LAKE FRANCIS NUTRIENT TMDL DEVELOPMENT (SUWANNEE RIVER BASIN)

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Madison, FL | July 24, 2025

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Presentation Agenda

- Introduction and overview of Florida's total maximum daily load (TMDL) program.
- Presentation of nutrient TMDLs for Lake Francis:
  - Water Body Identification Number (WBID) overview.
  - Assessment and Verified Impairments.
  - TMDL approach.
- Next steps.
- Public questions and comments.

WATER QUALITY RESTORATION

- Water Quality Standards.
- Monitoring.
- Assessment.
- **TMDL Development.**
- Restoration Plans:
  - Basin Management Action Plan (BMAP).
  - Reasonable Assurance Plan.

FEDERAL TMDL PROGRAM RESPONSIBILITIES

- The Federal Clean Water Act (CWA, 1972) established requirements for states in Section 303(d).
- States must:
  - Assess and provide lists of their impaired waters to the U.S. Environmental Protection Agency (EPA).
  - Develop TMDLs for impaired waters.
  - Identify pollutant reductions and allocations.

FLORIDA WATERSHED RESTORATION ACT

- The Florida Watershed Restoration Act (FWRA, section 403.067, Florida Statutes) established a framework for identifying impaired waters, developing TMDLs, and developing and implementing restoration plans:
  - Authorizes the Florida Department of Environmental Protection (DEP) to be lead agency in watershed assessment, TMDLs and BMAPs.
  - Directs DEP to work with stakeholders on scientifically informed restoration targets and strategies.

SITE SPECIFIC RESTORATION TARGETS

- Typically referred to as TMDLs.
- TMDLs are water quality restoration thresholds produced for waterbodies that are “impaired.”
  - “Impaired” means that the waterbody does not meet water quality standards.
- TMDLs serve as the legal basis for future restoration action as directed by the federal CWA and FWRA, particularly for permitted entities.

TOTAL MAXIMUM DAILY LOADS (TMDLs)

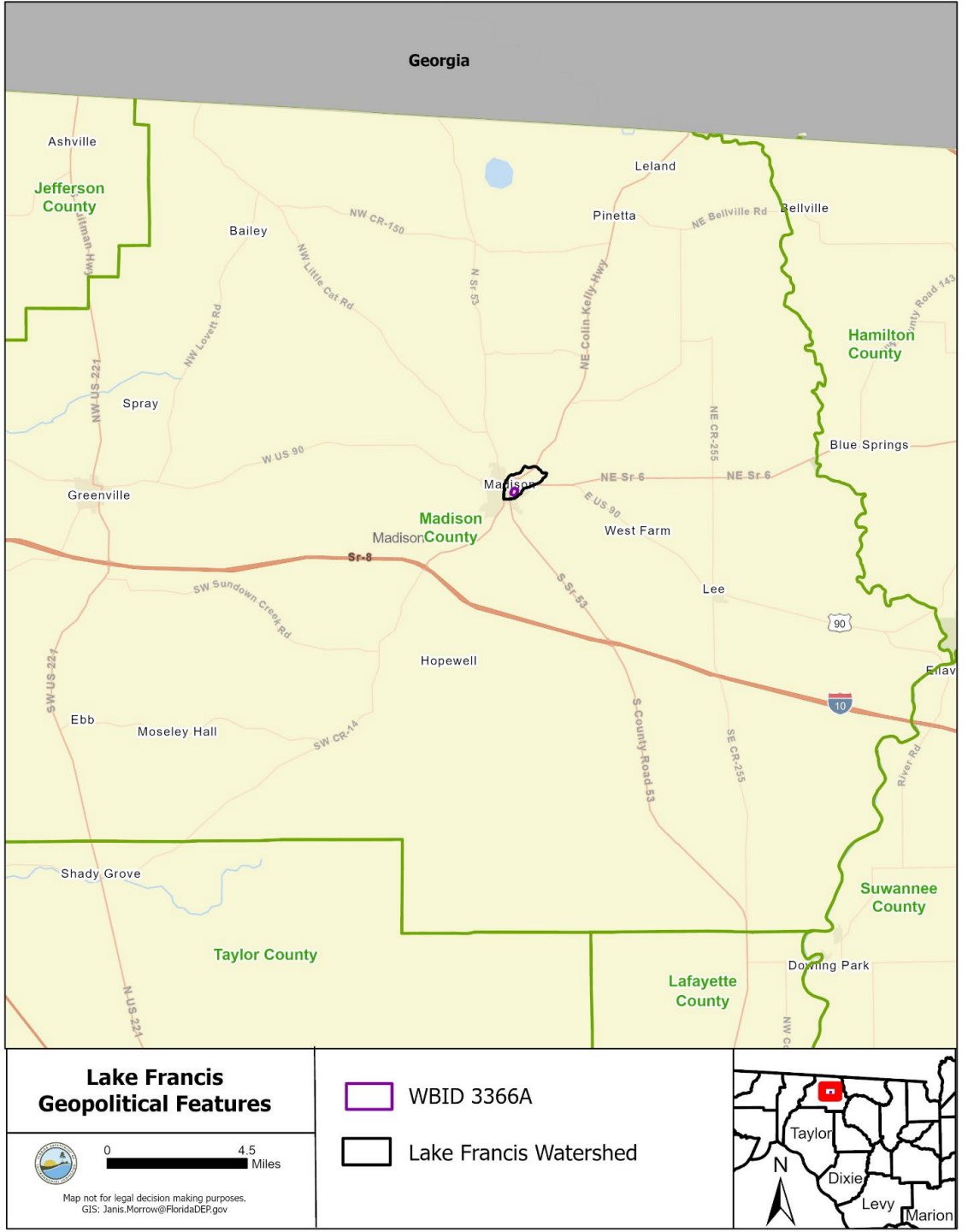
- TMDL: The maximum amount of a pollutant that a waterbody can receive and still maintain its designated uses (e.g., drinking water, fishing, swimming and shellfish harvesting).

- Under Section 303(d) of the federal CWA and the FWRA, TMDLs must be developed for impaired waters.

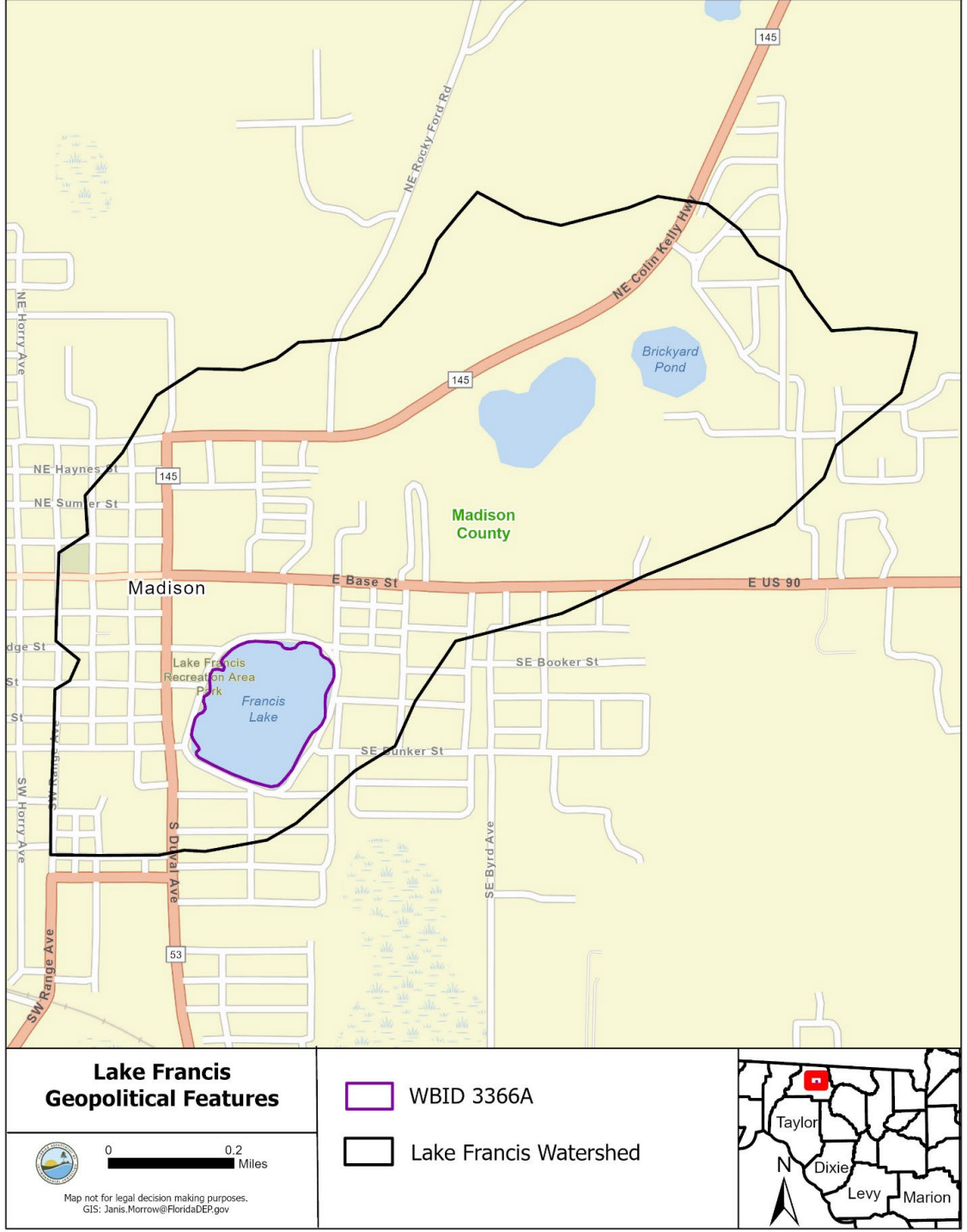
LAKE FRANCIS NUTRIENT TMDL DEVELOPMENT

LAKE FRANCIS (WBID 3366A)

- WBID Number: **3366A**
- Basin Group: **Suwannee River**
- Subbasin Group: **Withlacoochee River**
- County: **Madison**
- Waterbody Class: **Class III**
- Waterbody Type: **Lake**
- 303(d) impairment: **Nutrients**



