**6.72**
Distance (0-3)	2.4
Slope (1-3)	1.5
Shoreline Vulnerability Score (1-6)	**4**



SDS Calcs	Count of Parcels	Percentage
3	6	**4.3%**
4	10	**7.1%**
5	17	**12.1%**
6	35	**24.8%**
7	25	**17.7%**
8	24	**17%**
9	16	**11.3%**
10	6	**4.3%**
11	1	**0.7%**
12	1	**0.7%**
Grand Total	141	**100%**

Shoreline Vulnerability Score

Low Vulnerability	**0 - 2**	Excellent
Moderate	**3**	
High	**4**	
Very High	**5**	
Extreme	**6**	Poor

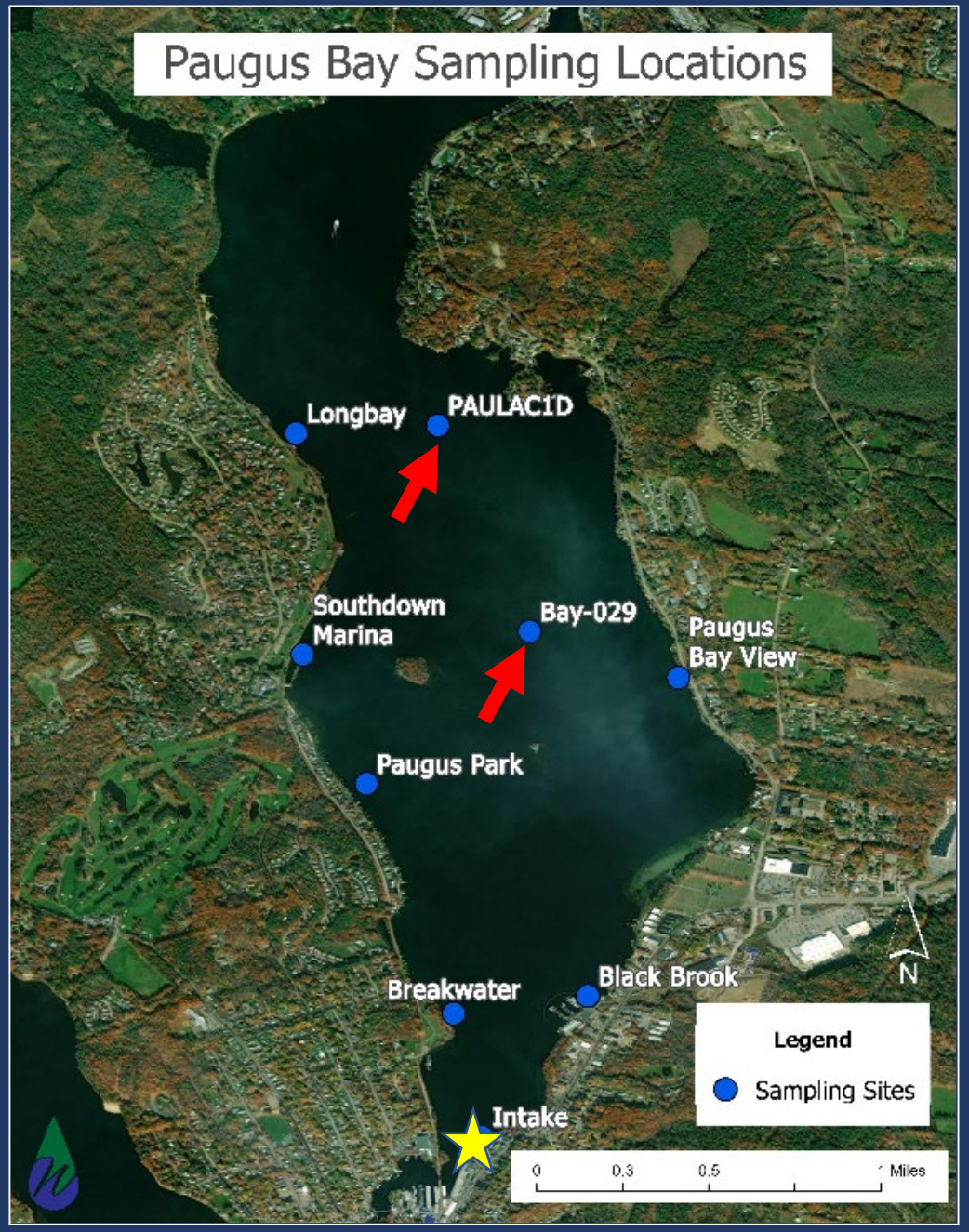


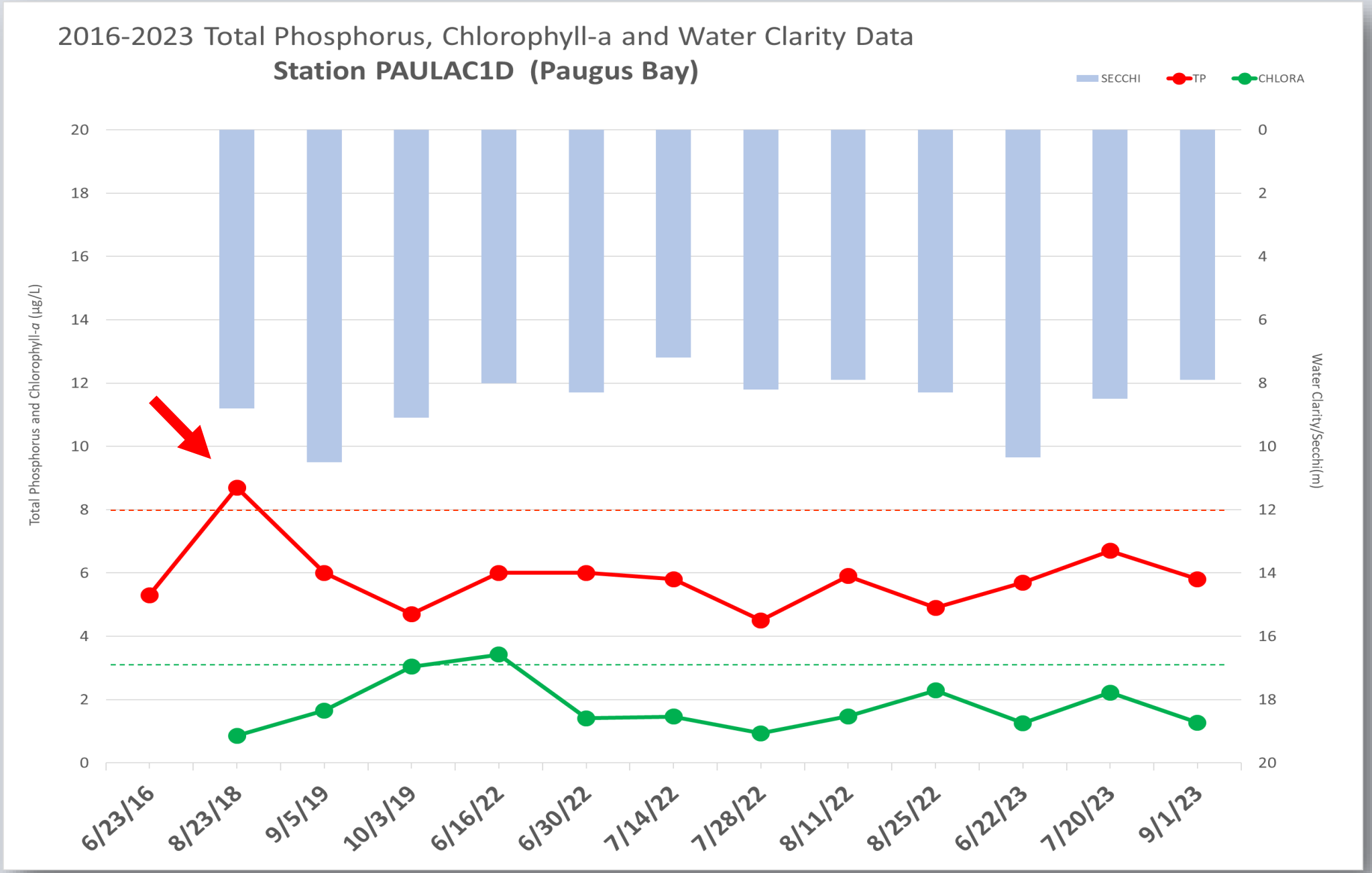
Evaluated Condition	Average Score
Buffer (1-5)	3.8
Bare Soil (1-4)	1.7
Shoreline Erosion (1-3)	1.3
Shoreline Disturbance Score (3-12)	**7**
Distance (0-3)	2.4
Slope (1-3)	1.5
Shoreline Vulnerability Score (1-6)	**4**

