Buffalo Lake
Water Quality Sampling Results

Ted Johnson
DNR - Lake Biologist

Dave Bolha
DNR - Stream Biologist

September 6th, 2025

Agenda

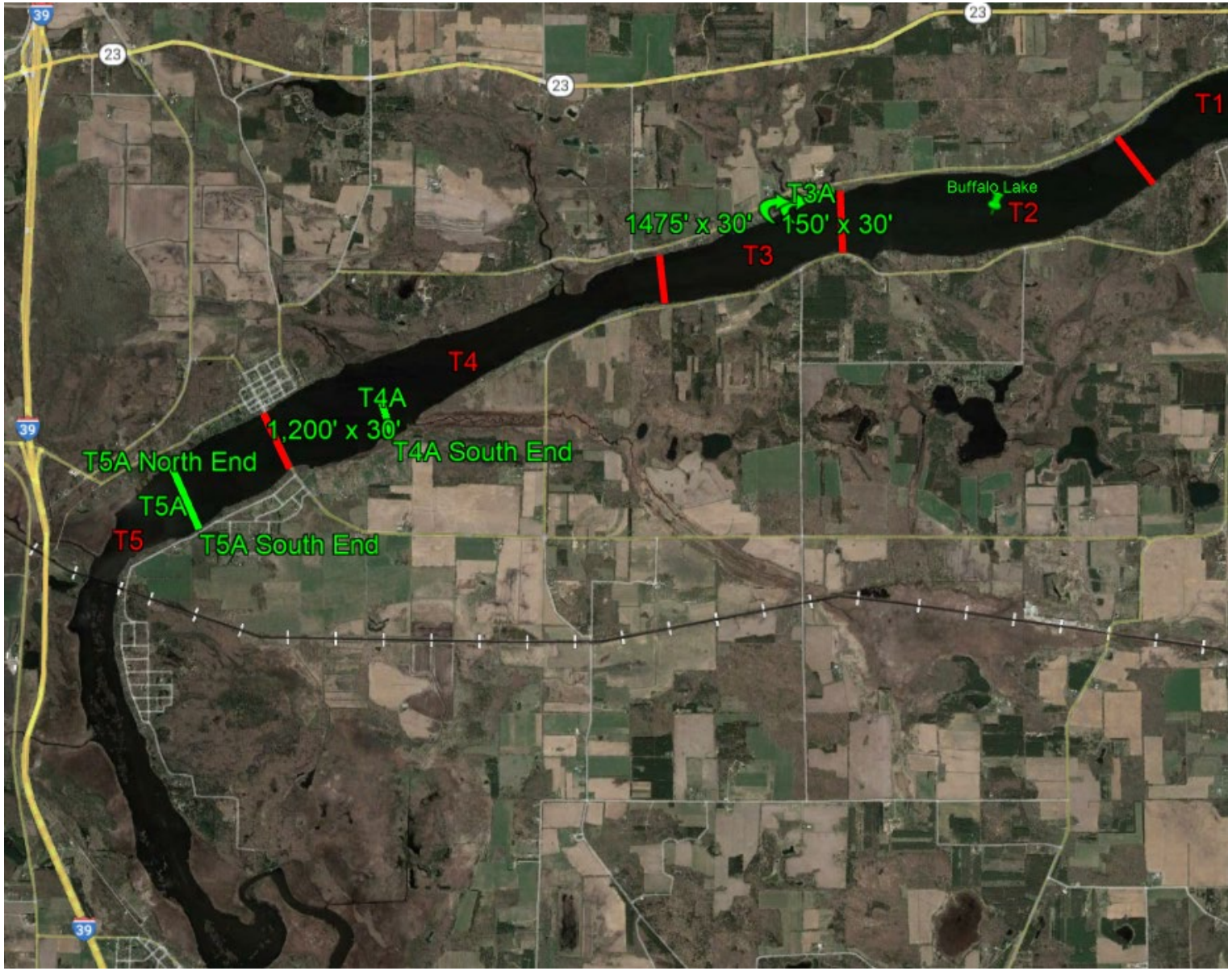
- Timeline: water quality concerns, loss of aquatic plants & low dissolved oxygen
- Study design
- Water quality results
- Possible causative factors to plant stress & loss
- Next steps

Timeline

- **May 21 & 22:** Buffalo Lake consultant applied herbicides for navigation on 8.2 acres. Followed permit conditions.
- **June 10-11**: Complaint calls about poor water quality, dead turtles, loss of aquatic plants, low dissolved oxygen.
- **June 11**: DNR staff toured Buffalo Lake and met with Lake District Reps (Jim Murre, Bob Fohey).
- DNR staff developed study design and got financial / technical approval to proceed.
- **June 17**: DNR staff conducted sampling @ 6 stations
- **June 26**: DNR and DATCP staff conducted herbicide & pesticide sampling plus water chemistry at 3 stations.
- **July 1**: DNR staff conducted water chemistry sampling at 2 stations.
- **August 15**: DNR staff checked basic water quality parameters at 2 stations.

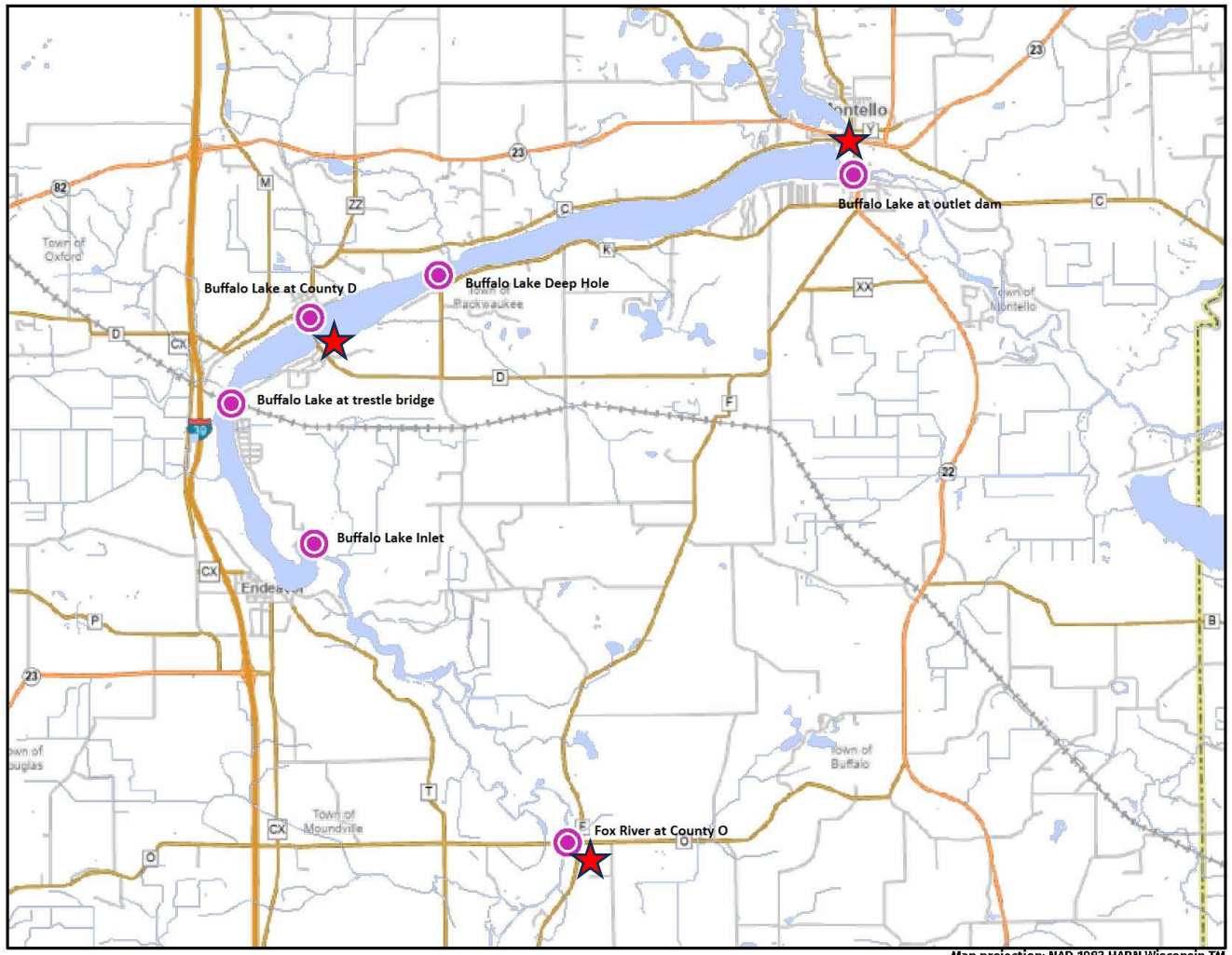
Herbicide Treatments

- Four total treatments done on 5/21/25 and 5/22/25.
- Treatment areas: 4.7, 1.1, 0.8 and 1.6 acres. **Total 8.2 acres**
- Total area **0.37%** of lake surface area (2,210 acres).
  - Aquastrike = Endothall & Diquat
  - Cutrine
- Not enough herbicide to cause systemic plant loss.
- Sean Strom (Fish & Wildlife - Environmental Toxicologist) opinion, herbicide likely did not cause turtle mortality.



WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Buffalo Lake Sampling Points



Legend: (some map layers may not be displayed)

- Rivers and Streams
- Intermittent Streams
- Open Water
- City or Village
- County Boundaries

Major Roads

- Interstate Highway
- State Highway

County and Local Roads

- County HWY
- Local Road
- Railroads

Notes:

Map projection: NAD 1983 HARN Wisconsin TM

N

Map: 0 8,000 16,000 Feet
0 2,000 4,000 Meters

Service Layer Credits:
Cities, Roads & Boundaries: , Surface Water (Cached): WiDNR, USGS, and other data

Date Printed: 6/18/2025 11:52 AM

DATCP – Herbicide Pesticide Sampling

- Sampled three stations on 6/26/25
- Sampled for 100 common herbicide / pesticides
- Three compounds were detected at low levels:
  - Atrazine, Metolachlor, 2,4(D)
- Most typical compounds found in streams
- All levels below EPA - Aquatic Life Benchmarks.
  - Didn't cause loss of plants

Sampling Parameters

Short Course

1. Field Parameters- Temperature, Dissolved Oxygen (DO), Dissolved Oxygen- Percent Saturation, pH, Conductivity, Secchi.
2. E. coli – Type of bacteria that live in the guts of warm-blooded animals. Indicator of runoff pollution. Levels over 235 cfu's are considered high for lakes. Greater than 1,000 cfu beach closures.
3. BOD(5) - 5-day biological demand. Measures amount of oxygen consumed by microorganisms over 5-days. High BOD(5) equals large amounts of organic matter. Lake levels: 1-2 mg/L good; 3-5 mg/L fair; >5 mg/L poor.
4. Total Suspended Solids – Measure of fine particles (soil, algae) in the water column. Values < 20 mg/L = clear water.
5. Chl a – Chlorophyll a is a measure of how much algae is in the system. <20 ug/L water quality standard.
6. Color - Can appear as blue, green, brown or red. Colors range from 0 - 300 SU (Standard Units).
7. Total Phosphorus (TP) – Most important nutrient limiting the growth of algae and aquatic plants. Water Quality Standard for Lowland Drainage Lakes is 0.04 mg/L.
8. Nitrogen – In lakes consists of organic and inorganic forms = Total Nitrogen (TN). Inorganic forms, ammonia (NH3) and nitrate (N03) are bioavailable. Nitrite (N02) is a form between organic and inorganic.

Main Water Quality Sampling Event Results (Six Stations)

Date	Sample Location	Temperature (C)	DO (mg/L)	DO % saturation	pH	Conductivity	Secchi (ft)	E.coli (/100 ml)	BOD 5 (mg/l)	TSS (mg/l)	Chl a (ug/l)	Color	TP (mg/l)	NO3 - NO2 (mg/l)	NH3 (mg/l)	TN (mg/l)
6/17/25	Fox @ Cty O	24.4	**8.0**	95.0	8.1	443.3	-	96.0	**3.09**	20.9		**30**	**0.083**	0.525	0.101	1.270
6/17/25	Buffalo inlet	24.1	**6.9**	82.4	8.0	440.5	**2.5**					**40**				
6/17/25	Buffalo @ trestle	23.5	**5.1**	60.4	7.8	433.5	**2.5**					**40**				
6/17/25	Buffalo @ Cty D	22.9	**5.1**	60.0	7.3	422.3	**2.5**					**40**				
6/17/25	Buffalo deep hole	22.7	**6.1**	71.1	8.0	413.0	**3.0**	4.0	**2.42**	7.0	**15.7**	**40**	**0.123**	0.226	0.116	1.050
6/17/25	Buffalo @ dam	23.9	**11.0**	**131.0**	8.6	401.4	-					**40**				

1. Dissolved Oxygen – Temporarily decreased in the lake then became super-saturated near the dam. Super-saturation can happen from high amounts of photosynthesis usually from large algal biomass.
2. Secchi Depth - 2.5– 3 feet is poor. (2016 & 2018: 4-6 feet)
3. BOD(5) – Fair level of organics in lake contributing to lower DO
4. Color – Increase from river 10 standard units. Lake is tea colored with reduced light penetration.
5. TP – Lake acting as a source of P. Normally, the opposite.