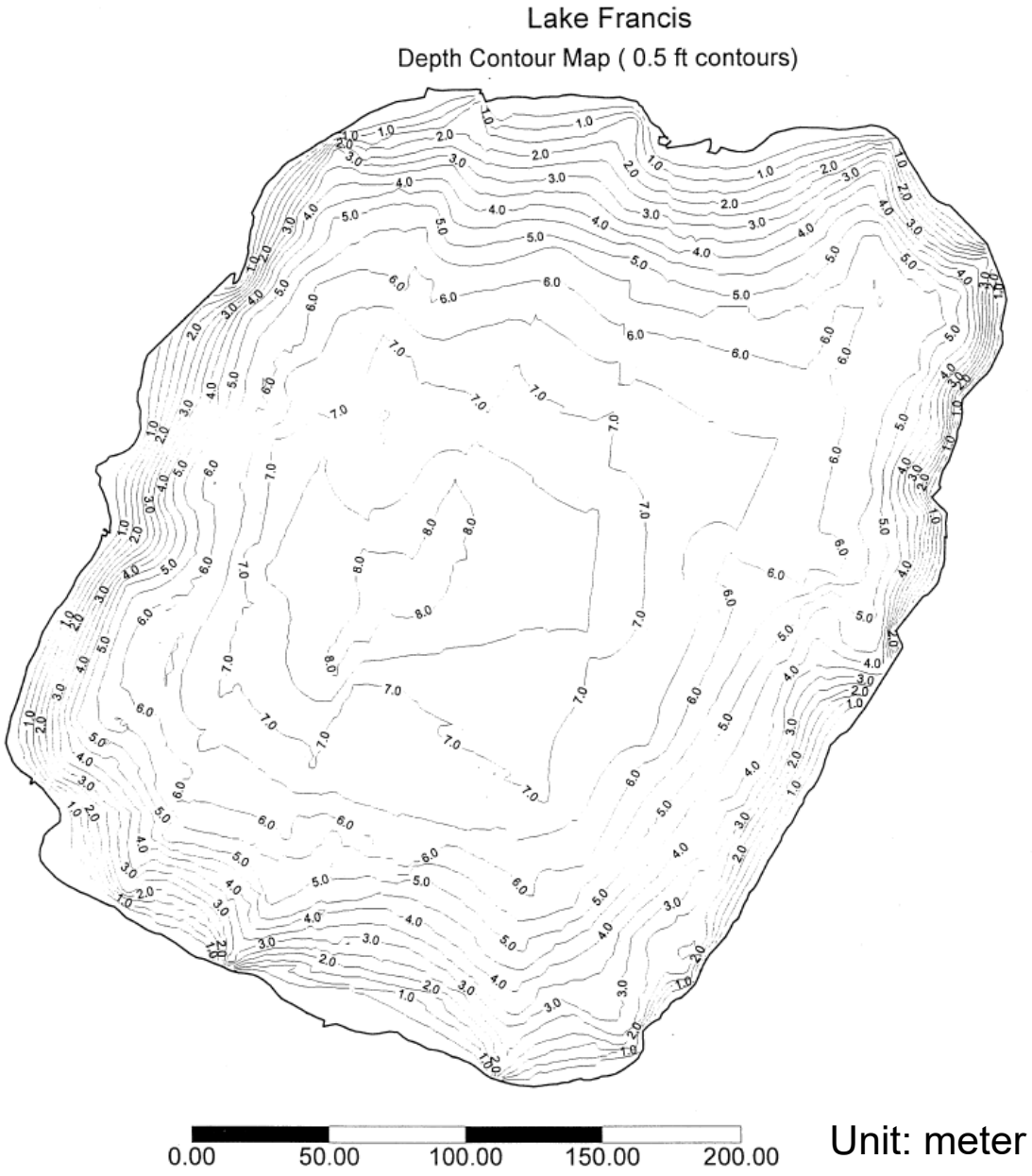
LAKE FRANCIS WATERSHED



LAKE FRANCIS BATHYMETRY

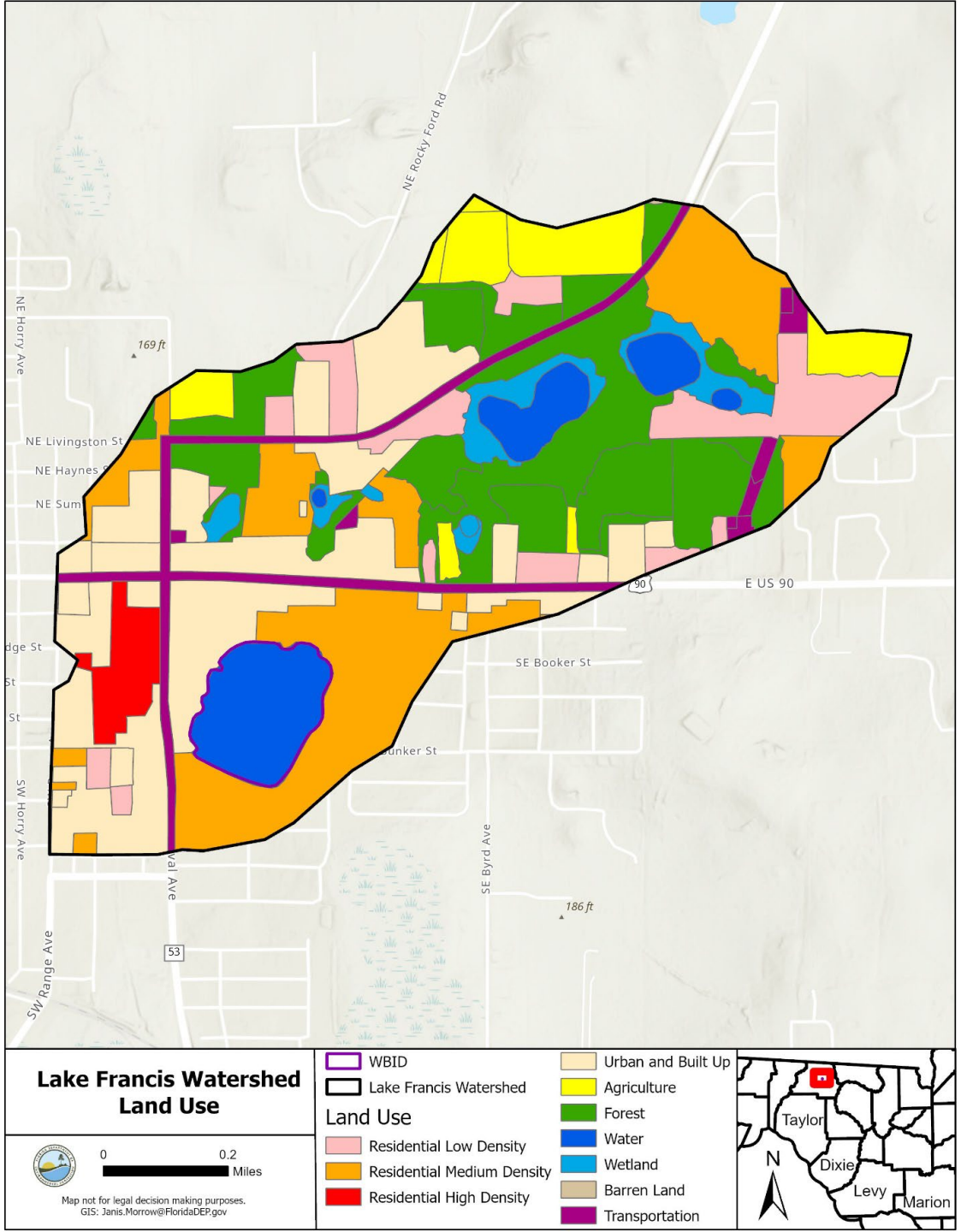
Lake Surface Area (ac.)	Lake Volume (ac.-ft.)	Mean Depth (ft.)	Maximum Depth (ft.)
25	113	4.5	8

Ac. = Acre
Ft. = feet



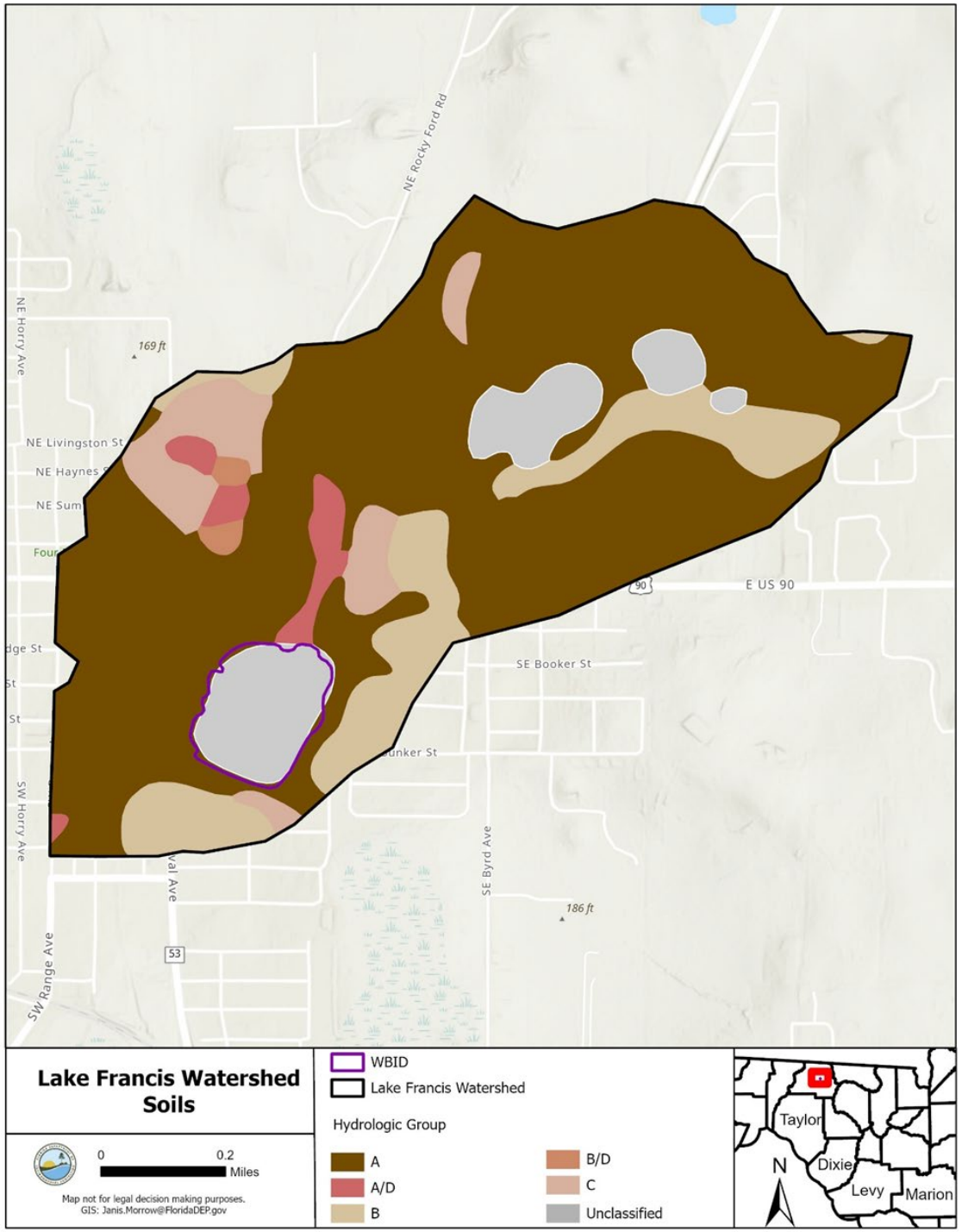
LAKE FRANCIS LAND USE

Land Use Classification	Acreage	Percent of Watershed
Urban and Built-Up	117.0	23
Residential Low Density	43.2	9
Residential Medium Density	103.5	20
Residential High Density	12.4	2
Agriculture	36.3	7
Upland Forest	110.3	22
Water	41.4	8
Wetland	17.4	3
Barren Land	0.1	0
Transportation, Communication, and Utilities	28.3	6
Total	**509.8**	**100**



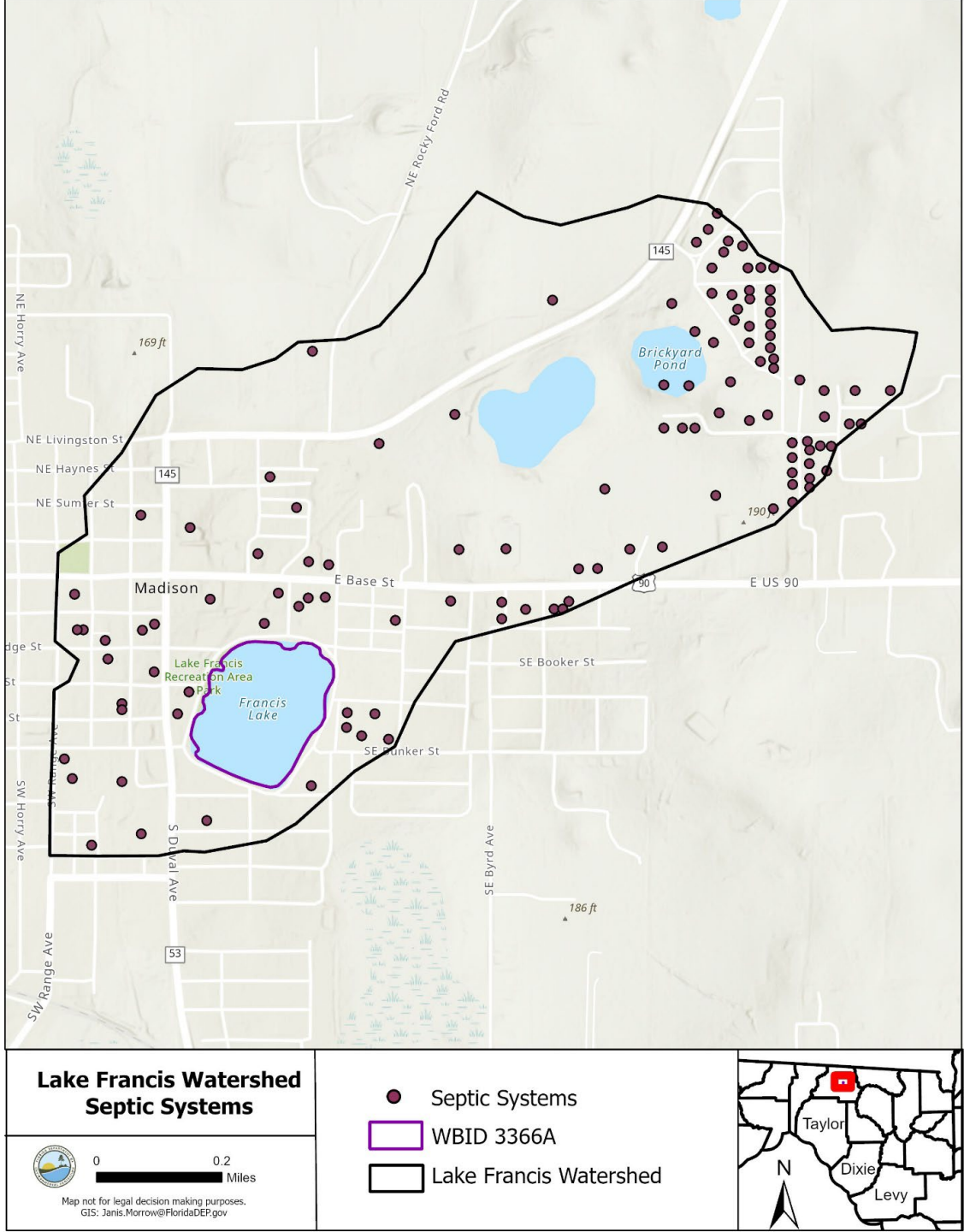
LAKE FRANCIS SOILS

Hydrologic Soil Group	Area (acres)	Percent
A	348.4	68
A/D	12.9	3
B	68.0	13
B/D	3.5	1
C	32.2	6
Unclassified	44.8	9
Total	509.8	100.0



ONSITE TREATMENT AND DISPOSAL SYSTEMS (OSTDS)

Watershed	Number of OSTDS
Lake Francis	117



NUMERIC NUTRIENT CRITERIA (NNC) FOR FLORIDA LAKES (SUBPARAGRAPH 62-302.531(2)(B)1, F.A.C.)