SVS Calcs	Count of Parcels	Percentage
1	5	**3.5%**
2	5	**3.5%**
3	12	**8.5%**
4	98	**69.5%**
5	20	**14.2%**
6	1	**0.7%**
Grand Total	141	**100%**

Monitoring Program

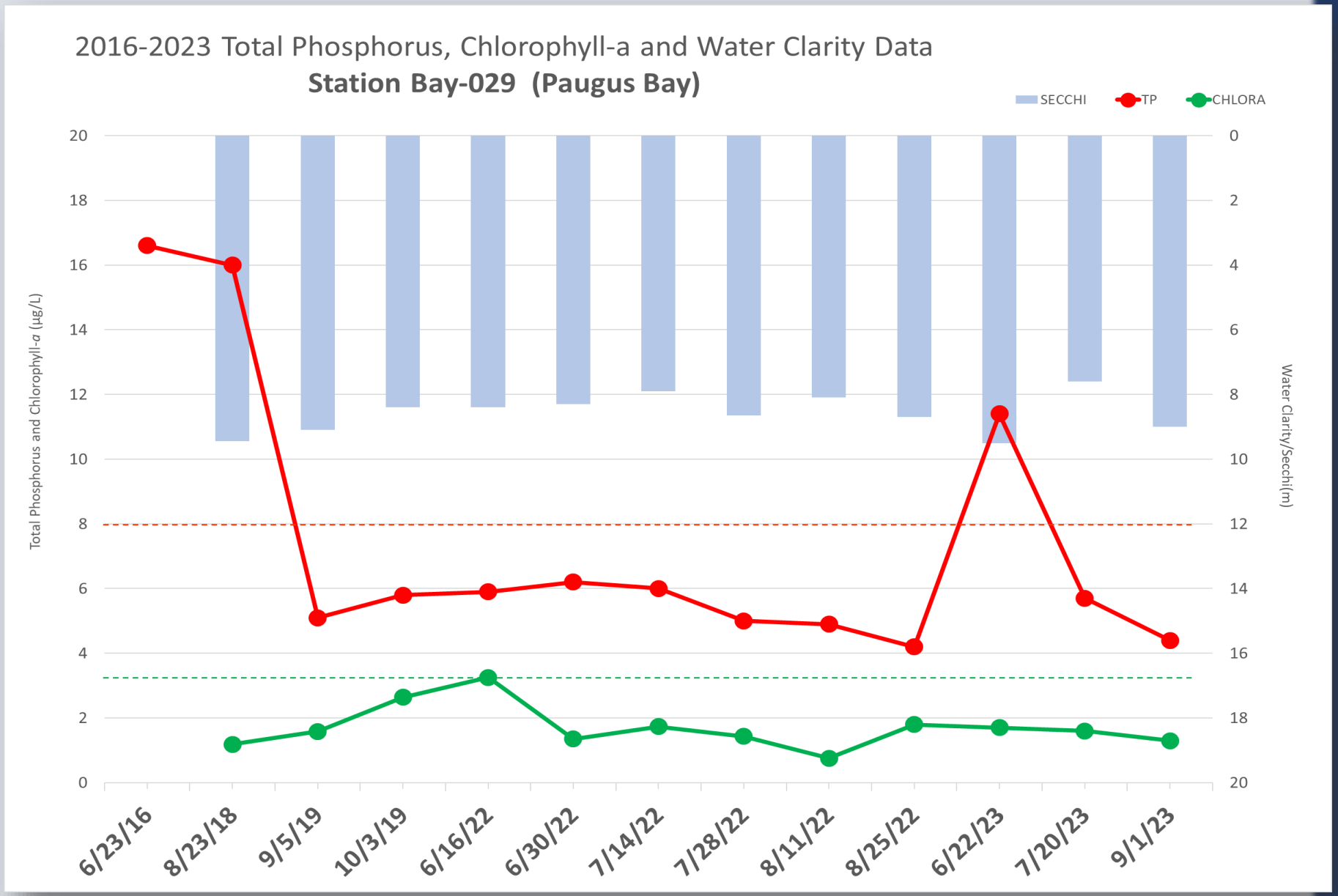
- The Laconia Conservation Commission (CC) has re-established the monitoring on Paugus Bay.
- LWA in collaboration with the CC monitors the deep-water sites in the Bay for total phosphorus, chl-a, and water clarity through the UNH Lakes Lay Monitoring Program.
- The Laconia Water Department has increased their E.Coli monitoring program to add TP and chl-a sample collection in nearshore areas of concern.
- 2 Deep Sites