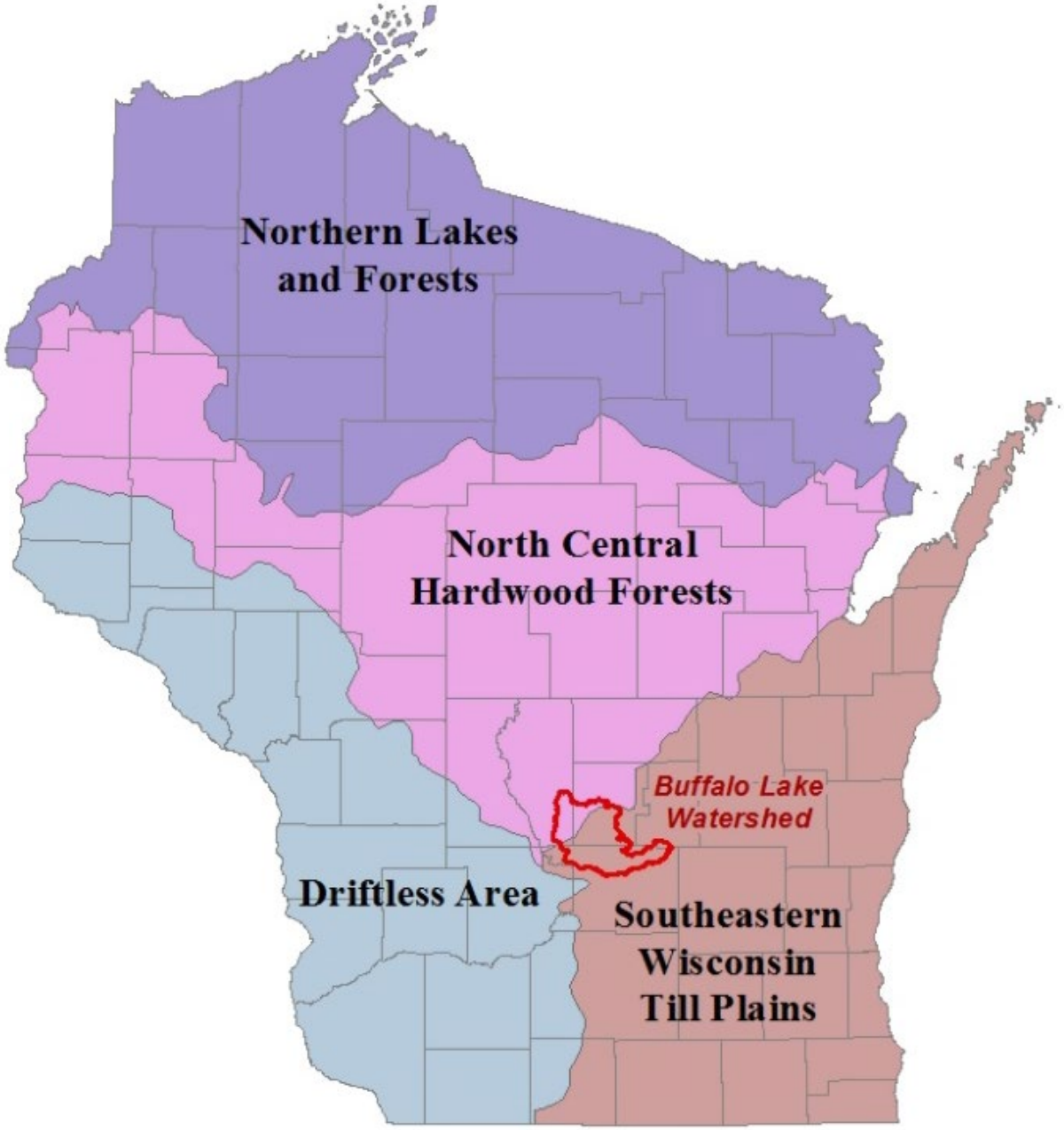
Date	Sample Location	Temperature	DO (mg/L)	DO % saturation	pH	Conductivity	**Secchi (ft)**	E.coli (/100 ml)	BOD 5 (mg/l)	**TSS (mg/l)**	Chl a (ug/l)	Color	TP (mg/l)	NO3 - NO2 (mg/l)	NH3 (mg/l)	TN (mg/l)
6/17/2025	Fox @ Cty O	24.4	8.0	95.0	8.1	443.3	-	96.0	3.09	**20.9**		30	0.083	0.525	0.101	1.270
6/17/2025	Buffalo inlet	24.1	6.9	82.4	8.0	440.5	**2.5**					40				
6/17/2025	Buffalo @ trestle	23.5	5.1	60.4	7.8	433.5	**2.5**					40				
6/17/2025	Buffalo @ Cty D	22.9	5.1	60.0	7.3	422.3	**2.5**					40				
6/17/2025	Buffalo deep hole	22.7	6.1	71.1	8.0	413.0	**3.0**	4.0	2.42	7.0	15.7	40	0.123	0.226	0.116	1.050
6/17/2025	Buffalo @ Dam	23.9	11.0	131.0	8.6	401.4	**-**					40				
6/26/2025	Fox @ Cty O	23.0	5.2	61.1	7.6	381.4										
6/26/2025	Buffalo @ Cty D	23.1	**3.2**	**37.2**	7.5	396.4										
6/26/2025	Buffalo @ Dam	24.0	5.3	62.9	8.0	391.5										
7/1/2025	Fox @ Cty O	26.5	**3.8**	**48.2**	7.5	371.0	**3.2**			**9.8**	**12.7**		**0.16**	0.304	0.069	1.530
7/1/2025	Buffalo @ Dam	27.9	**13.7**	**179.1**	8.7	351.0	**1.3**			**22.4**	**55**		**0.13**	0.034	0.023	1.310
8/15/2025	Buffalo @ Cty D	29.4	5.8	76.3	8.1	398.2	**3.0**									
8/15/2025	Buffalo @ Dam	30.2	10.8	141.0	8.5	390.2	**1.5**									

What is causing the loss of plants? Stressors?

1. External nutrient load (watershed).
   - Large storm events → rapid runoff → delivery of tanic acids → reduced clarity
2. Internal nutrient load
   - Release of nutrients from lake-bed sediments
     - With loss of plants, phosphorus levels increased from the Fox River Inlet to the dam.
3. Aquatic plant harvesting
   - Cutting plants causes stress to plants
     - Comments indicating that once plants were harvested a few times they didn't grow back.
     - DNR understands the need to harvest.

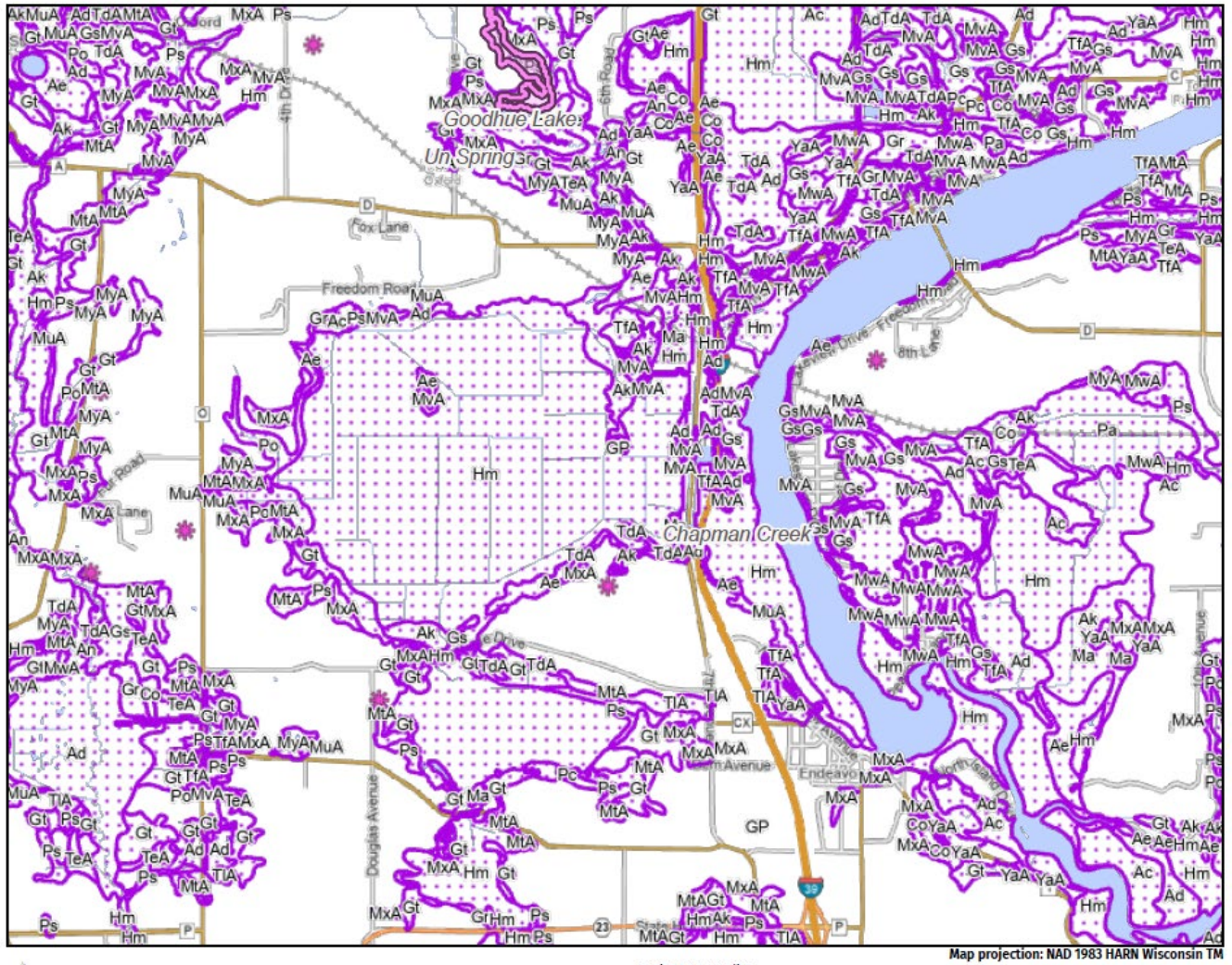
Buffalo Lake Watershed

- 257,418 Acres
- 19% Wetland (36,000 acres)