Long-Term Geometric Mean Lake Color and Alkalinity	AGM Chlorophyll *a* (µg/L)	Minimum Calculated AGM TP NNC (mg/L)	Minimum Calculated AGM TN NNC (mg/L)	Maximum Calculated AGM TP NNC (mg/L)	Maximum Calculated AGM TN NNC (mg/L)
>40 PCU	20	0.05	1.27	0.16	2.23
≤ 40 PCU and ≥ 20 mg/L $CaCO_3$	20	0.03	1.05	0.09	1.91
≤ 40 PCU and ≤ 20 mg/L $CaCO_3$	6	0.01	0.51	0.03	0.93

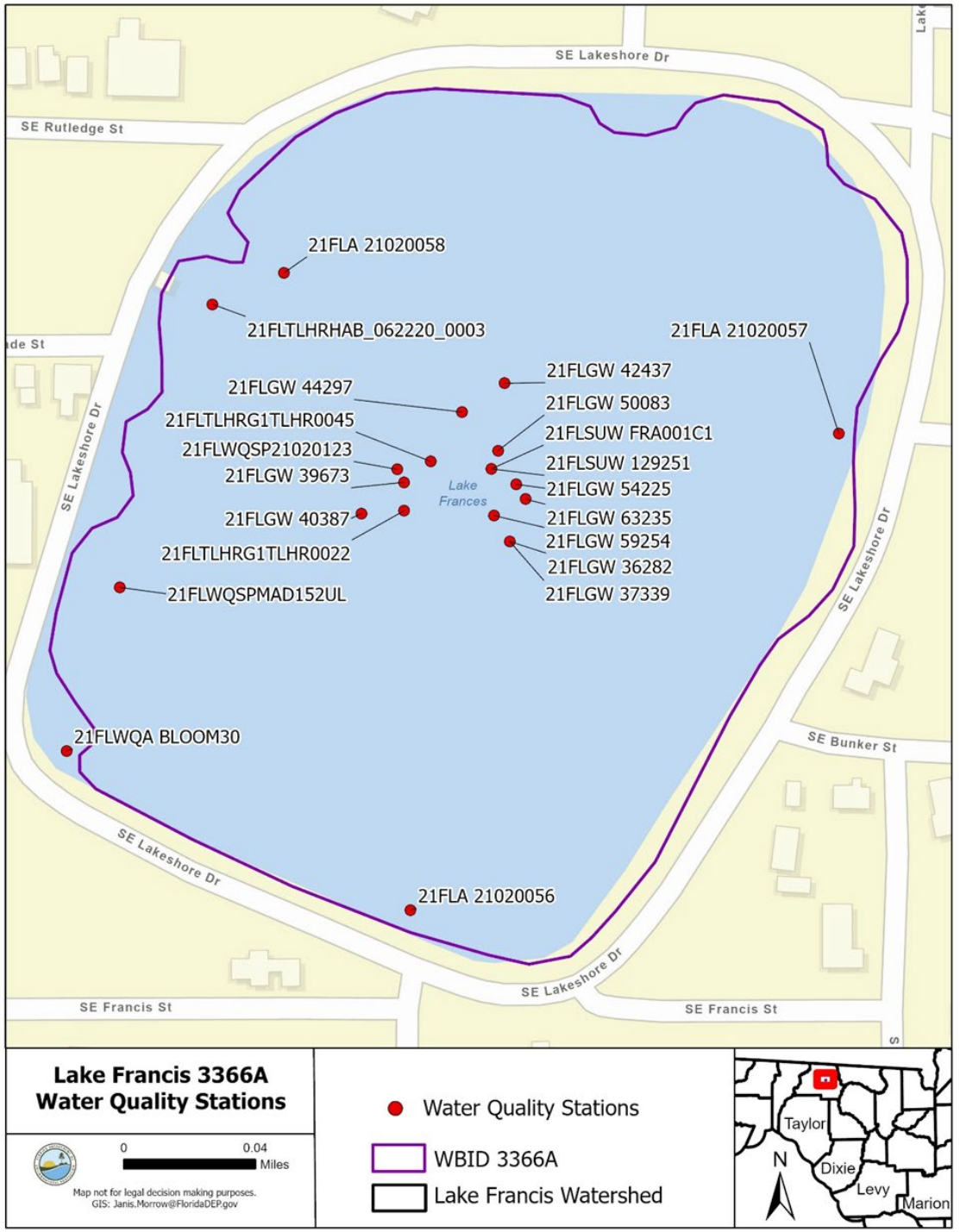
... NNC applicable to Lake Francis (Suwannee River Basin)

AGM = Annual Geometric Mean.
PCU = Platinum Cobalt Units
$CaCO_3$ = Calcium carbonate.
TN = total nitrogen.
TP = total phosphorus.

- Lake Francis: Low-color (≤40 PCU), High-alkalinity (≥ 20 CaCO3) lake
- Color long term geometric mean: 23 PCU
- Alkalinity long term geometric mean: 29 mg/L $CaCO_3$

LAKE FRANCIS

WATER QUALITY SAMPLING STATIONS



NUTRIENT ASSESSMENT STATUS: LAKE FRANCIS

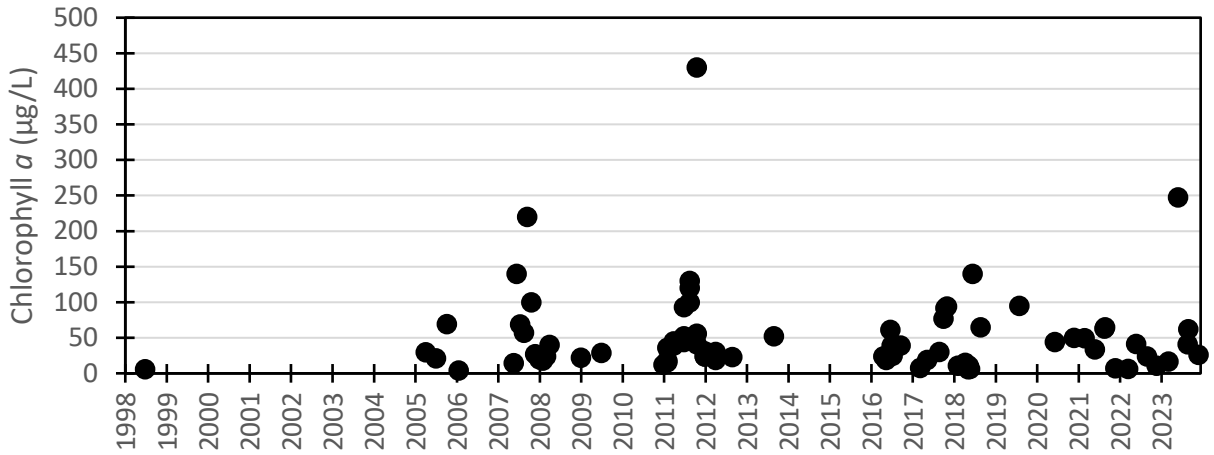
The Group 1, Cycle 4 IWR assessment (Jan. 1, 2011 – June 30, 2018)

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2011	**52**	**1.72**	**0.09**
2012	ID	ID	ID
2013	ID	ID	ID
2014	ND	ND	ND
2015	ND	ND	ND
2016	**32**	0.88	**0.14**
2017	**38**	**1.37**	**0.07**
2018	18	0.90	0.09
2019	ID	ID	ID
2020	ID	ID	ID
2021	**34**	**1.57**	**0.11**
2022	16	1.26	**0.12**
2023	**49**	**1.33**	**0.11**

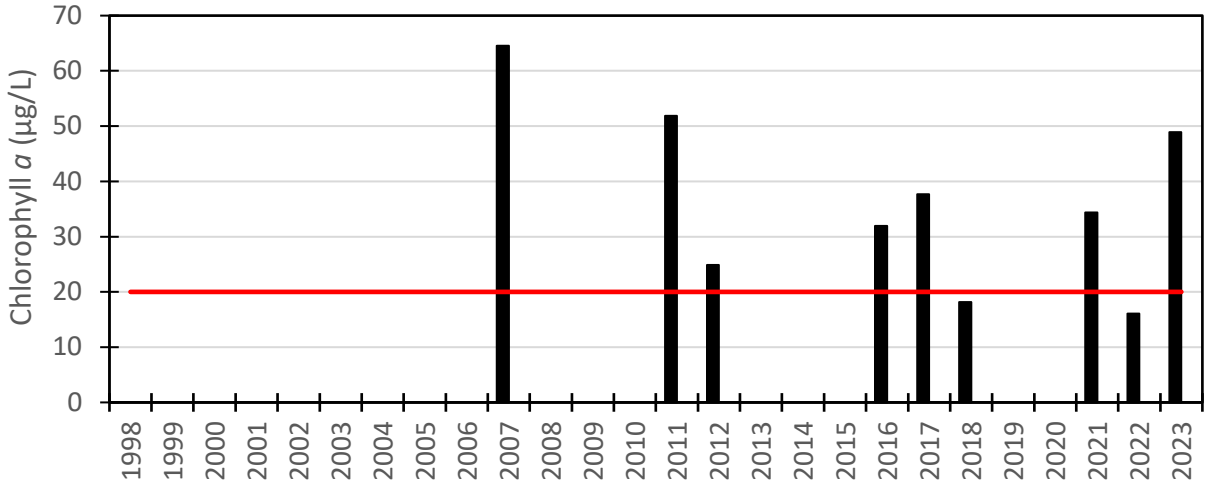
ID = Insufficient data
ND = No data

CHLOROPHYLL *A* IN THE PERIOD OF RECORD (IWR RUN 66)

(A) Individual Sampling Results

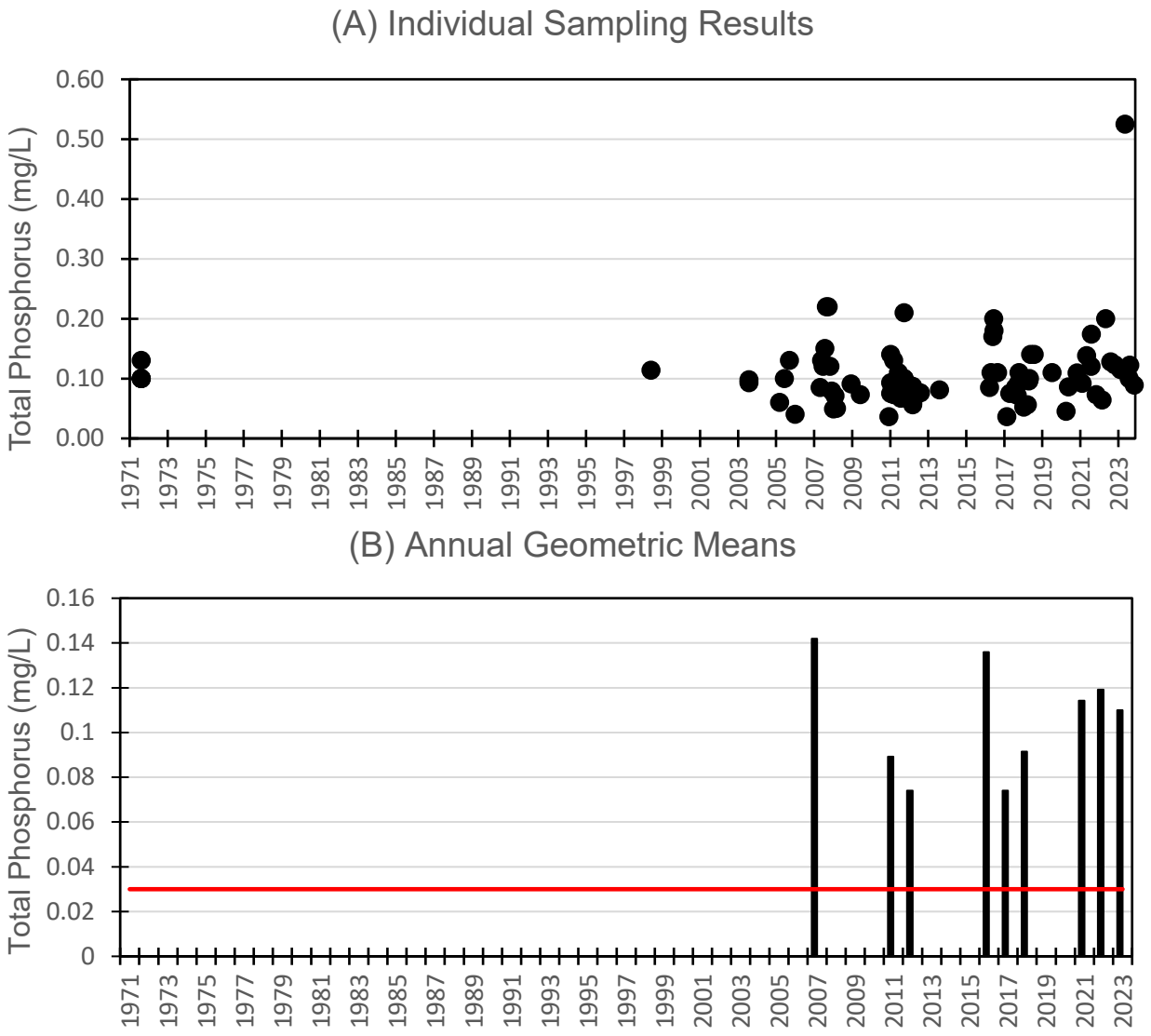


(B) Annual Geometric Means



Red line: NNC value of 20 µg/L

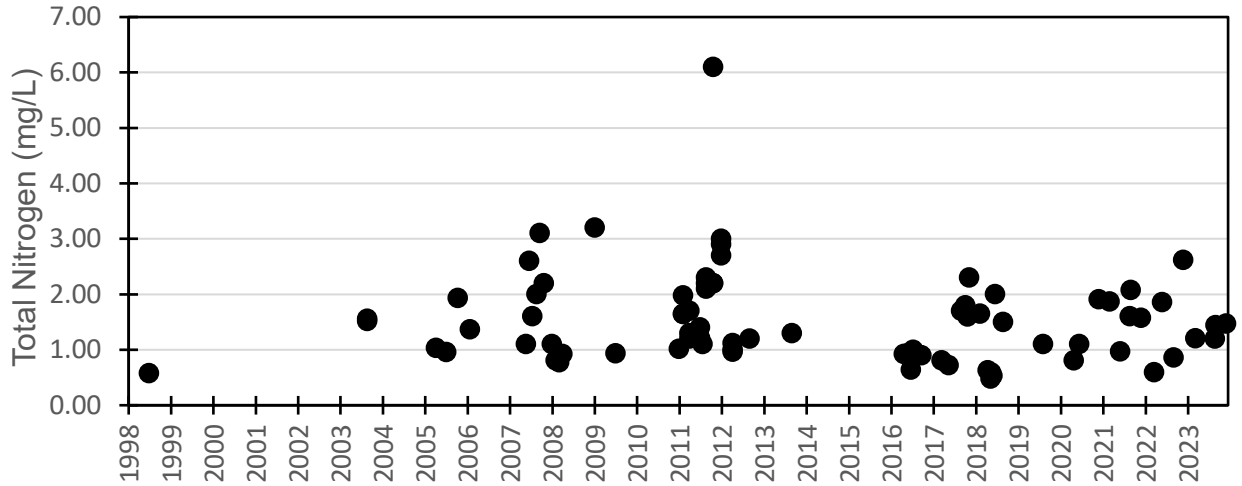
TOTAL PHOSPHORUS IN THE POR (IWR RUN 66)



