Wetlands for Cost-Effective Nitrogen Wastewater Compliance

Florida Rural Water Association
Annual Conference
July 29, 2026, 9:00 AM

Scott Knight, Ph.D., P.E.
Wetland Solutions, Inc.
Gainesville, FL

Wetland Solutions Inc

Outline

- TMDLs
- BMAPs
- Why it matters
- Nitrogen modeling
- Utility allocations
- How does a utility address their allocation?
- Wetlands as a wastewater unit process
- Case Study – High Springs
- Nutrient reductions by disposal type
- Recharge wetlands for wastewater disposal
- Case Study – Lake City

Total Maximum Daily Loads (TMDLs)

- TMDLs set the load of a “pollutant” that can be received by a waterbody without causing adverse impacts to its designated uses
- Developed at the WBID scale
- TMDL Process
  - Biennial review of all state waterbodies
  - Impaired waters are added to the Section 303(d) Verified List of Impaired Waters
  - Prioritization of waterbodies for TMDL development
  - TMDL developed

Spring TMDL in Practice

- Suwannee/Santa Fe Rivers and Priority Springs
  - 233 WBIDs
  - Nutrients
  - DO
  - Fecal coliform
- Established a nitrate concentration of 0.35 mg/L as protective for springs
- Concentration not load
- At spring vent

Final

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

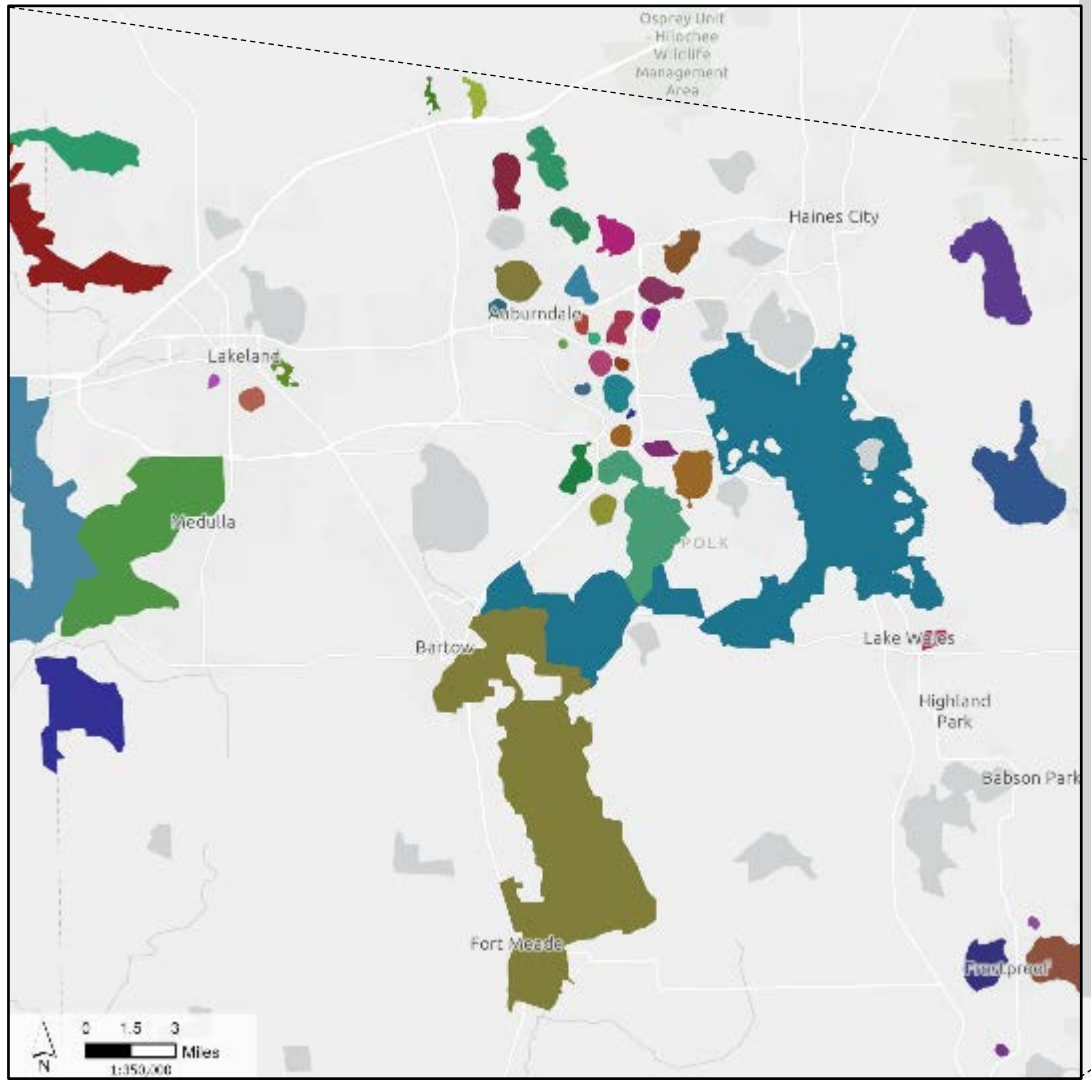
NORTHEAST DISTRICT • SUWANNEE RIVER BASIN