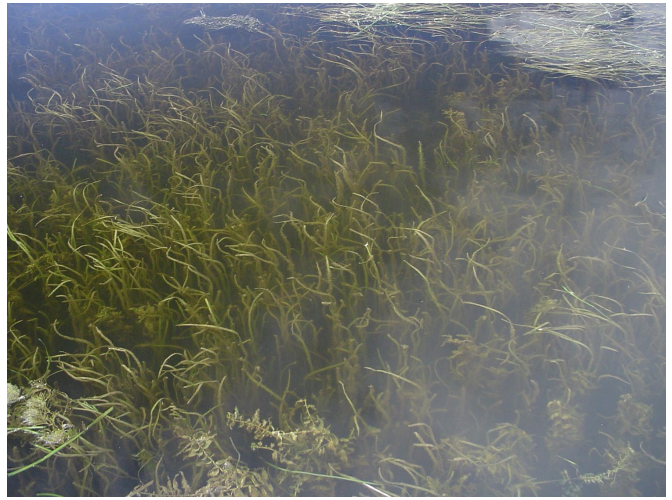
Buffalo Lake
Wetland Indicator Soils

WISCONSIN DEPARTMENT OF NATURAL RESOURCES



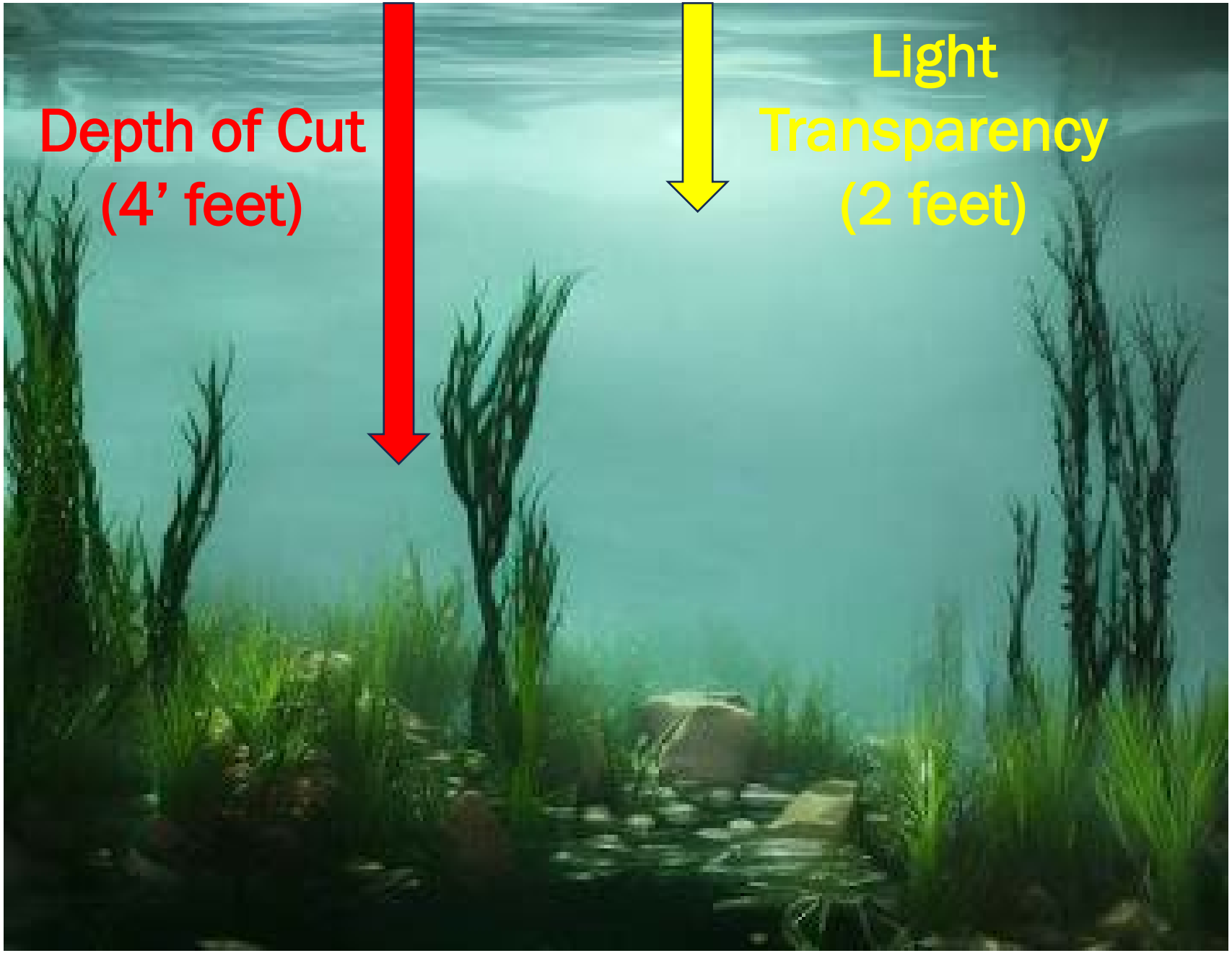
Benefits of Aquatic Plants

- Increased water clarity
- Better water quality
- Reduced algae
- Root systems stabilize lake-bed sediment, hold it in place.
- Use and storage of nutrients such as phosphorus
- Increases zooplankton habitat (refuge).
- Critical habitat for fish & wildlife.
- Reduces wind/wave energy.
- Protects shorelines from erosion.