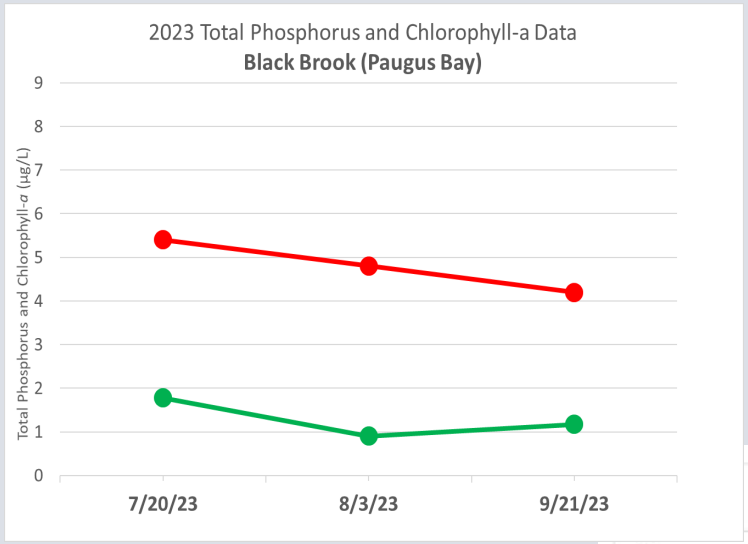

2016-2023 Total Phosphorus, Chlorophyll-a and Water Clarity Data
Station PAULAC1D (Paugus Bay)
SECCHI
TP
CHLORA
Total Phosphorus and Chlorophyll-a (µg/L)
Water Clarity/Secchi(m)
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
6/23/16
8/23/18
9/5/19
10/3/19
6/16/22
6/30/22
7/14/22
7/28/22
8/11/22
8/25/22
6/22/23
7/20/23
9/1/23