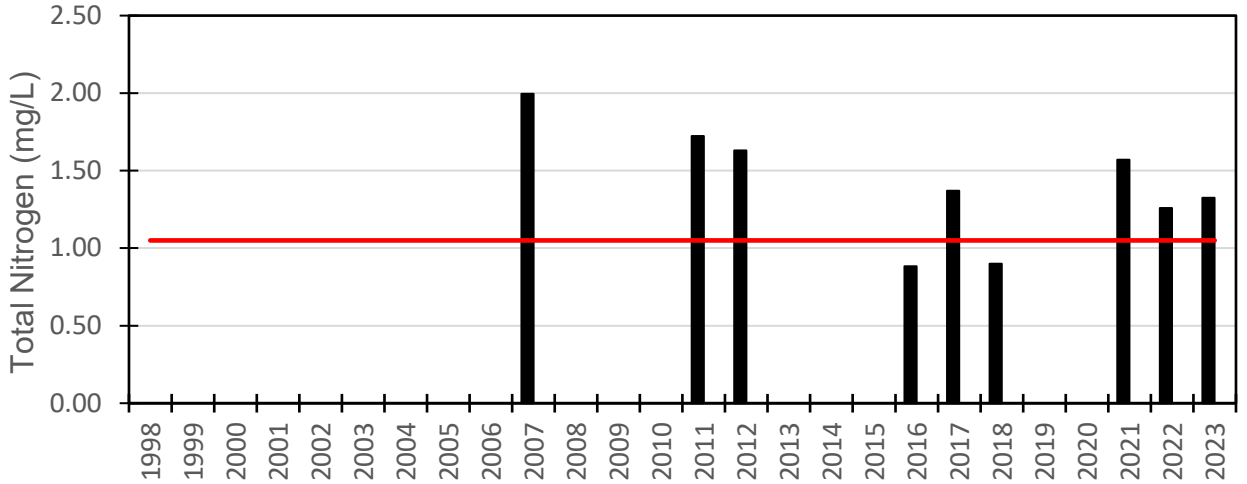
Red line: NNC value of 0.03 mg/L

TOTAL NITROGEN IN THE POR (IWR RUN 66)

(A) Individual Sampling Results



(B) Annual Geometric Means



Red line: NNC value of 1.05 mg/L

RESTORATION CHLOROPHYLL *a* TARGET

- Based on the available information, there are no data suggesting that Lake Francis differs from the lakes used to develop the numeric nutrient criteria; therefore, the generally applicable chlorophyll *a* threshold of 20 µg/L is necessary to protect the designated uses.

- Therefore, we used the applicable lake chlorophyll *a* target of 20 µg/L as the restoration target.

MODELING APPROACHES

- Watershed Model: **Curve Number Approach**.
  - Simulates flow and nutrient loads from the watershed.

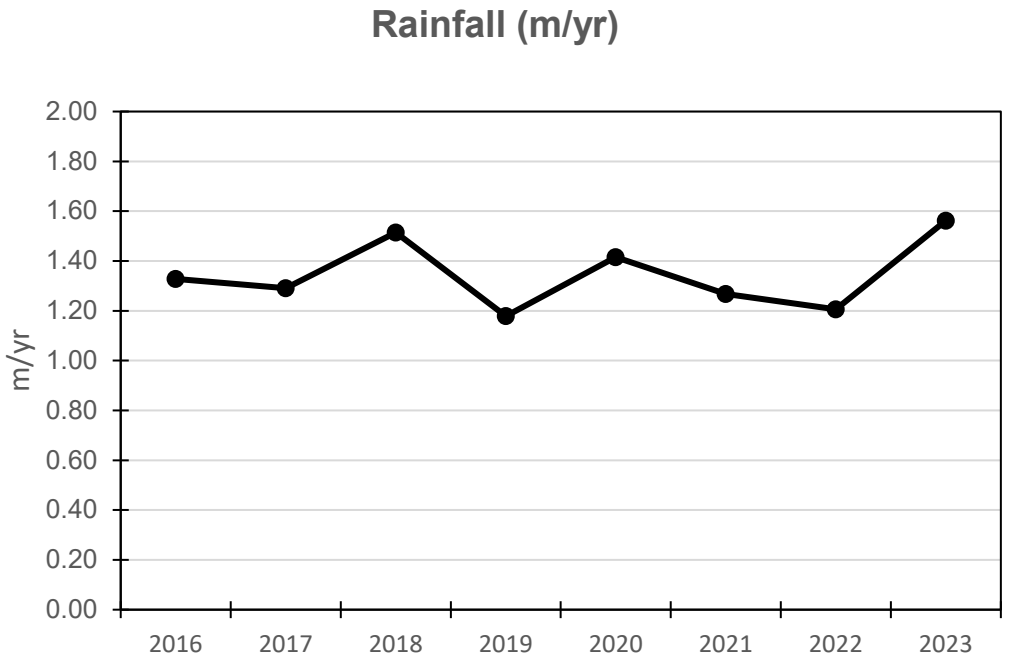
- Water Quality Model: **Bathtub Model**.
  - Simulates in-lake nutrient and chlorophyll *a* concentrations.

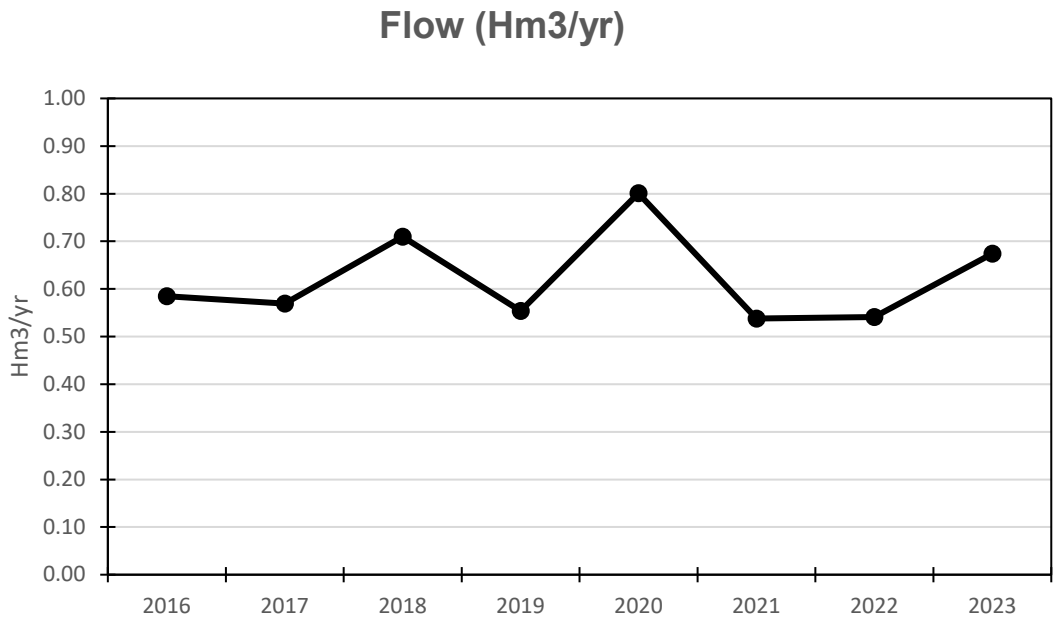
THE CURVE NUMBER APPROACH
SPREADSHEETS PROVIDED BY SJRWMD

1. **Estimating Runoff Volume and Coefficient**
   - Land use, soil type, daily rainfall, antecedent moisture condition (AMC), and imperviousness of the watershed.

2. **Estimating the Runoff Nutrient Loads**
   - Runoff volume and coefficient.
   - Event mean concentrations (EMCs).
   - Percent of nutrients in dissolved fraction.
   - Flow path distance.

RAINFALL (MADISON) AND RUNOFF FLOW 2016 - 2023



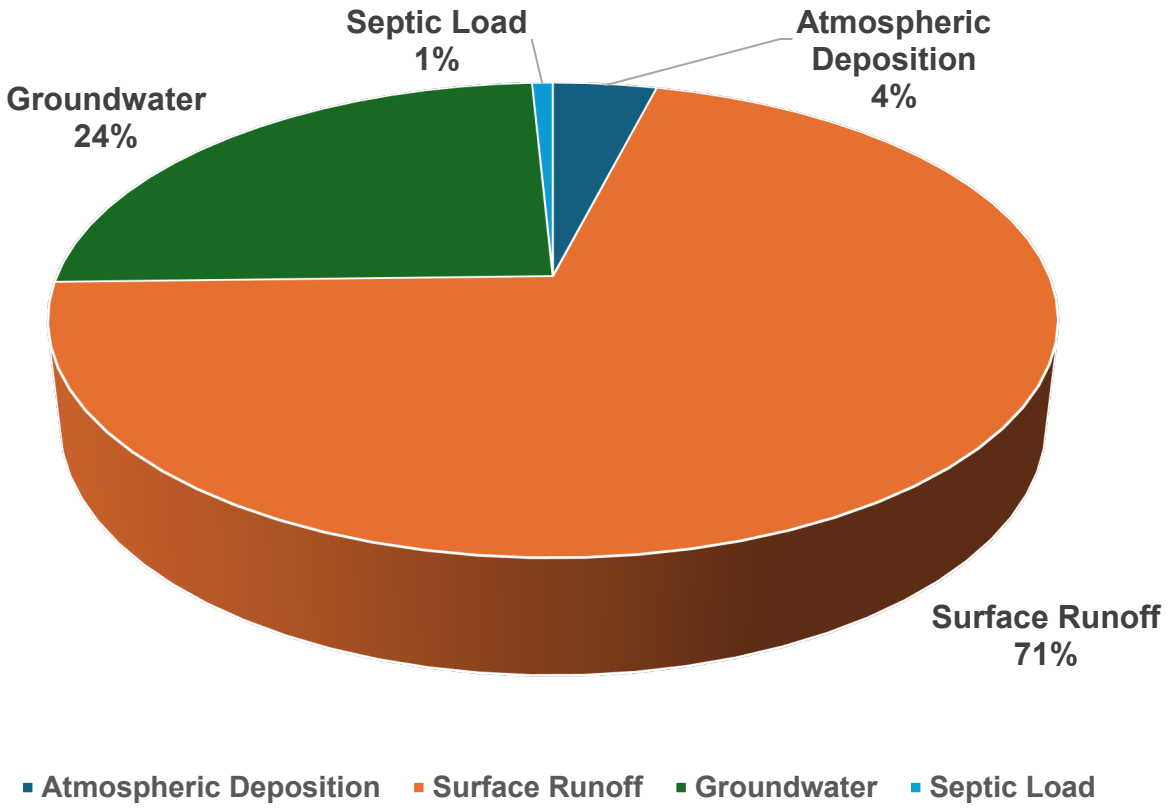


EMCS USED FOR EACH LAND USE

Land Use	TP EMC (mg/L)	TN EMC (mg/L)
Low-density residential	0.178	1.51
Medium-density residential	0.301	1.87
High-density residential	0.497	2.10
Low-density commercial	0.179	1.07
High-density commercial	0.248	2.2
Industrial	0.213	1.19
Mining	0.150	1.18
Pasture	0.621	3.30
Tree crops	0.152	2.07
Cropland	0.489	2.46
Other agriculture	1.050	3.24
Open land/recreational	0.301	1.87
Forest/rangeland	0.055	1.15
Wetlands	0.055	1.15
Water	0.025	0.716

ANNUAL MEAN OF TP LOADS (2016 -2023)

Loading Source	Atmospheric Deposition	Surface Runoff	Ground water	Septic Load	Total
Long-Term Mean Annual (kg/yr)	5	90	31	1	127