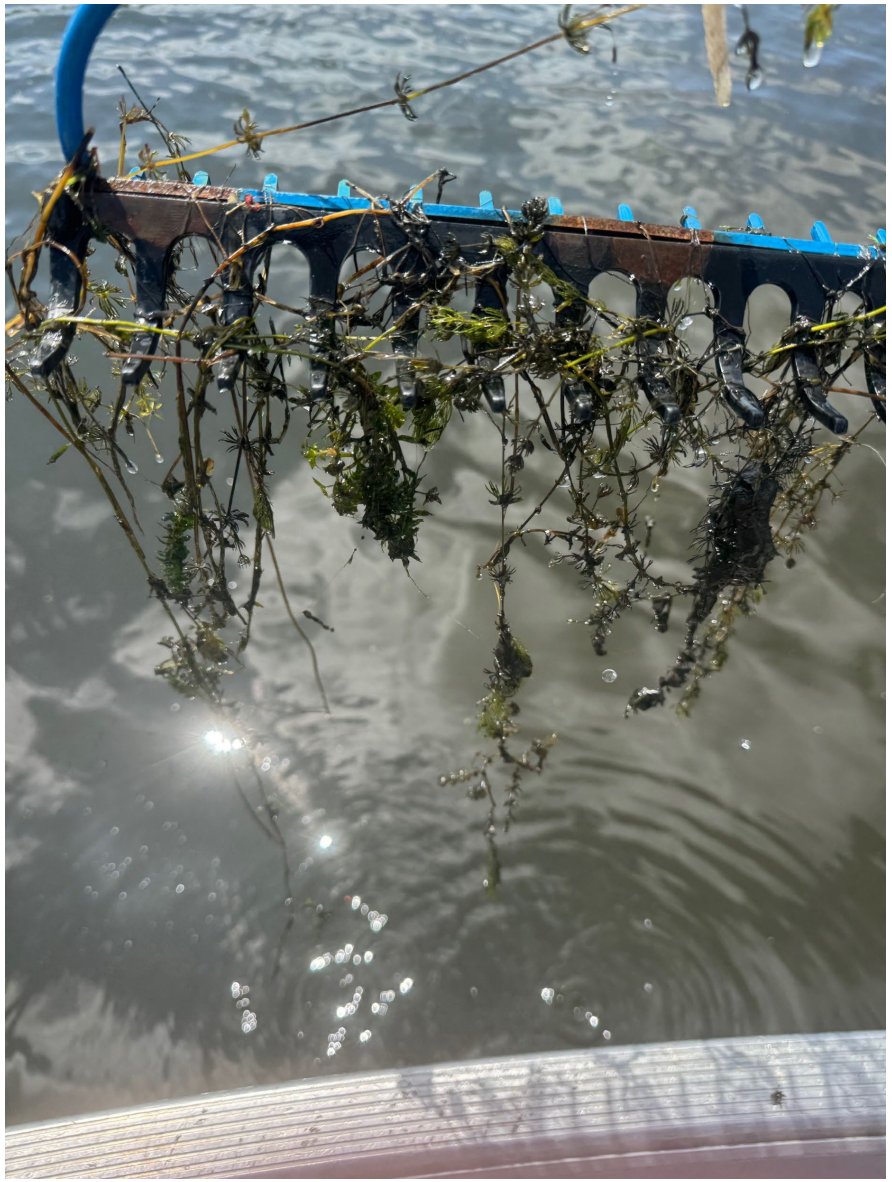
Role of Aquatic Plant Root System

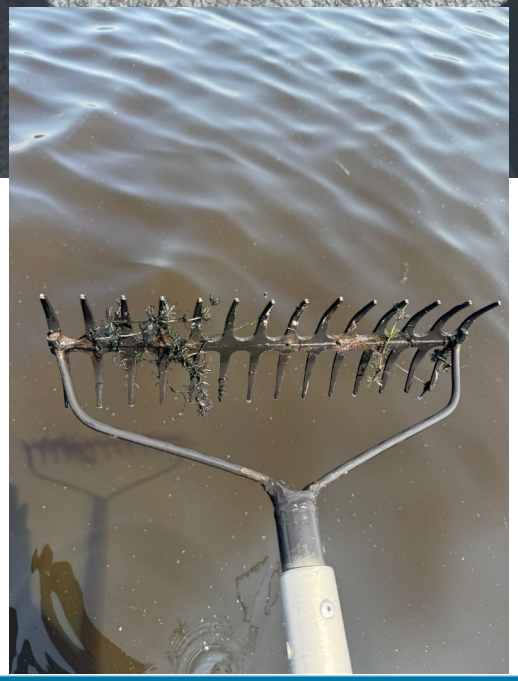
- Water and nutrient uptake from sediment.
- Energy storage / reserve.
  - Photosynthesis converted to sugars
  - Energy reserves needed when plant is under stress or low-light conditions.
- Cutting plants causes stress and staining of water limits light penetration.
  - Finite amount of stored energy.


Depth of Cut
(4’ feet)
Light
Transparency
(2 feet)

Aquatic Plants Dying in Harvest Lane 6/17/25

- Plants were 2-3 feet tall with only the tips still green.
- By June 26, most plants were dead and hard to capture on rake.

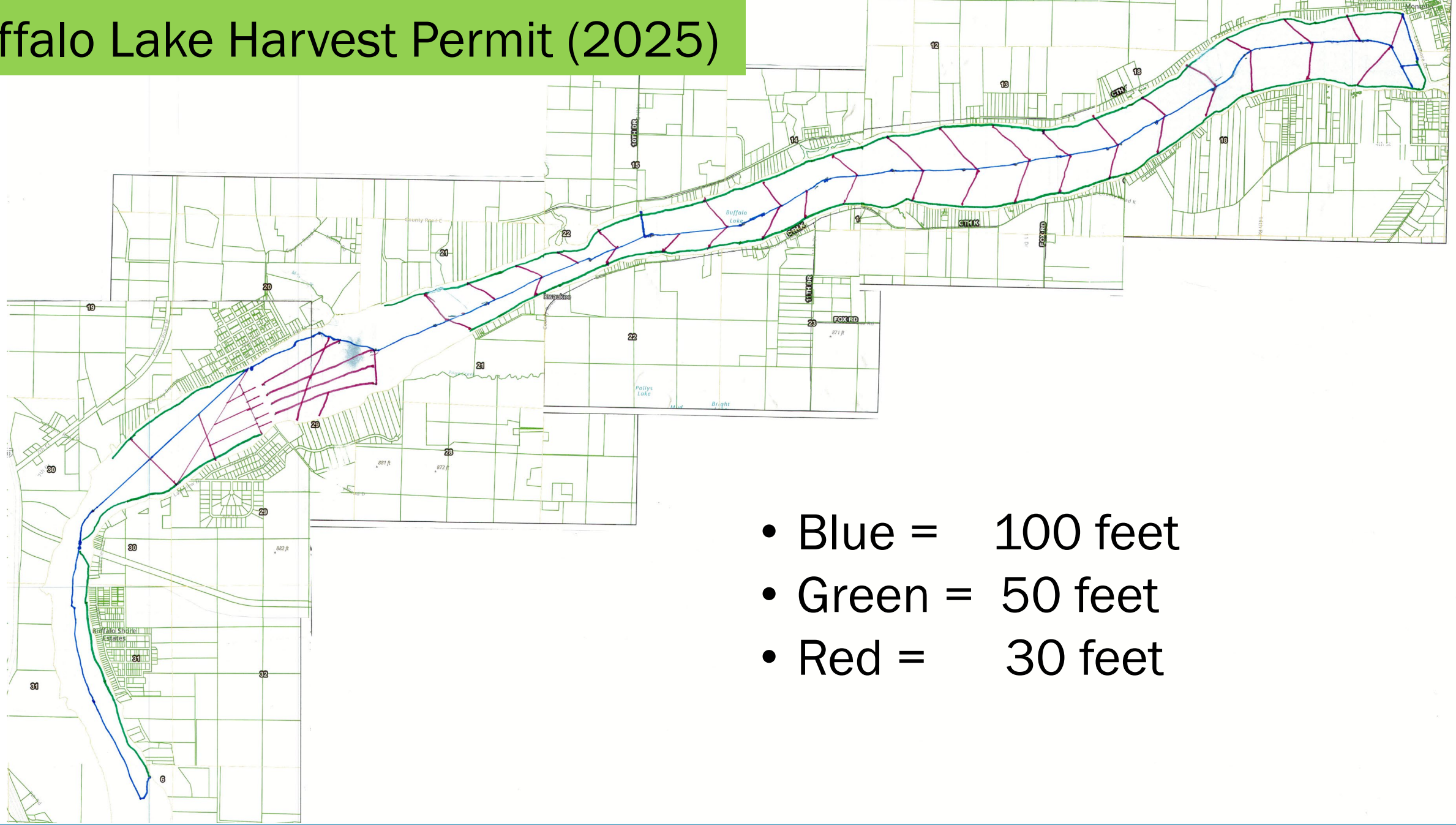




Water Quality Impacts from Loss of Submersed Aquatic Plants

- Reduces the amount of phosphorus that would have been tied up in plant biomass.
- Increases algae both planktonic and mass forming (filamentous algae).
  - ➢ Further reduces light penetration, leads to more plant loss (Compounding).
- Decomposition of dead plants adds to internal nutrient load.
  - ➢ Lowers dissolved oxygen levels

Buffalo Lake Harvest Permit (2025)