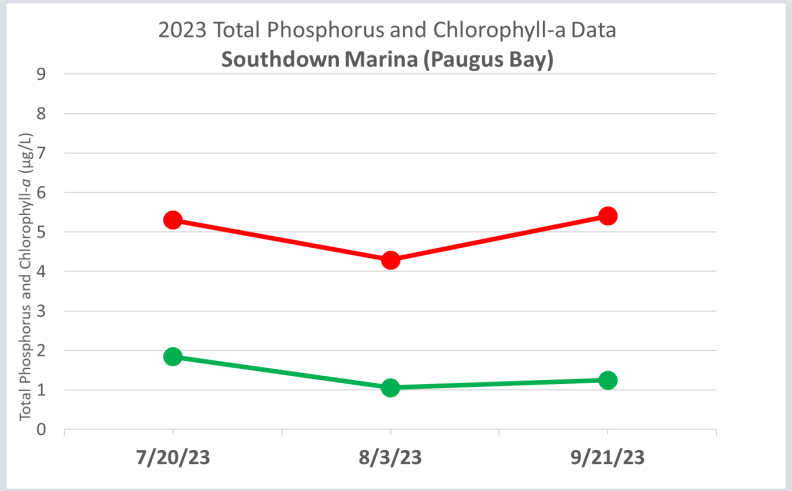
Water Quality

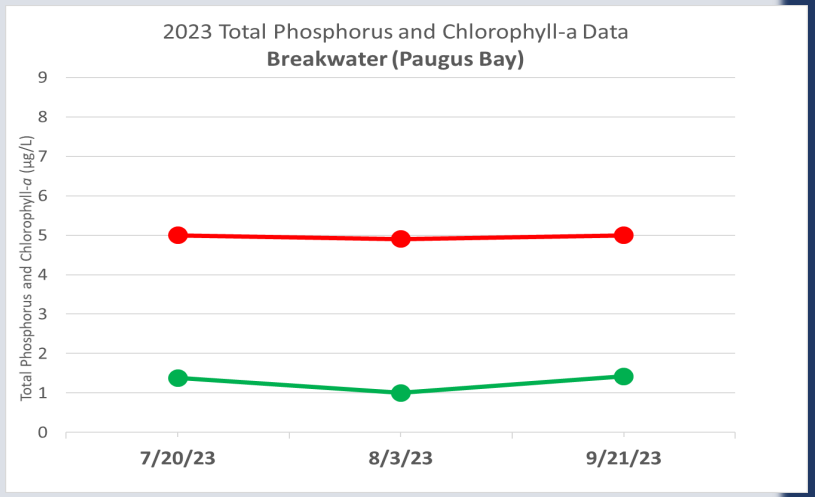
In **June of 2023**, TP results at Bay-029 were well over the threshold for the first time since 2018.