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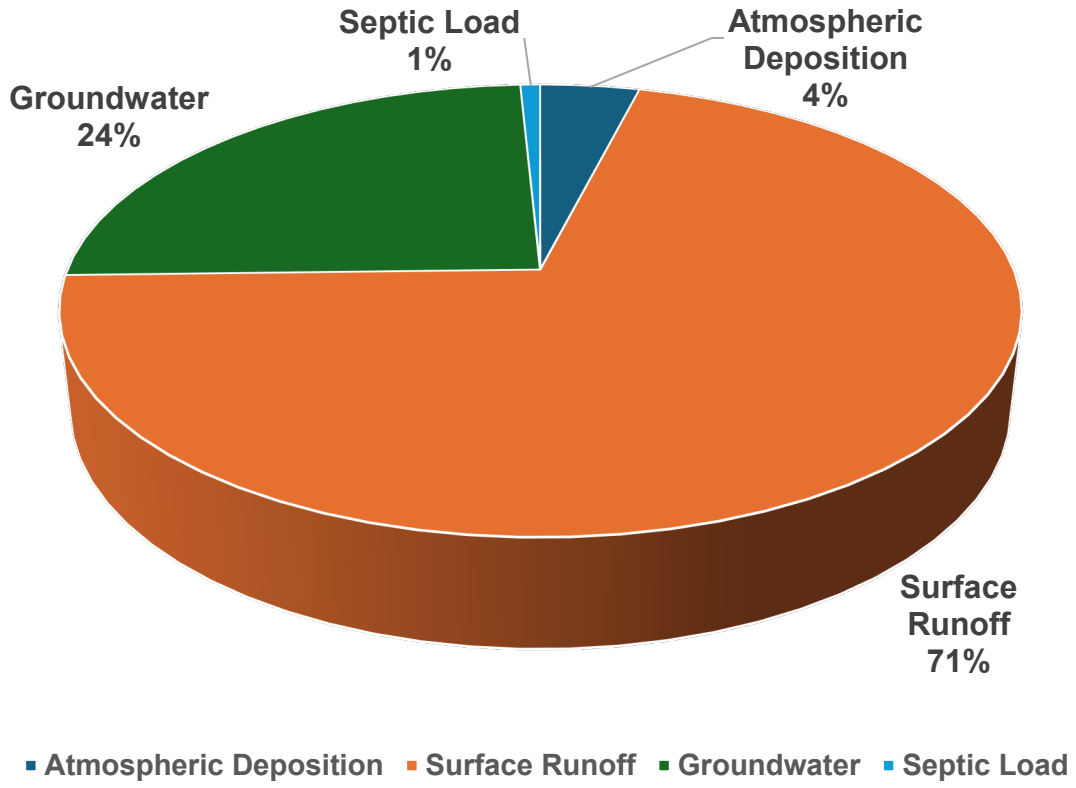
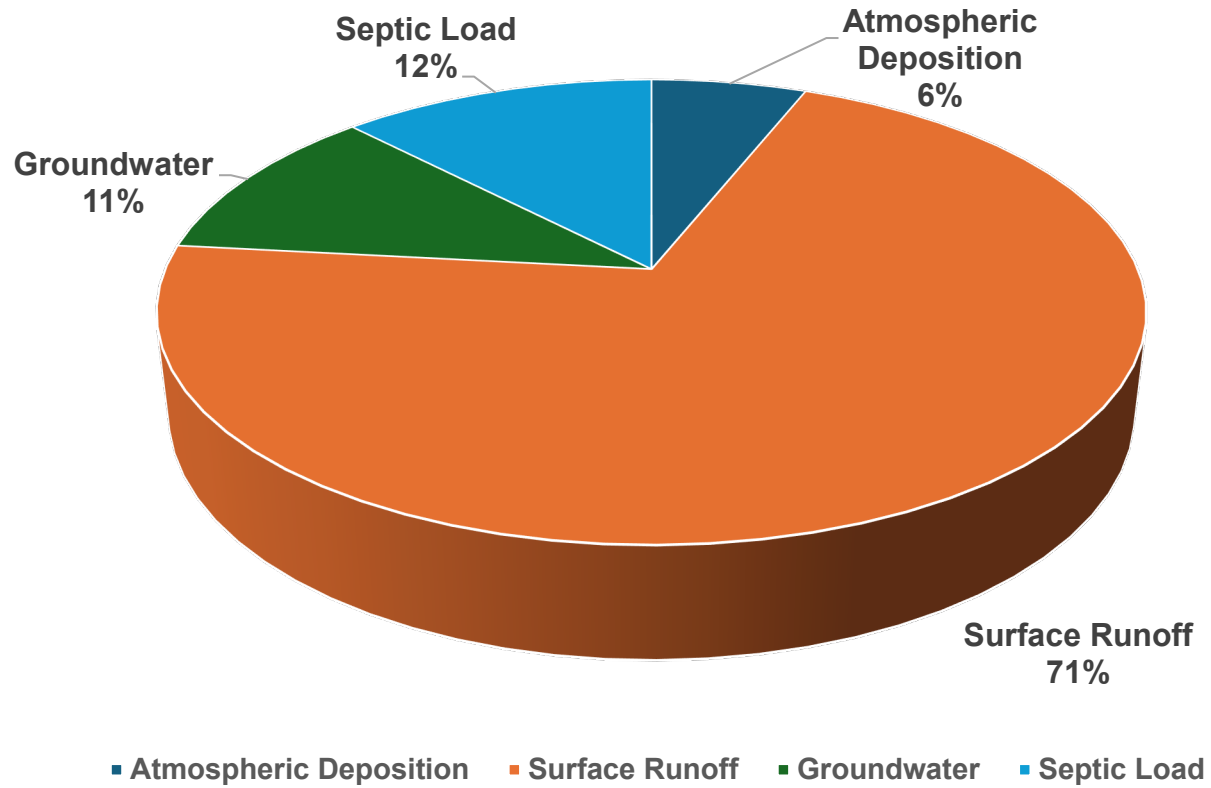
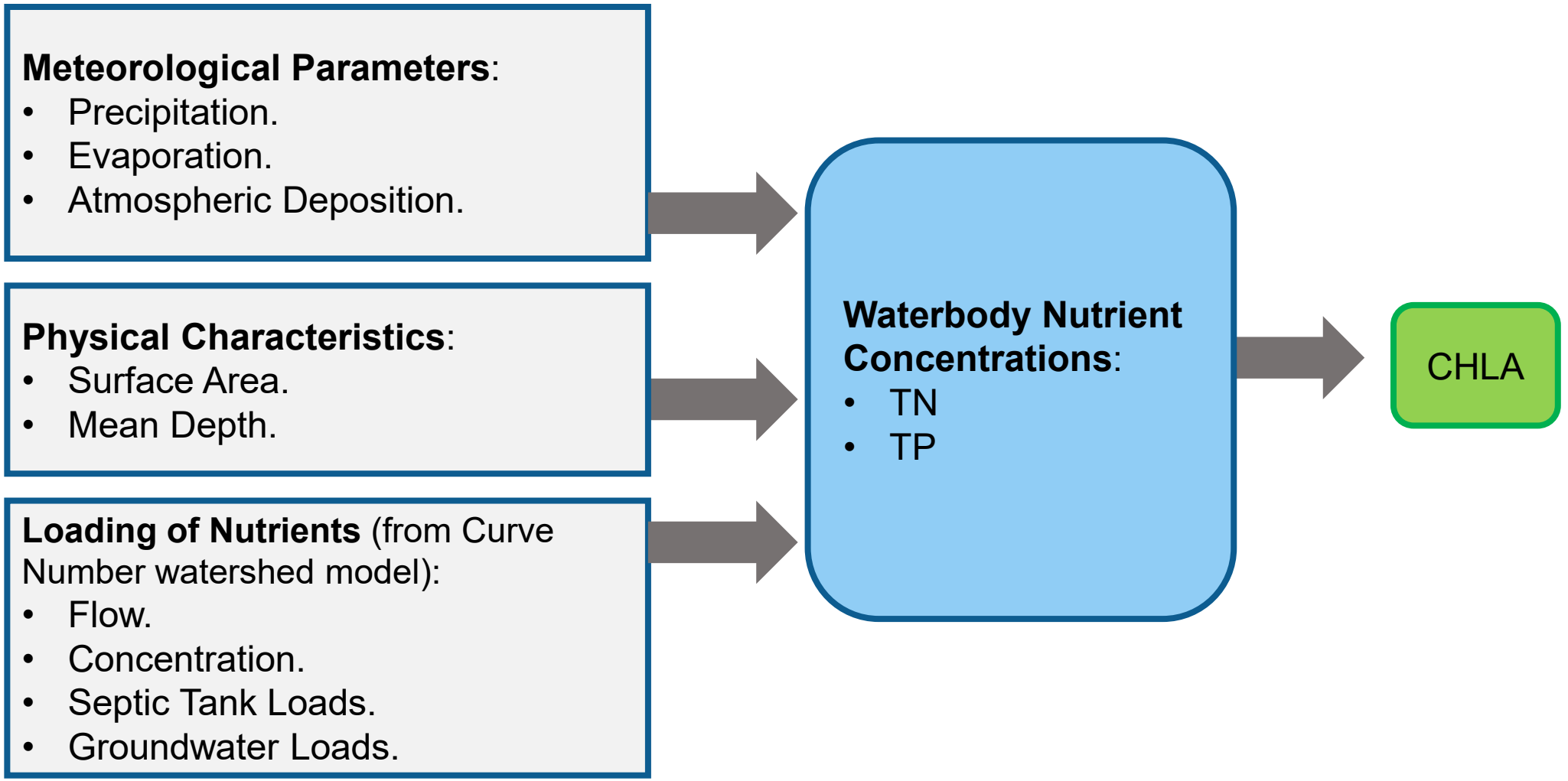


ANNUAL MEAN OF TN LOADS (2016 -2023)

Loading Source	Atmospheric Deposition	Surface Runoff	Groundwater	Septic Load	Total
Long-Term Mean Annual (kg/yr)	72	840	131	146	1,189



MODELING IN-LAKE CHLOROPHYLL RESPONSE TO NUTRIENT LOADING WITH BATHTUB



MODEL SELECTION AND COEFFICIENTS

- **Model Selection:**
  - TP: 08 CANF and BACH, LAKES
  - TN: 03 2nd Order, Fixed
  - Chl *a*: 01 P, N, Light, Flushing

- **Model Coefficients:**
  - TP: 1.2
  - TN: 0.7
  - Chl *a*: 1

CANF and BACH = Canfield and Bachmann

GLOBAL VARIABLE

Year	Precipitation (m/yr)	PET (m/yr)	Atmospheric TP ($mg/m^2/yr$)	Atmospheric TN ($mg/m^2/yr$)
2016	1.328	1.074	41	710
2017	1.290	1.069	46	681
2018	1.514	1.057	32	665
2019	1.179	1.087	44	582
2020	1.415	1.085	68	781
2021	1.267	1.031	83	910
2022	1.207	1.072	44	643
2023	1.562	1.075	53	770

PET = Potential evapotranspiration.

SEGMENTS (1)

Morphometry	
Surface Area (km^2)	0.0998
Mean Depth (m)	1.38
Length (km)	0.4
Mixed Layer Depth (m)	1.38

SEGMENTS (2)

Observed Water Quality (Annual Arithmetic Mean)					Internal Load	
Year	Chl-*a* (µg/L)	TN (µg/L)	TP (µg/L)	Non-algal Turbidity	TP ($mg/m^2/day$)	TN ($mg/m^2/day$)
2016	34.5	893	143	1.30	2.5	1
2017	53.3	1490	78	0.08	0.5	20
2018	36.4	1056	97	0.30	0.5	1
2019				1.00	0.8	3
2020	46.9	1275	80	0.20	0.3	10
2021	43.6	1620	119	1.30	1.0	25
2022	20.5	1486	129	4.00	1.5	20
2023	78.8	2182	190	0.40	3.5	32

TRIBUTARIES (1): TYPE2: NONPOINT INFLOW

Land Uses

Land Use Category	FLUCCS Code	Drainage Area (km^2)
Low Density Residential	1100	0.1750
Medium Density Residential Recreational	1200 1800	0.4366
High Density Residential	1300	0.0501
Commercial	1400	0.5706
Agriculture	2000	0.1468
Upland Forests	4000	0.4464
Water	5000	0.0675
Wetlands	6000	0.0703

NON-POINT SOURCE EXPORT COEFFICIENTS

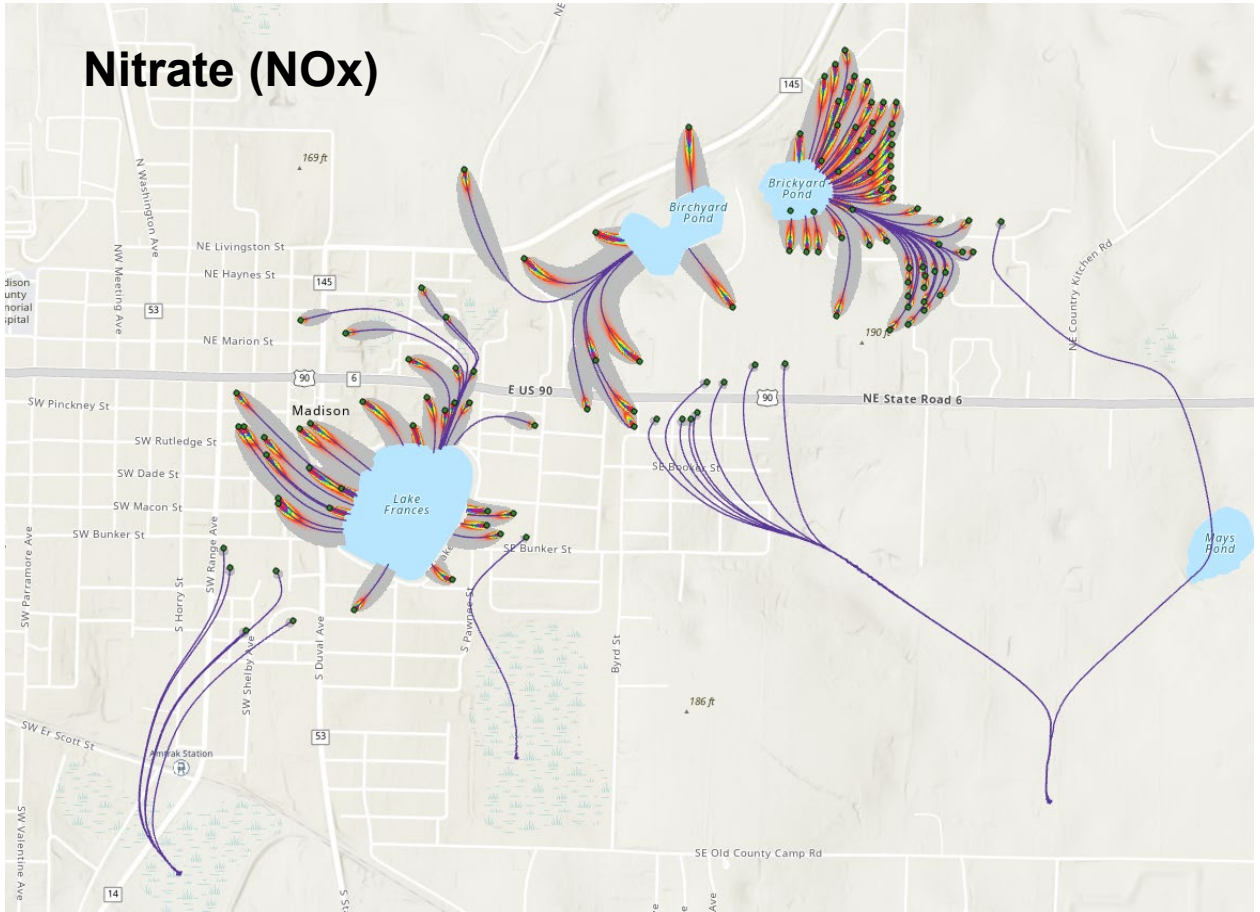
Runoff (m/yr), TP (mg/m3), TN (mg/m3)