- Blue = 100 feet
- Green = 50 feet
- Red = 30 feet

Satellite Image of Buffalo Lake in early 2000's

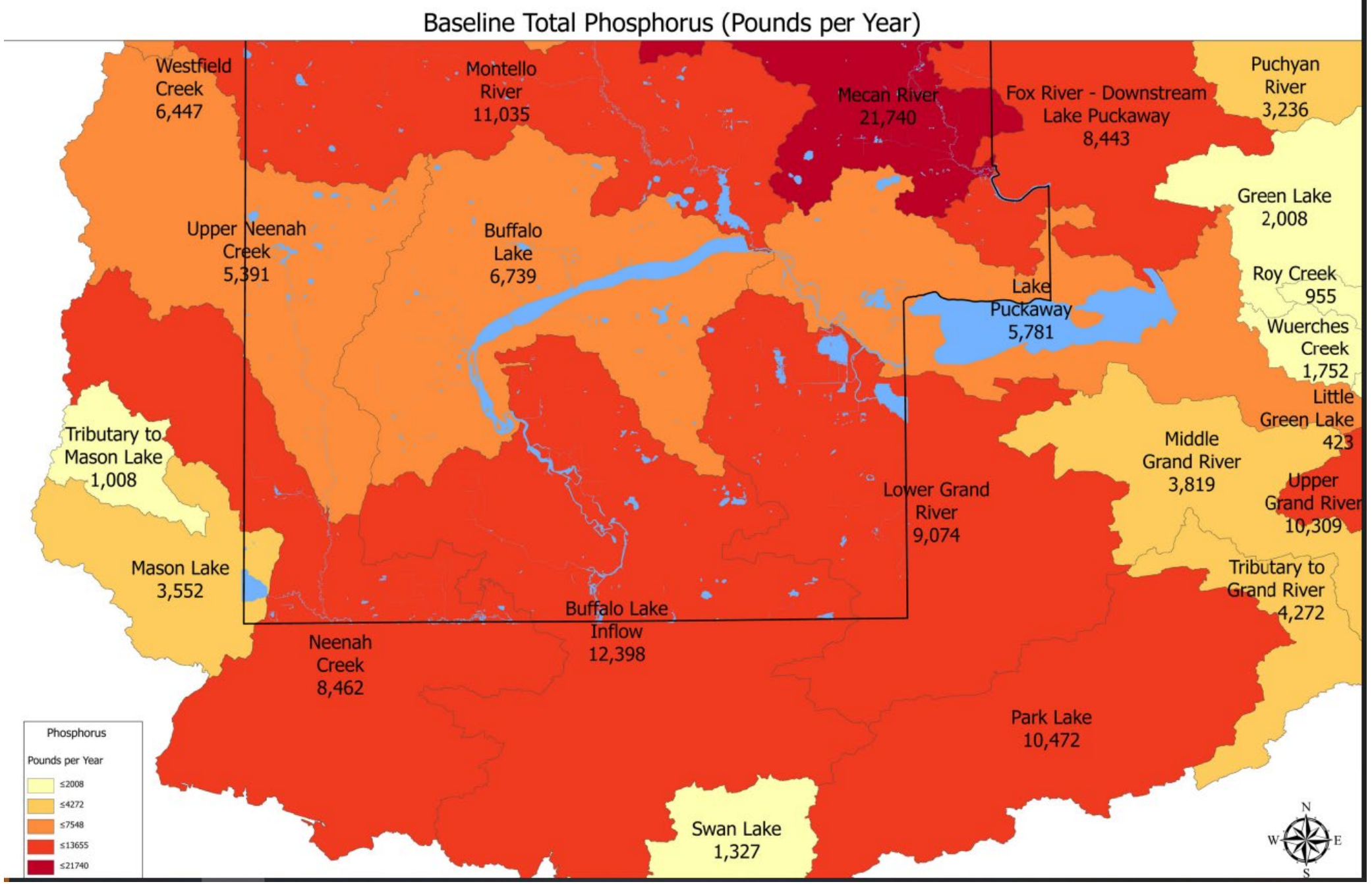
2021

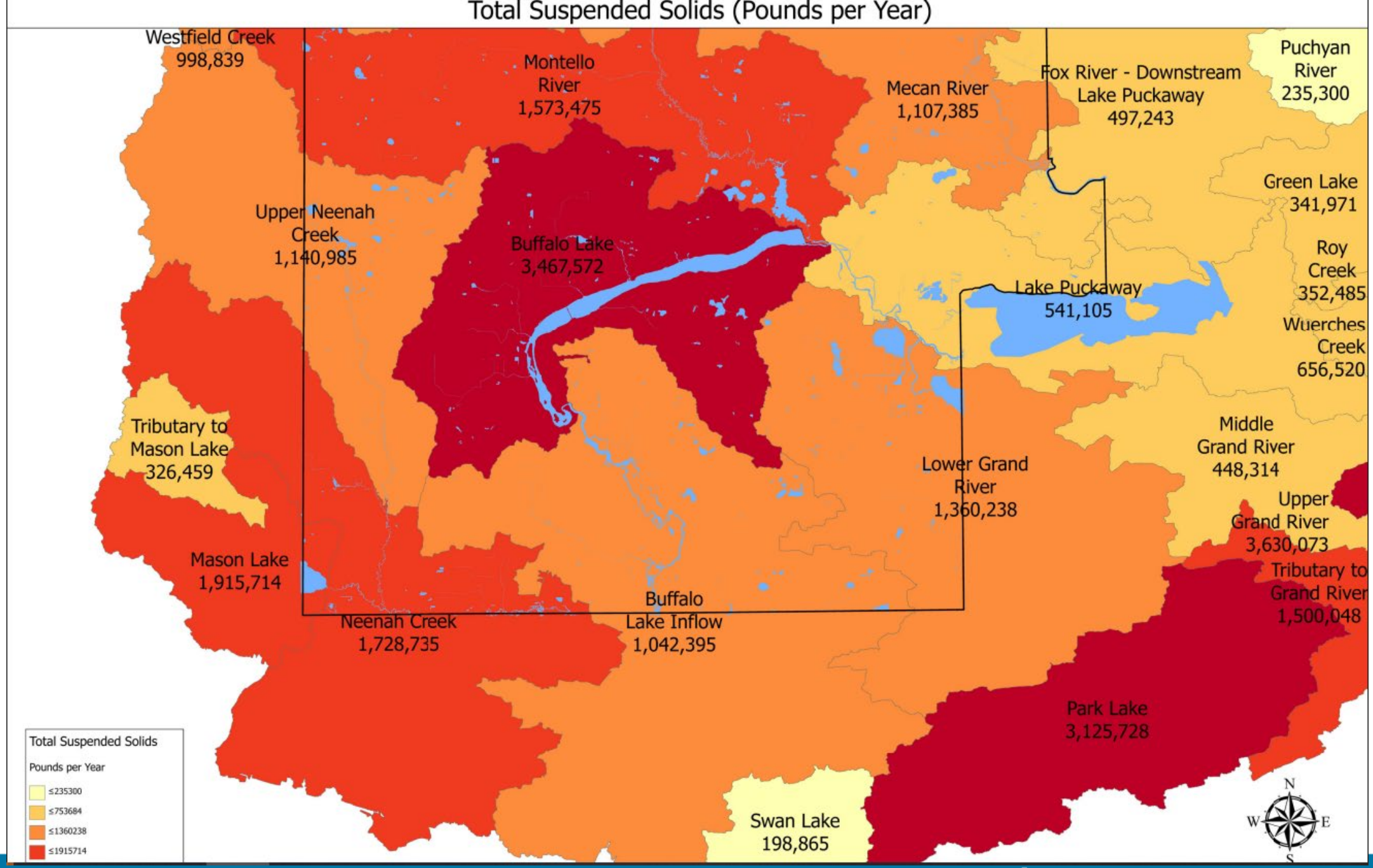

Legend
Feature 1
Lane
lane width
Packwaukee Public Library
Chestnut St
Joanie's Home For the Happy Sr
Packwaukee Public Library
Main St
Lake St
D
N
1000 ft

Next Steps

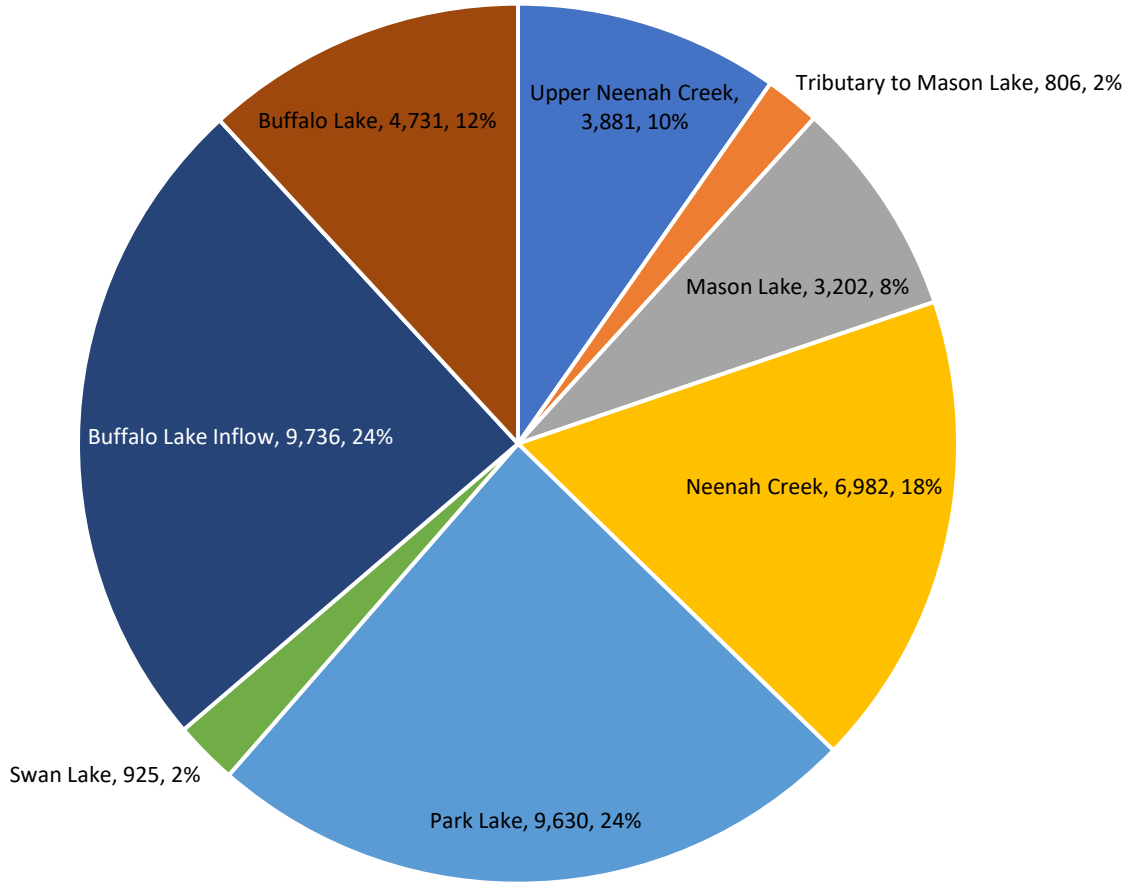
1. Update your Lake Management Plan & Nine Key Element Watershed Plan.
   - Strategies to minimize external nutrient - load
     - Work with Marquette County / DNR to implement Plan strategies.
2. Develop contingencies to implement when conditions warrant plant protection.
   - Stop harvesting if plant decline starts (triggers).
     - Protecting remaining plants is critical for water quality and DO.
   - Increase water quality sampling
3. Develop a harvesting strategy that assists with lane integrity.
   - GPS on harvesters, additional buoys, etc.
   - DNR fully understands the need for harvesting on Buffalo Lake.