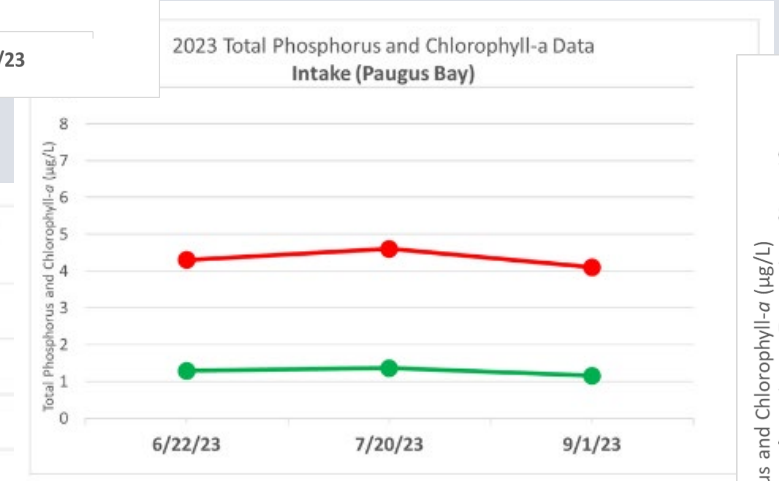


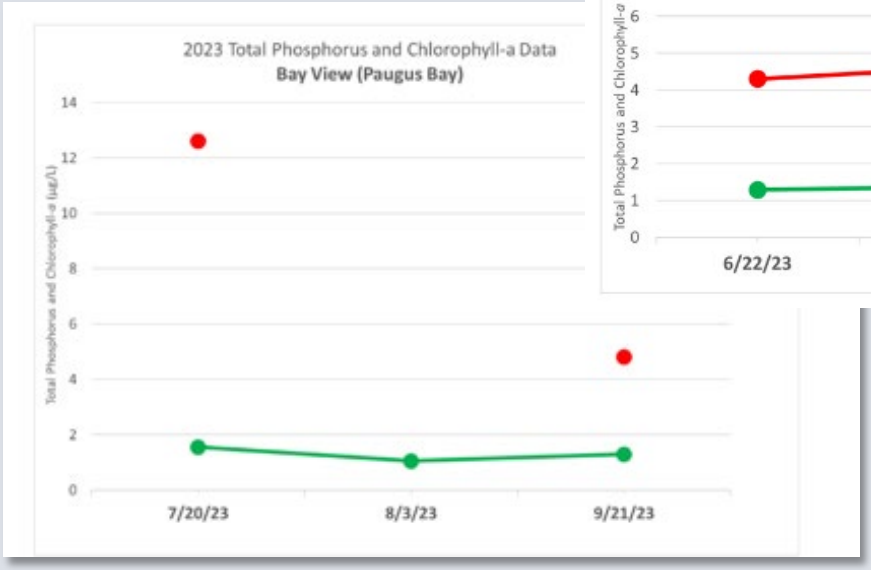
Nearshore Water Quality

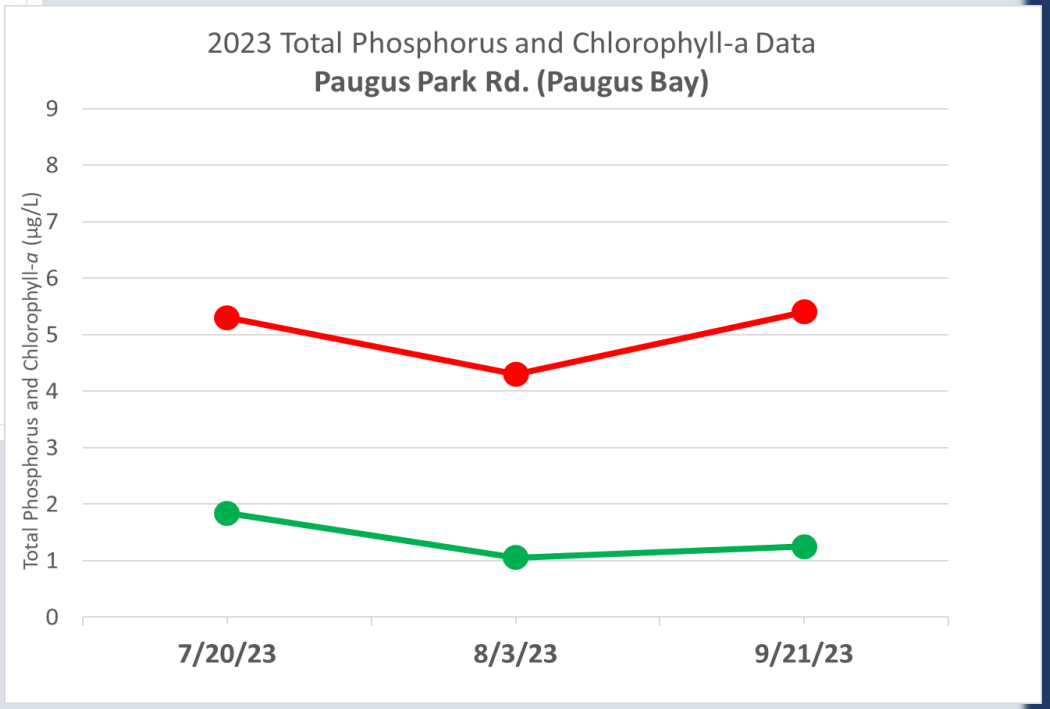






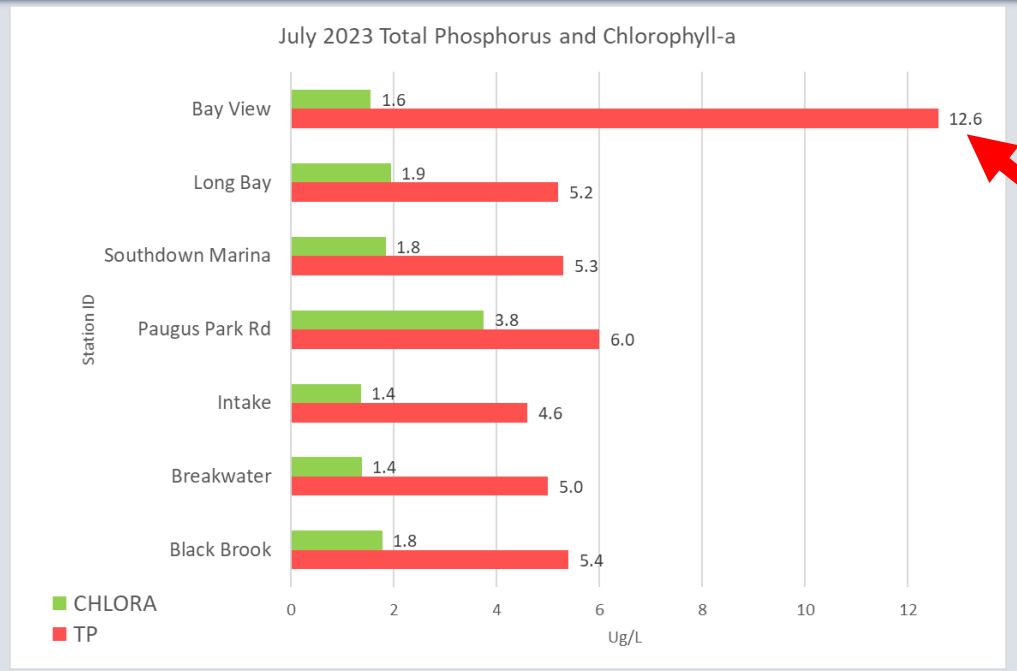