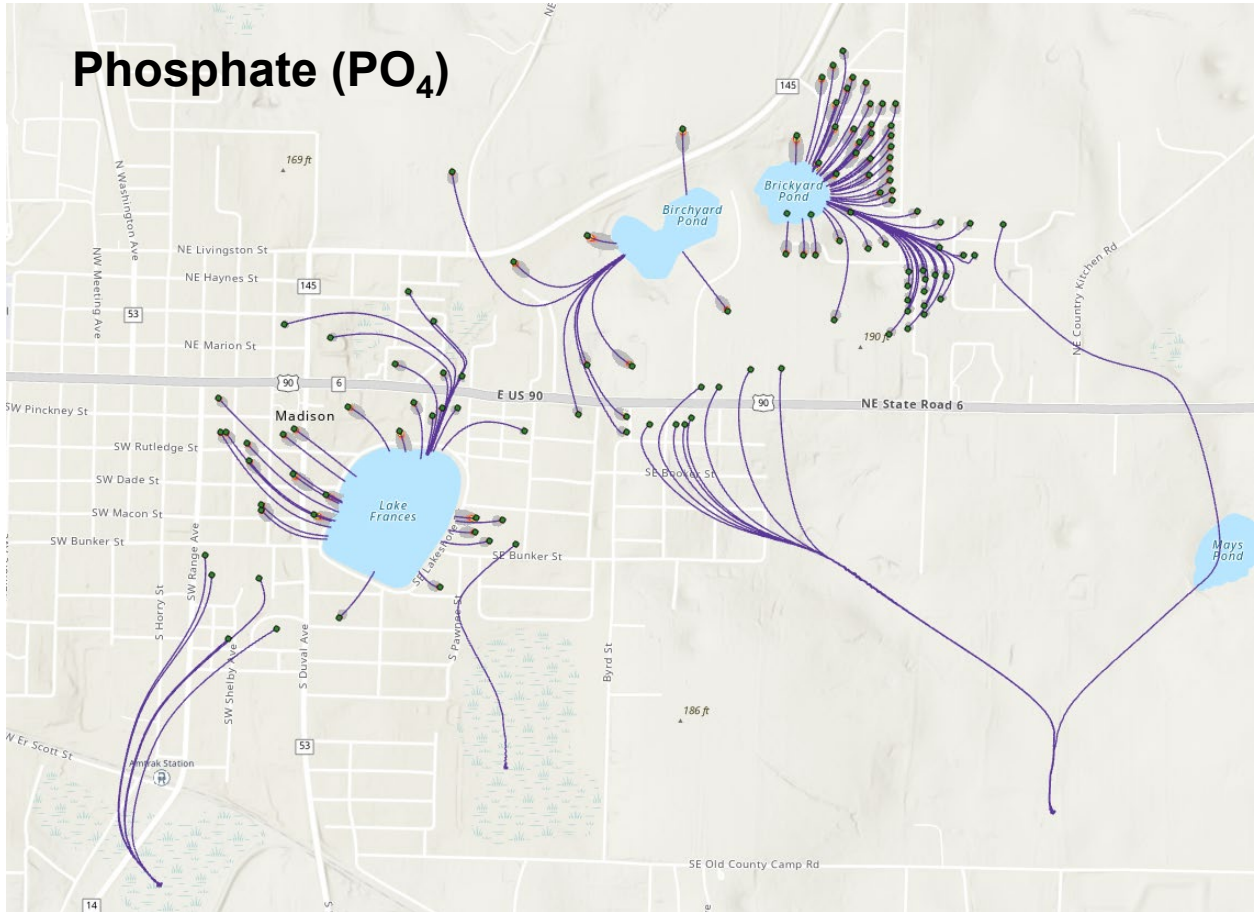
	2016			2017			2018			2019			2020			2021			2022			2023		
Landuse	Runoff	TP	TN	Runoff	TP	TN	Runoff	TP	TN	Runoff	TP	TN	Runoff	TP	TN	Runoff	TP	TN	Runoff	TP	TN	Runoff	TP	TN
LDR	0.0858	114	1239	0.0840	114	1239	0.1215	114	1239	0.0952	114	1239	0.1890	114	1239	0.0707	114	1239	0.0834	114	1239	0.0935	114	1239
MDR_Rec	0.2004	192	1535	0.1953	192	1535	0.2536	192	1535	0.1982	192	1535	0.3177	192	1535	0.1793	192	1535	0.1878	192	1535	0.2277	192	1535
HDR	0.3153	317	1723	0.3067	317	1723	0.3743	317	1723	0.2918	317	1723	0.3975	317	1723	0.2938	317	1723	0.2898	317	1723	0.3661	317	1723
COMM	0.5387	181	1583	0.5237	181	1583	0.6288	181	1582	0.49	181	1582	0.6351	181	1582	0.507	181	1583	0.4927	181	1582	0.6289	181	1583
AGR	0.0409	380	2469	0.0404	380	2469	0.073	380	2468	0.0576	380	2468	0.1522	380	2468	0.0267	380	2469	0.0432	380	2469	0.0399	380	2469
FOR	0.0444	35	944	0.0439	35	944	0.0801	35	944	0.0632	35	944	0.1691	35	944	0.0285	35	944	0.0471	35	944	0.0430	35	944
WAT	1.0290	9	411	0.9998	9	411	1.1843	9	411	0.9223	9	411	1.1439	9	411	0.9763	9	411	0.9373	9	411	1.2064	9	411
WET	0.9097	35	962	0.8839	35	962	1.0485	35	962	0.8166	35	962	1.0177	35	962	0.8624	35	962	0.8289	35	962	1.0660	35	962

TRIBUTARIES (2): SEPTIC LOADS

Loadings from Septic (ArcNLET-py):

- Flow: 0.05872 hm^3/yr.
- TN Concentration: 2,943 µg/L.
- TP Concentration: 19 µg/L.





TRIBUTARIES(3): GROUNDWATER

Groundwater Flow (hm3)

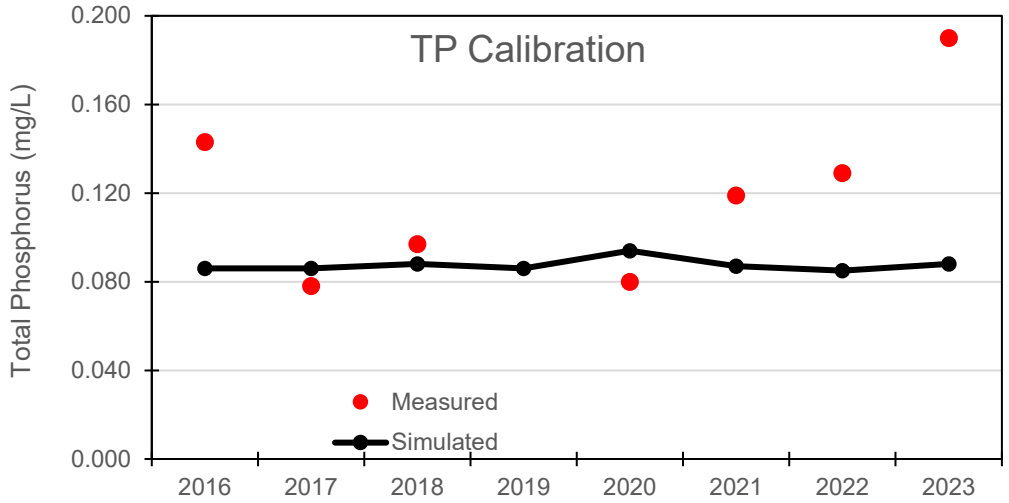
Parameter	2016	2017	2018	2019	2020	2021	2022	2023
Runoff (hm3)	0.129	0.125	0.156	0.122	0.176	0.118	0.119	0.148

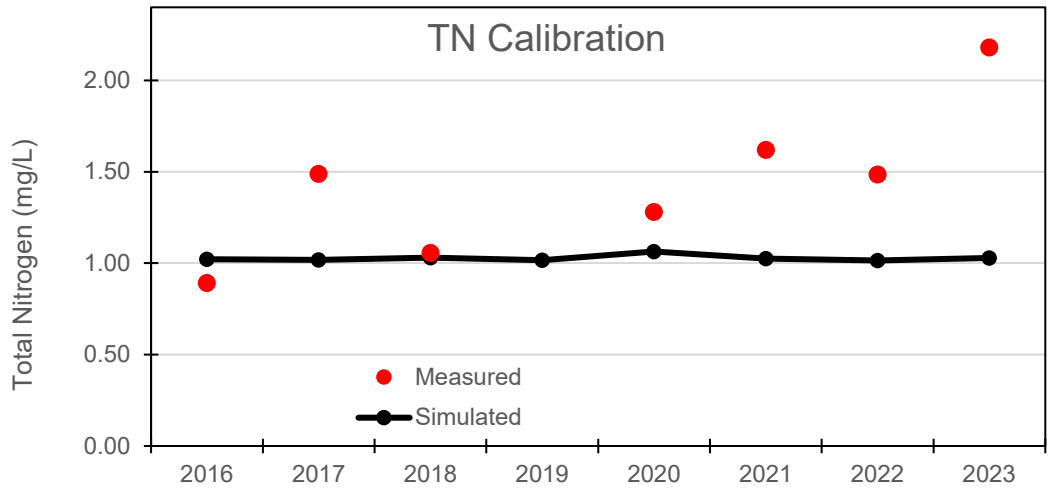
Groundwater Nutrient Concentrations (Mean values of 3 samples from WBID 3329)

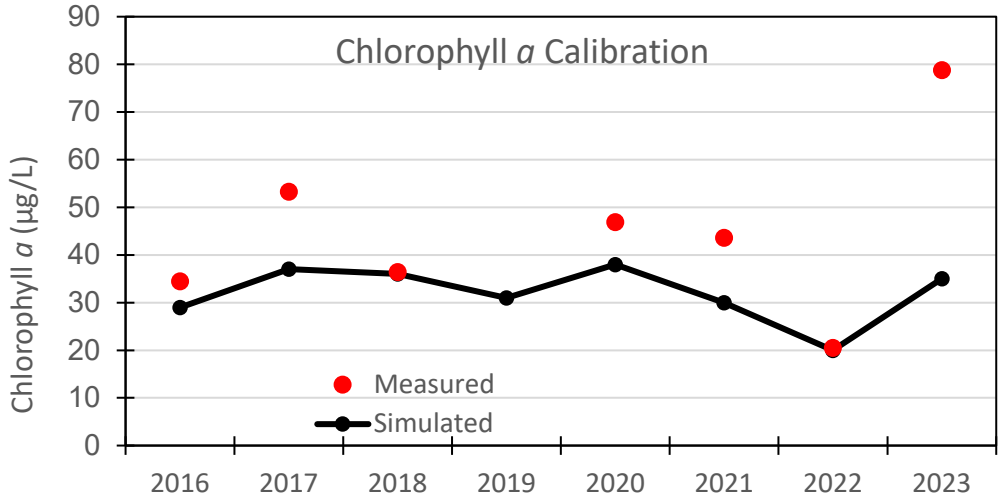
TN: 960 µg/L.

TP: 226 µg/L.