Questions?

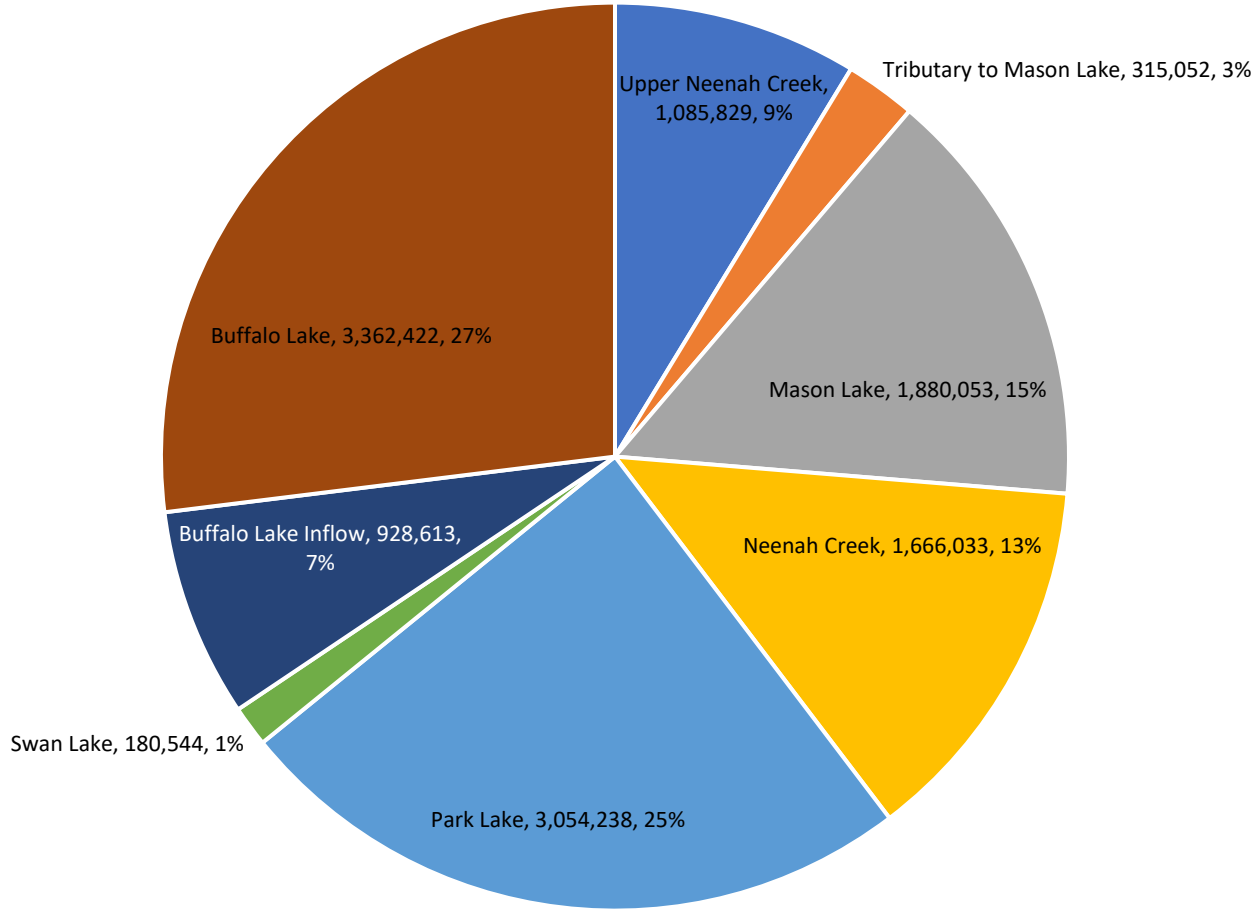

Baseline Total Phosphorus (Pounds per Year)
Westfield Creek 6,447
Montello River 11,035
Mecan River 21,740
Fox River - Downstream Lake Puckaway 8,443
Puchyan River 3,236
Green Lake 2,008
Upper Neenah Creek 5,391
Buffalo Lake 6,739
Lake Puckaway 5,781
Roy Creek 955
Wuerches Creek 1,752
Little Green Lake 423
Tributary to Mason Lake 1,008
Middle Grand River 3,819
Upper Grand River 10,309
Lower Grand River 9,074
Mason Lake 3,552
Tributary to Grand River 4,272
Buffalo Lake Inflow 12,398
Neenah Creek 8,462
Park Lake 10,472
Swan Lake 1,327
Phosphorus
Pounds per Year
≤2008
≤4272
≤7548
≤13655
≤21740
N
W
E
S


Total Suspended Solids (Pounds per Year)
Westfield Creek
998,839
Montello
River
1,573,475
Mecan River
1,107,385
Fox River - Downstream
Lake Puckaway
497,243
Puchyan
River
235,300
Green Lake
341,971
Upper Neenah
Creek
1,140,985
Buffalo Lake
3,467,572
Roy
Creek
352,485
Lake Puckaway
541,105
Wuerches
Creek
656,520
Tributary to
Mason Lake
326,459
Middle
Grand River
448,314
Lower Grand
River
1,360,238
Upper
Grand River
3,630,073
Mason Lake
1,915,714
Tributary to
Grand River
1,500,048
Buffalo
Lake Inflow
1,042,395
Neenah Creek
1,728,735
Park Lake
3,125,728
Swan Lake
198,865
Total Suspended Solids
Pounds per Year
≤235300
≤753684
≤1360238
≤1915714
N
W
E
S