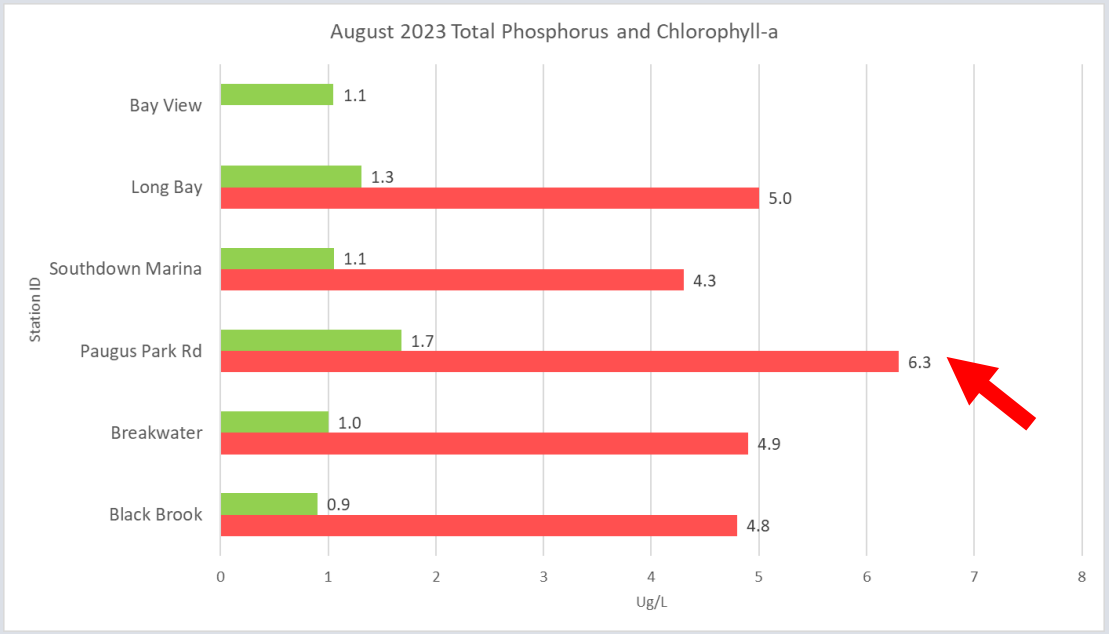

Paugus Bay Sampling Locations
Longbay
PAULAC1D
Southdown Marina
Bay-029
Paugus Bay View
Paugus Park
Breakwater
Black Brook
Intake
N
Legend
Sampling Sites
0
0.3
0.5
Miles