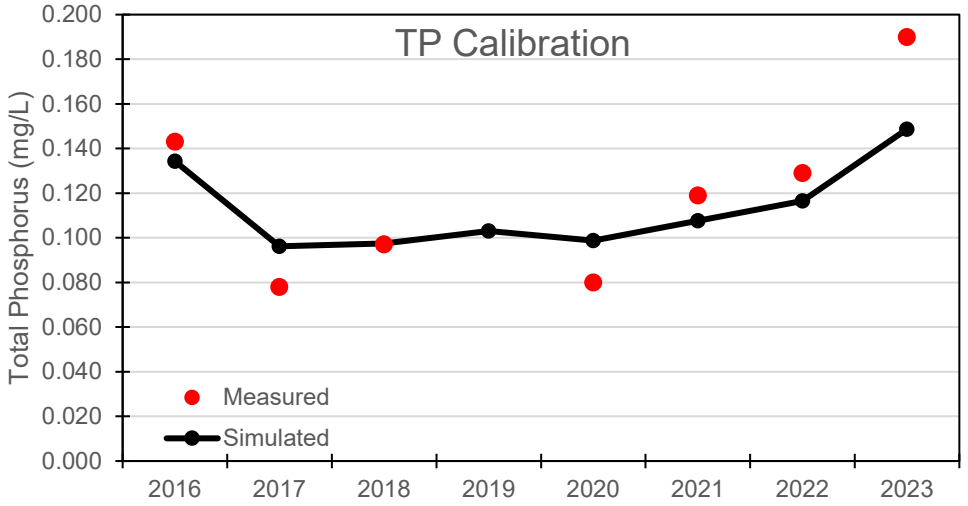
CALIBRATIONS WITHOUT INTERNAL LOADS

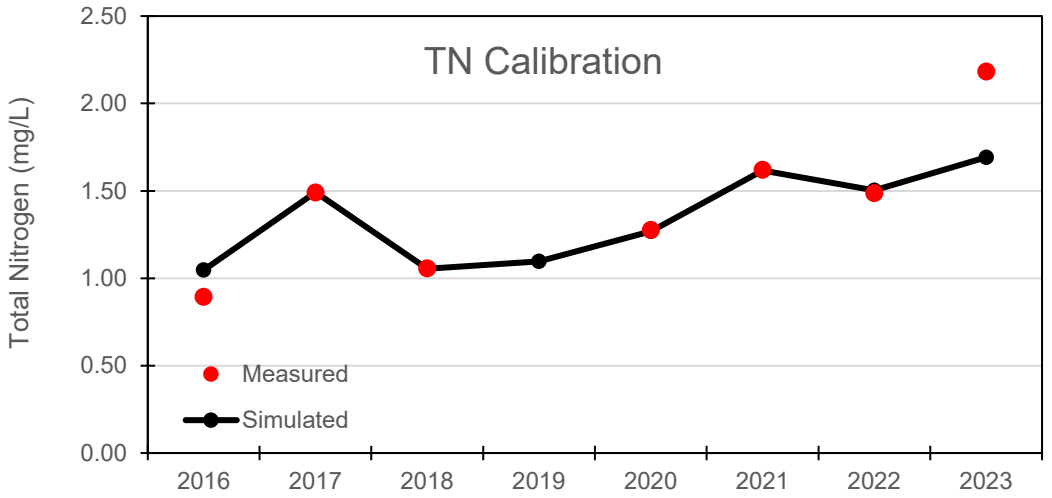


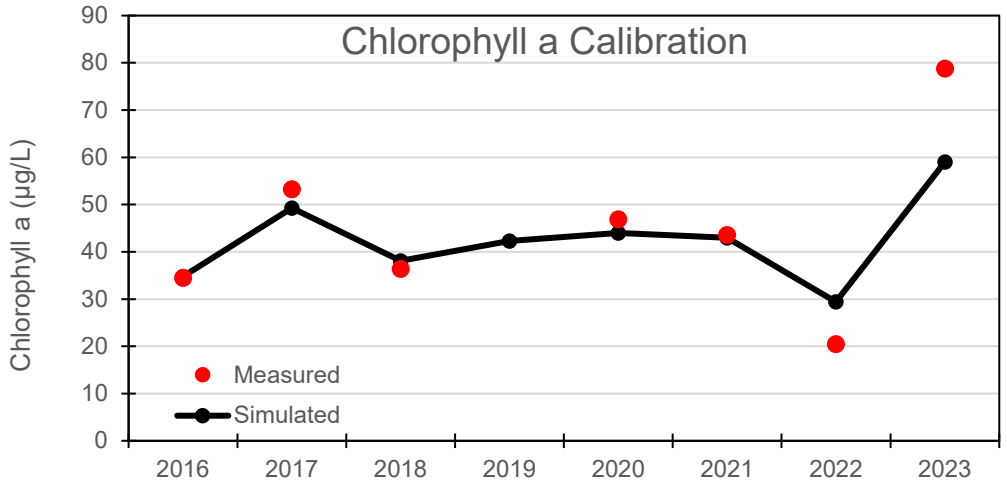




CALIBRATIONS WITH INTERNAL LOADS







NITROGEN FIXERS IN LAKE FRANCIS

Percent Based on Algal Density (units/mL): DEP Biology Lab

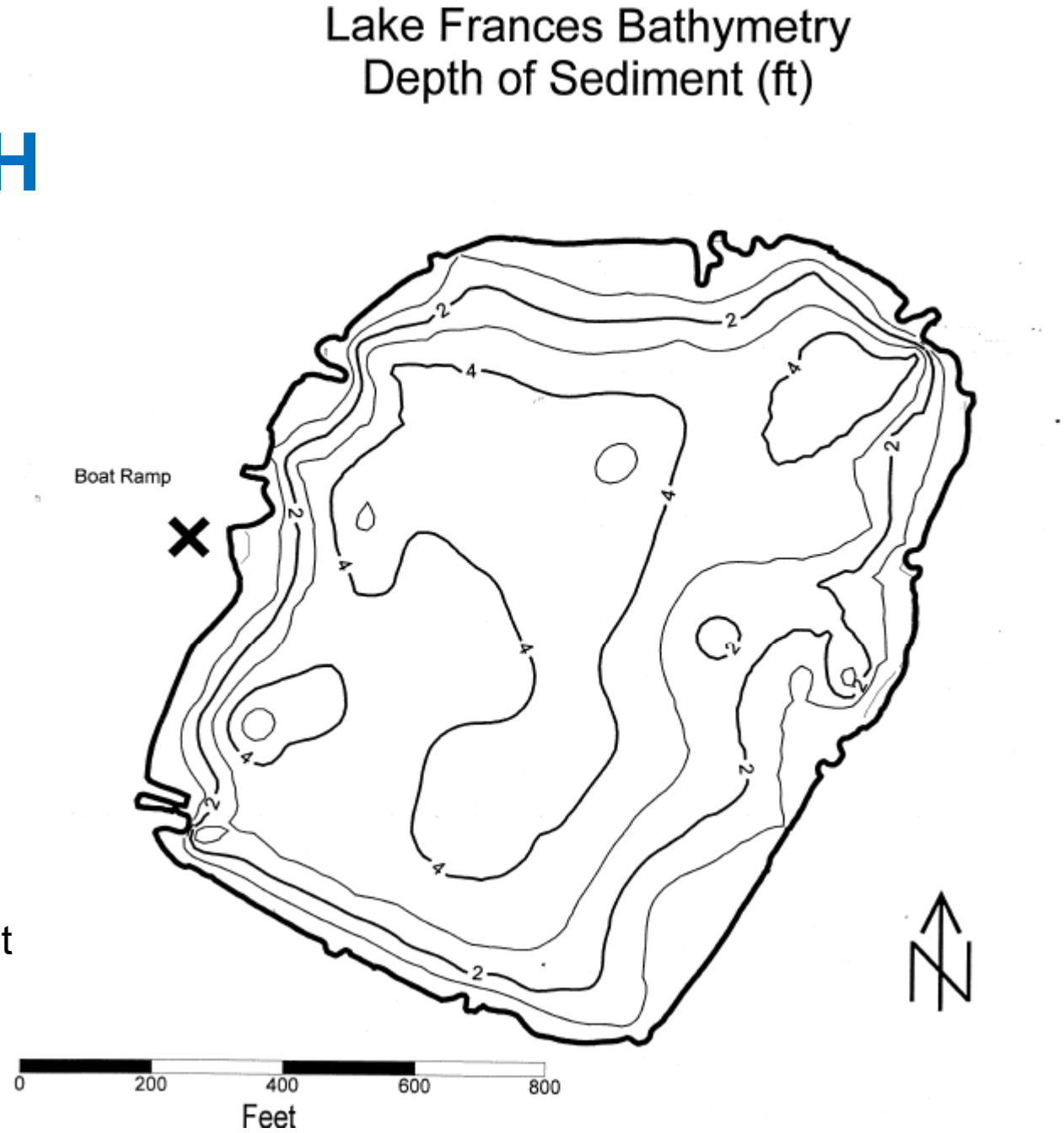
Sampling Date	9/4/1996	10/7/2003	11/15/2006	6/19/2007	7/18/2007	9/19/2007	4/3/2008
Percent	2%	60%	1%	49%	25%	4%	9%

Anabaena spp.
Aphanizomenon spp.
Cylindrospermopsis raciborskii
and others

LAKE FRANCIS SEDIMENT DEPTH

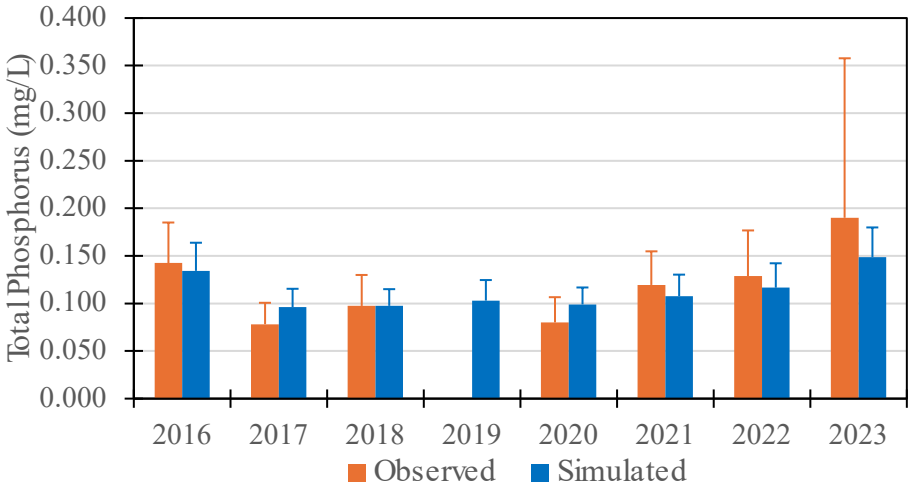
2002 (FROM FWC)

Sediment depths: up to 5 feet

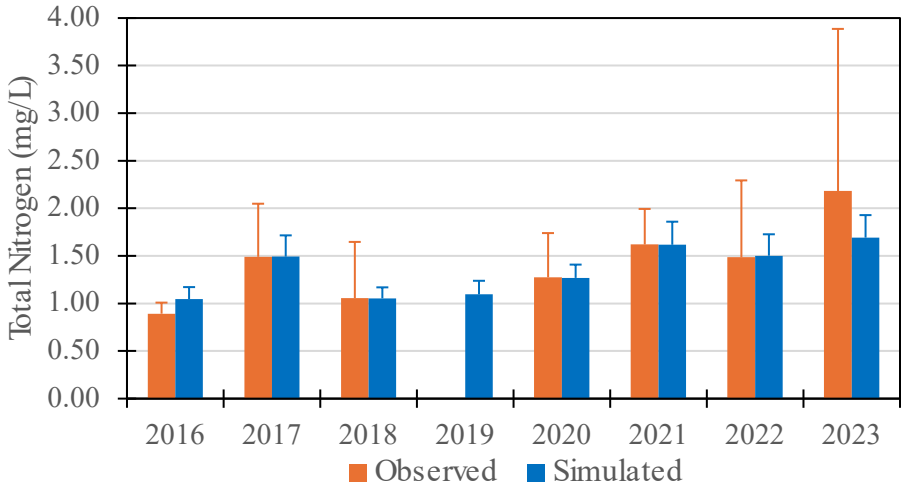


CALIBRATIONS

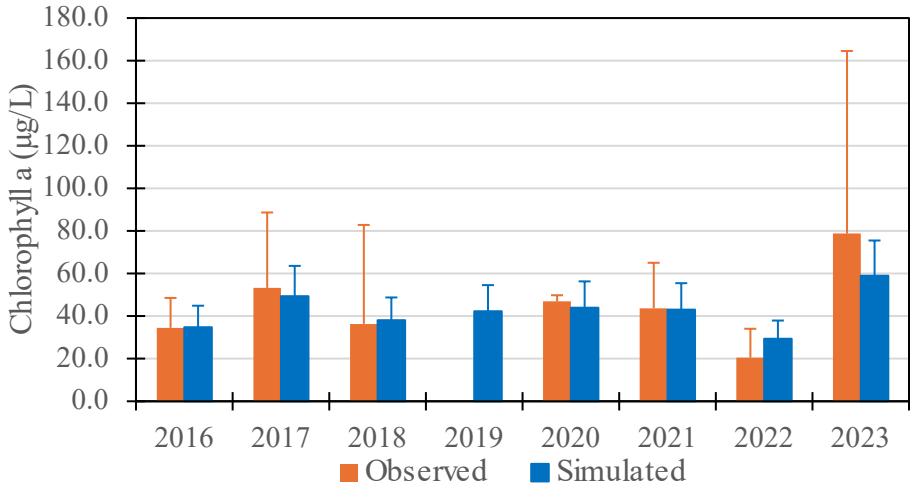
TP Calibration



TN Calibration



Chlorophyll a Calibration



SIMULATED VERSUS MEASURED

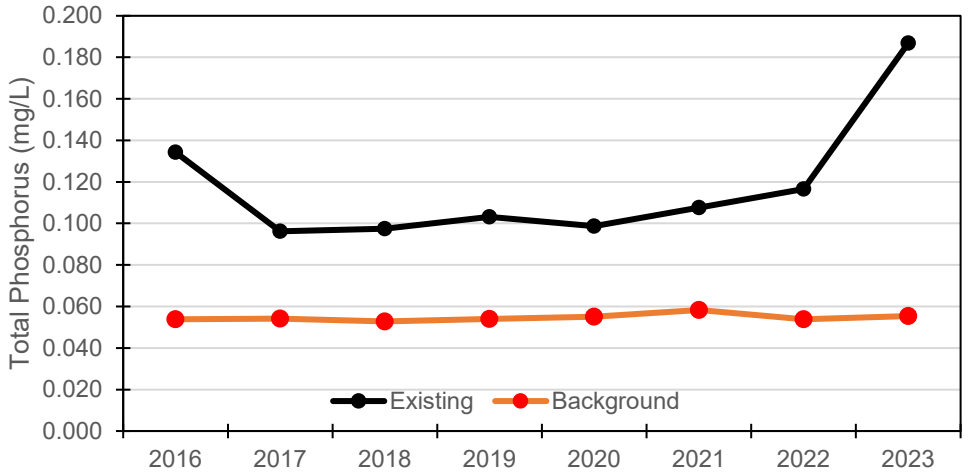
Data	Measured	Simulated	Measured	Simulated	Measured	Simulated
Parameter	TP (mg/L)	TP (mg/L)	TN (mg/L)	TN (mg/L)	Chl*a* (µg/L)	Chl*a* (µg/L)
Mean	0.119	0.114	1.43	1.38	45	43
% Difference		4%		3%		5%
Median	0.119	0.108	1.49	1.49	44	43
% Difference		9%		0%		1%

NATURAL BACKGROUND SIMULATION

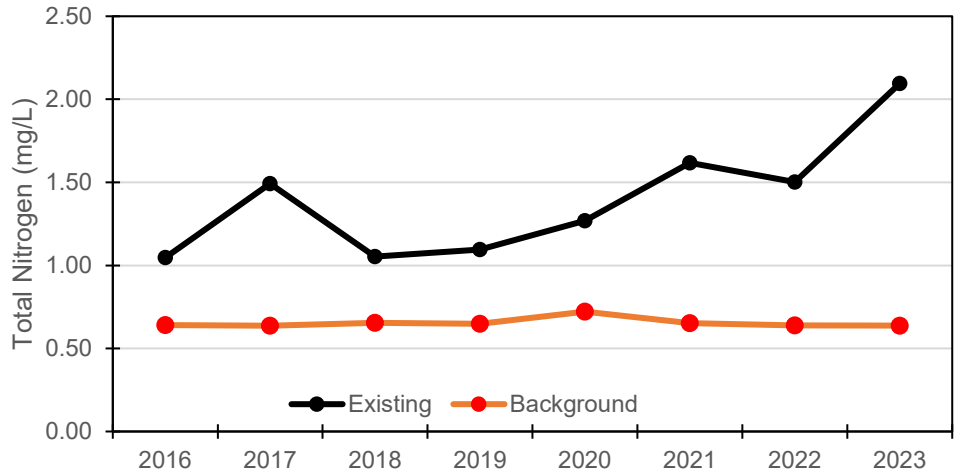
- Human land uses were converted to upland forest.
- The septic tank loads were removed.
- Internal loads were removed.