Agricultural Nonpoint TP lb/year

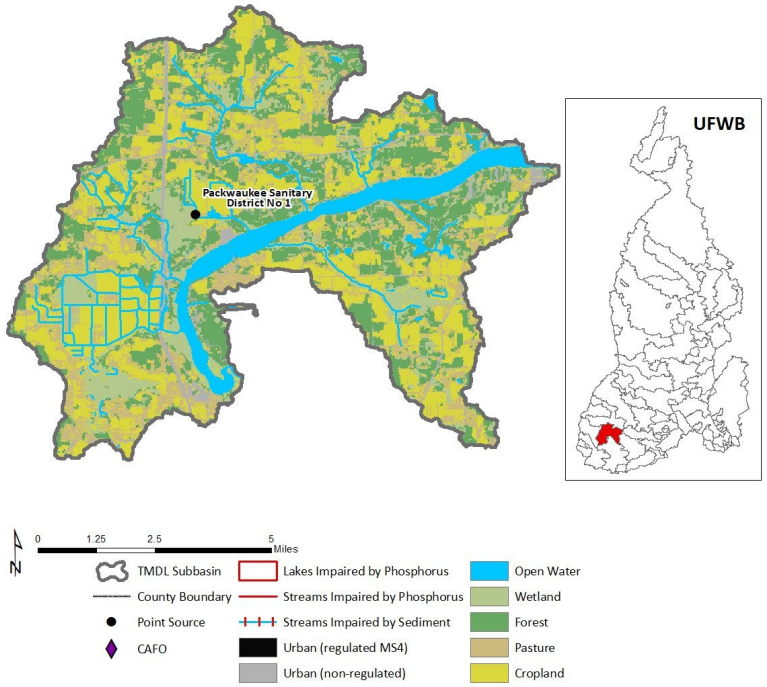


Agricultural Nonpoint TSS
lb/year

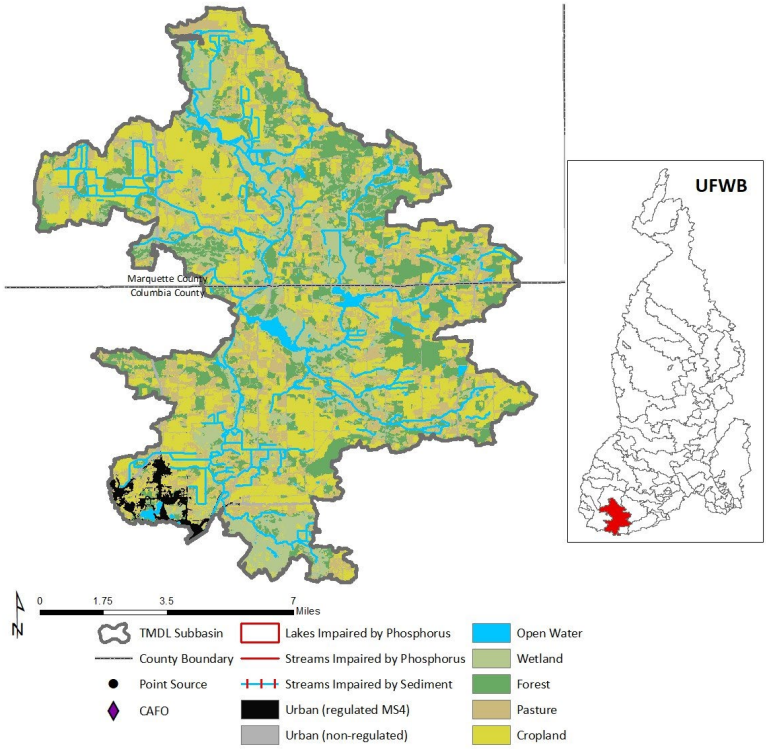


Sub-Basins within proximity to Buffalo Lake (2 of the highest 4 loading sub-basins)

Buffalo Lake Sub-Basin

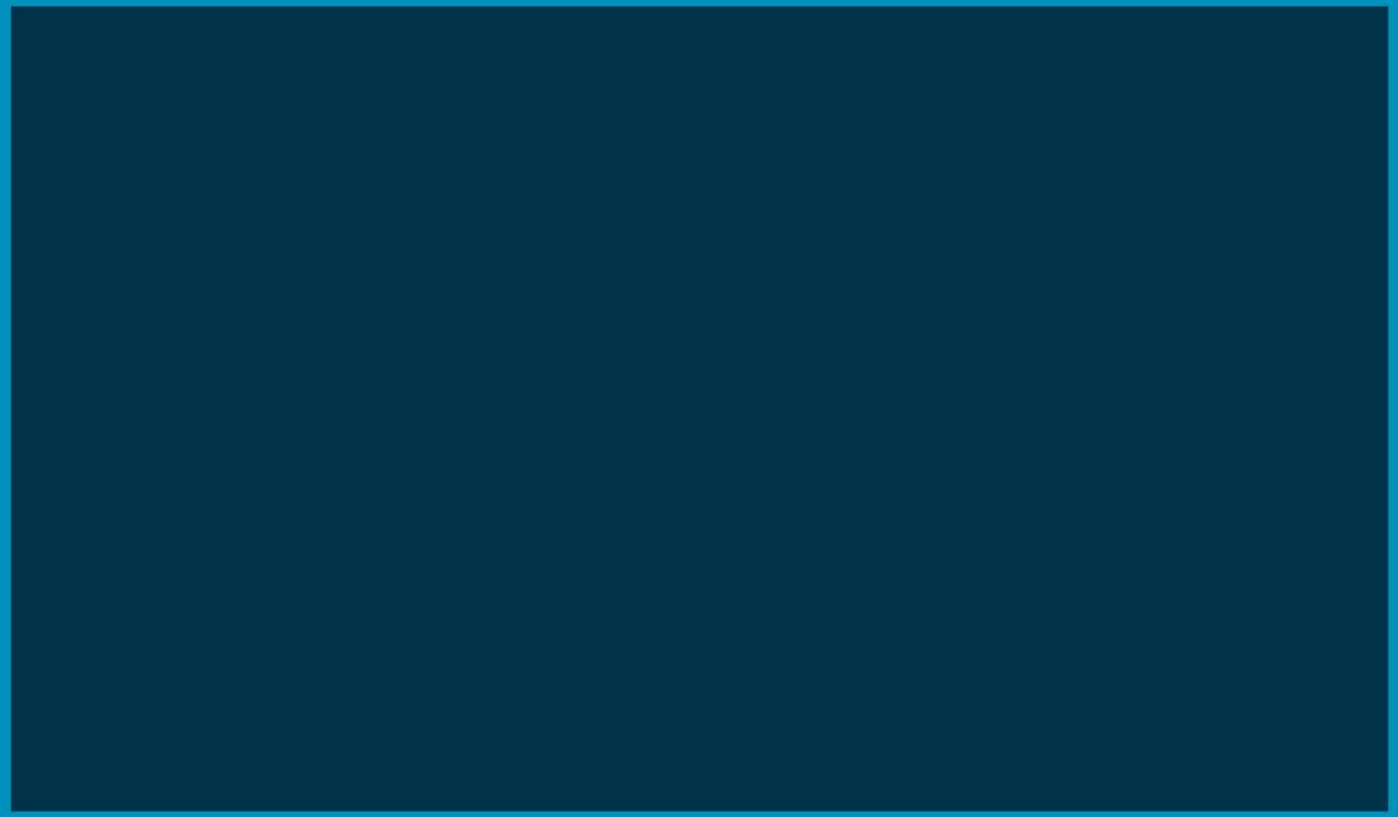


Buffalo Lake *Inlet* Sub-Basin



		July 21, 2024	August 19, 2024	Sept 10, 2024	Oct 20, 2024	May 11, 2025	June 8, 2025	July 13, 2025
	DNR Max							
Ox Creek Cty Rd C	0.075	0.0433	0.026	0.0259	0.0178	0.037	0.0343	0.045
Fox River Hwy 22	0.10	0.046	0.153	0.119	0.0505	0.0536	0.137	0.12
Page Creek Cty Rd K	0.075	0.0429	0.066	0.0326	0.0178	0.0701	0.0649	0.158
Fox River Cty Rd O	0.10	0.243	0.098	0.062	0.042	0.0898	0.0931	0.165
Chapman Creek Gale Dr	0.075	no test this month	0.0439	0.0319	0.179	0.0446	0.165	0.182
Chapman Creek Cty Rd CX	0.075	0.387	0.589	0.121	0.0856	0.136	0.251	0.135
Allen Creek 7th	0.075	0.0299	0.027	0.0221	0.0297	0.0489	0.0484	0.153
Mad River	0.075	0.028	0.085	0.0638	0.0258	0.0489	0.14	0.0794
red means exceeds allowable mg/l								
Turbidity- Measured in CM - Goal - min of 106cm								
Ox Creek Cty Rd C		117	120	120	120	66	120	120
Fox River Hwy 22		65	52	49	40	28	36	28
Page Creek Cty Rd K		120	58	65	76	120	120	105
Fox River Cty Rd O		65	52	49	40	40.00	36	28
Chapman Creek Gale Dr		No test this month	110	116	19	120	65	110
Chapman Creek Cty Rd CX		118	72	120	52	55	70	120
Allen Creek 7th		118	120	120	38	55	60	103
Mad River		38	46	60	45	35	50	75

CONNECT WITH US



@WIDNR

@WI_DNR

/WIDNRTV

"WILD WISCONSIN:
OFF THE RECORD"