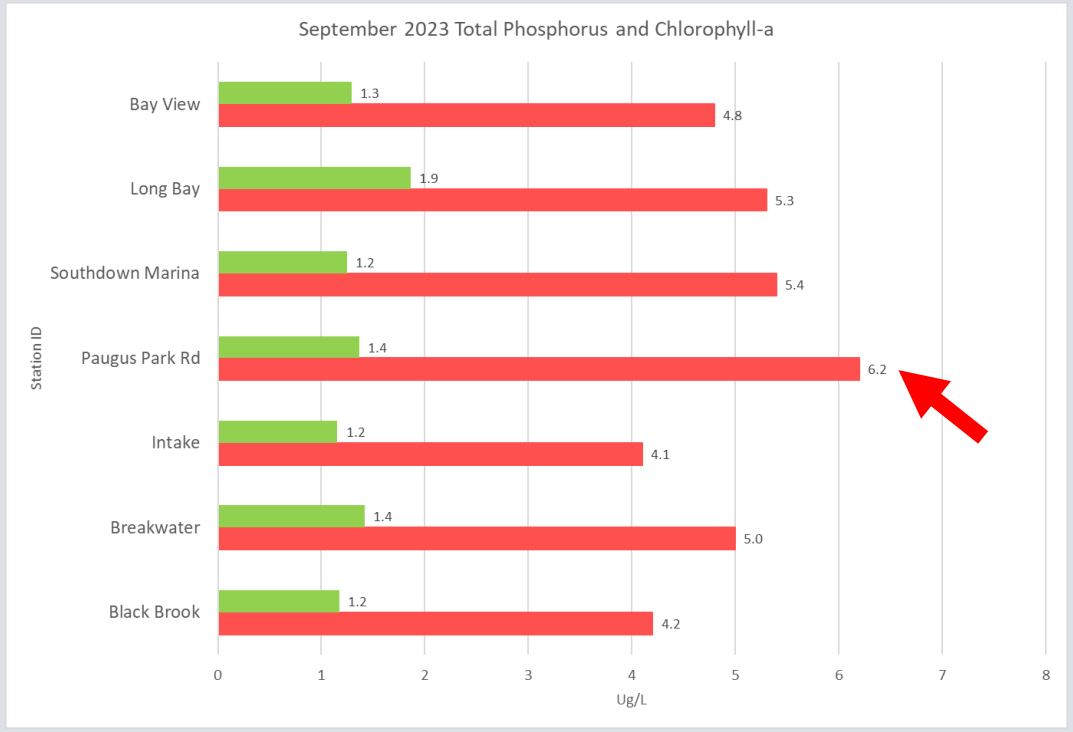

P4
P9
P7
P5
P6



Comparing all Stations

TP and Chl-a levels were significantly higher at Paugus Park Road at almost every sampling event.





Action Plan

- What are the priorities?
- What is the expected nutrient load reduction?
- When will tasks be implemented?
- Who will do the work?
- How will it be tracked/monitored?

Table 16. Action plan for the Lake Kanasatka watershed.

Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
Watershed & Shoreline BMPs			
Complete design and construction of mitigation measures at the top five high priority sites identified in the watershed survey. **Achieves 12% (7 kg/yr P of 59 kg/yr P) of Objective 1.**	LKWA, CCCD, Municipalities, private landowners	$72K-$155K 2022-27	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipalities, private landowners
Complete design and construction of mitigation measures at 17 medium and low priority sites identified in the watershed survey as opportunities arise (refer to Appendix B for complete list). **Achieves 7% (4 kg/yr P of 59 kg/yr P) of Objective 1.**	LKWA, CCCD, BCCD, Municipalities, private landowners	$188K-$493K 2022-31	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipalities, private landowners
Continue promoting the LakeSmart program evaluations and certifications through NH Lakes to educate property owners about lake-friendly practices such as revegetating shoreline buffers with native plants, avoiding large grassy areas, and increasing mower blade heights to 4 inches. Coordinate with NHDES Soak Up the Rain NH program for workshops and trainings. Direct landowners to UNH Extension's *Landscaping at the Water's Edge*. Cost assumes coordination of and materials for up to five workshops.	LKWA, CCCD, BCCD, NH Lakes, NHDES Soak Up the Rain NH, Municipalities	$5K 2022-31	NH Lakes, NHDES Soak Up the Rain NH, Grants (319, Moose plate), CWSRF, Municipalities
Provide technical assistance and/or implementation cost sharing to watershed/shoreline property owners to install stormwater and/or erosion controls such as rain gardens and buffer plantings. Prioritize high impact properties identified during the shoreline survey. Cost assumes technical assistance and implementation cost sharing provided to the three high impact shoreline properties. **Achieves 5% (3 kg/yr P of 59 kg/yr P) of Objective 1.**	LKWA, CCCD, Municipalities, Landowners	$55K 2022-25	Grants (319, Moose plate), CWSRF, Landowners

[9] Cost estimates for each recommendation will need to be adjust

Best Management Practices

Education & Outreach

Municipal Ordinances

Monitoring & Assessment

Education and Outreach

Create a network of concerned community members and volunteers dedicated to protecting the lake.

The Takeaway:

- Paugus Bay is an extremely developed for a Source Water Protection Area.
- Increasing development on existing/outdated infrastructure is not sustainable.
- The smallest catchment (which is also the most urbanized) contributes the greatest load by area into Paugus Bay. That's significant!

Next Steps:

- We can work together to make a difference in our watersheds!
  - Working with the City of Laconia Public Works and Conservation Commission
    - Implement BMP Recommendations and address sites that are in need of mitigation
    - Continue to monitor the water quality of Paugus Bay
    - Targeted education and outreach efforts to businesses and residents within the watershed
      - Winni Blue/LakeSmart Program
      - Coordinate outreach events

Questions? Thank You!

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