EXISTING CONDITION VS NATURAL BACKGROUND CONDITION

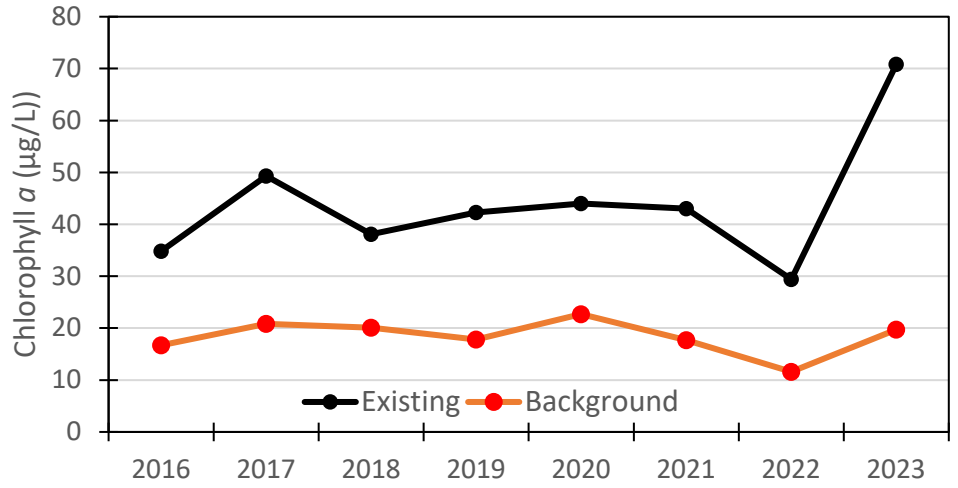
TP



TN



Chlorophyll *a*



TARGET SETTING AND TMDL SIMULATION

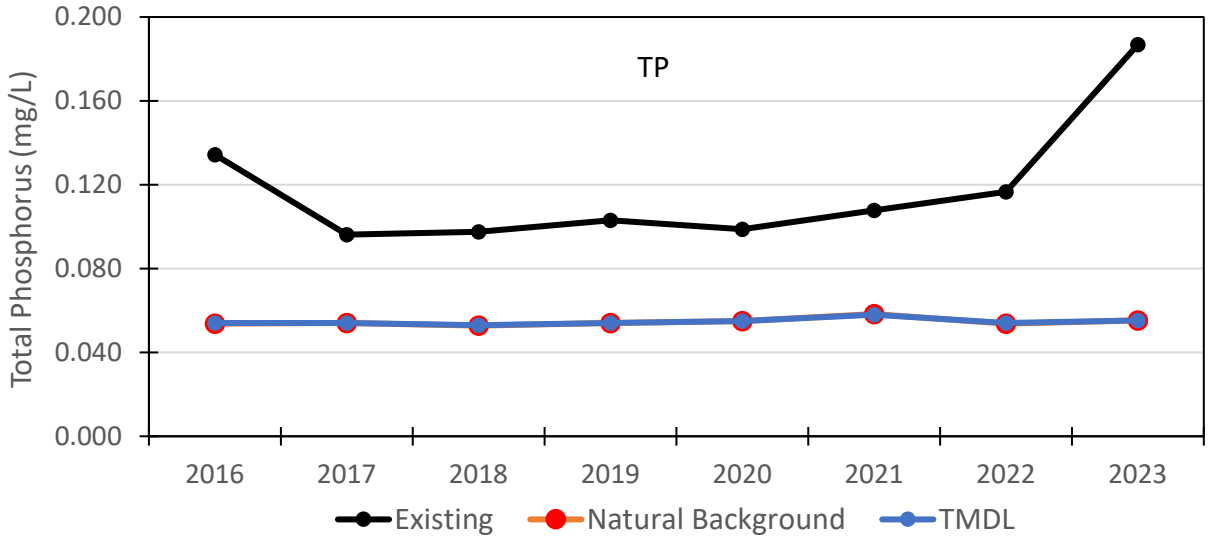
Target Setting

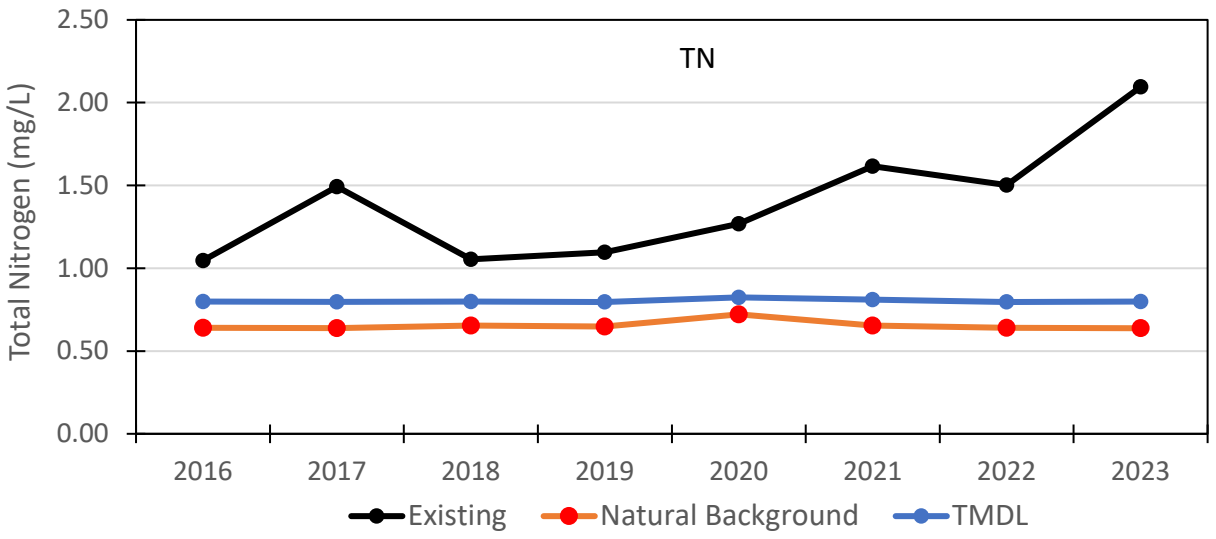
- Chl a: 20 µg/L, not to be exceeded 1 in 3 years.

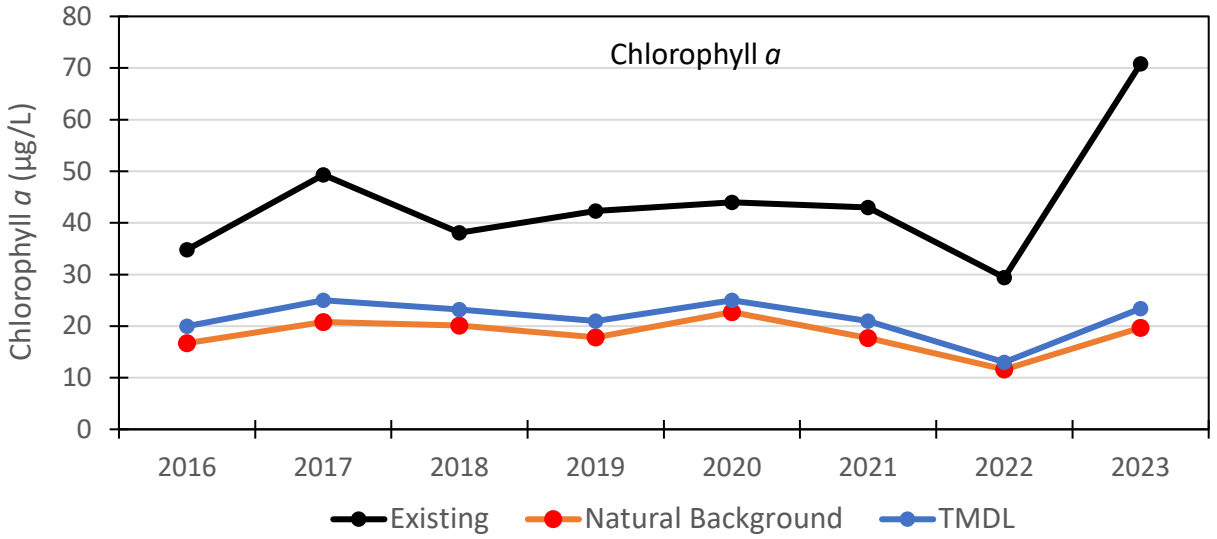
TMDL Simulation

- By reducing the watershed TN and TP loads iteratively from the existing condition until simulated chlorophyll *a* concentrations meet the restoration target.

EXISTING, NATURAL BACKGROUND AND TMDL SIMULATION







CONVERSION FROM ANNUAL ARITHMETIC MEAN (AAM) TO ANNUAL GEOMETRIC MEAN (AGM)

TP AGM = 0.9328 x TP AAM

TN AGM = 0.9654 x TN AAM

Chlorophyll *a* AGM = 0.8805 x Chlorophyll *a* AAM

Equations based on lake NNC development data set.

TMDL CONDITION (ANNUAL AVERAGE AND CONVERTED AGMS)

Year	Chlorophyll *a* Annual Average (µg/L)	Chlorophyll *a* AGM (µg/L)	TN Annual Average (mg/L)	TN AGM (mg/L)	TP Annual Average (mg/L)	TP AGM (mg/L)
2016	20	18	0.80	0.77	0.054	0.050
2017	25	22	0.80	0.77	0.054	0.050
2018	23	20	0.80	0.77	0.053	0.049
2019	21	19	0.80	0.77	0.054	0.050
2020	25	22	0.82	0.80	0.055	0.051
2021	21	18	0.81	0.78	0.058	0.054
2022	13	11	0.80	0.77	0.054	0.050
2023	23	21	0.80	0.77	0.055	0.051

Targets: informational purposes only.

Chl a: 20 µg/L : Not to be exceeded one in three years.

TP: 0.05 mg/L : Not to be exceeded.

TN: 0.80 mg/L : Not to be exceeded.

LAKE FRANCIS TMDL CONDITION NUTRIENT LOADS, 2016 – 2023

Year	Current Condition TN Loads (Kg/yr)	5-Year Rolling Average TN Loads (Kg/yr)	TMDL Condition TN Loads (Kg/yr)	5-Year Rolling Average TN Loads (Kg/yr)	Current Condition TP Loads (Kg/yr)	5-Year Rolling Average TP Loads (Kg/yr)	TMDL Condition TP Loads (Kg/yr)	5-Year Rolling Average TP Loads (Kg/yr)
2016	1,168		832		210		68	
2017	1,833		810		135		67	
2018	1,359		969		161		77	
2019	1,180		784		143		65	
2020	1,845	1,477	1,086	**896**	175	165	88	73
2021	1,988	1,641	798	889	151	153	70	**73**
2022	1,785	1,631	775	882	166	159	63	73
2023	2,442	**1,848**	937	876	265	**180**	79	73
Maximum 5-Year Average		**1,848**		**896**		**180**		**73**
% Reduction				**52%**				**59%**

TMDL PERCENT REDUCTIONS

$$\frac{\textit{[maximum existing load – maximum target load]}}{\textit{maximum existing load}} \textit{ X 100}$$

$$TN\ Reduction = \frac{(1{,}848 - 896)}{1{,}848} * 100 = 52\%$$

$$TP\ Reduction = \frac{(180 - 73)}{180} * 100 = 59\%$$

TMDL COMPONENTS FOR NUTRIENTS IN LAKE FRANCIS (WBID 3366A)

Waterbody (WBID)	Parameter	TMDL (kg/yr)	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)	LA (% reduction)	MOS
3366A	TN	896	NA	NA	52	Implicit
3366A	TP	73	NA	NA	59	Implicit

STAKEHOLDER INVOLVEMENT

Draft Report:

- Report posted on May 15, 2025.

https://floridadep.gov/dear/water-quality-evaluation-tmdl/content/draft-tmdls

Requesting Comments on the Report:

- Requesting comments by July 3, 2025.
- Requesting information on local water quality issues and projects that might influence the TMDLs.
  - Assuring that pertinent local information is used in the TMDL development.
  - Establishing contact with key stakeholders who will help us during the restoration process.

Submit Comments to Eric Simpson, Environmental Administrator

- Eric.Simpson@FloridaDEP.gov
- 850-245-8466

TMDL ADOPTION STEPS

- Review comments provided by stakeholders.
- Revise report and rule package that will be submitted to DEP Secretary for consideration.
- Adopt TMDL into state rule in fall 2025, assuming no major revisions.
- Submit to EPA for approval as a site-specific water quality standard and TMDL.


Photo by DEP Staff
(Kyeongsik Rhew)
3/11/2023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FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
QUESTIONS?

FOR MORE INFORMATION

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THANK YOU

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Florida Department of Environmental Protection

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