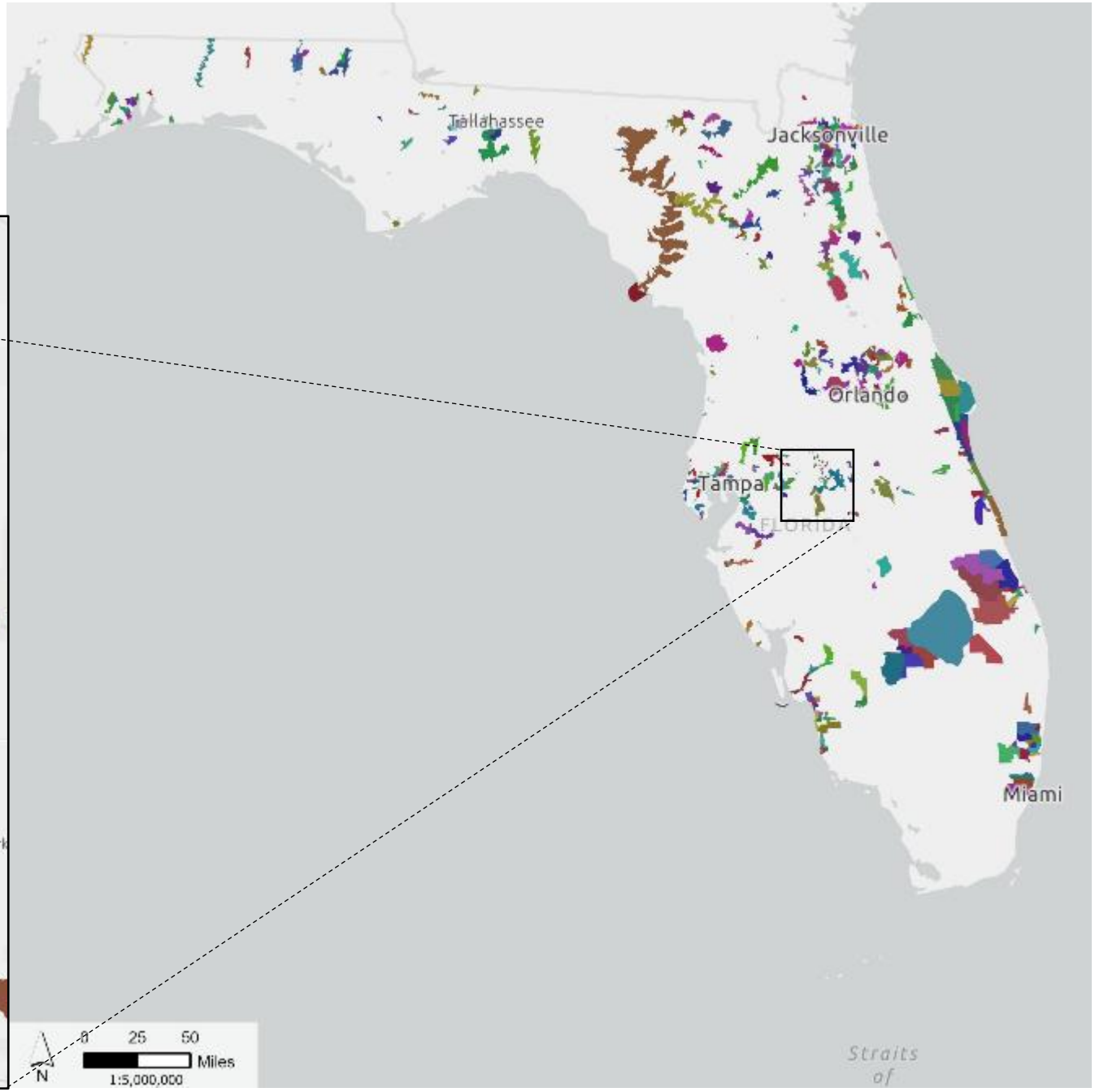
Nutrient and Dissolved Oxygen TMDL for the Suwannee River, Santa Fe River, Manatee Springs (3422R), Fanning Springs (3422S), Branford Spring (3422J), Ruth Spring (3422L), Troy Spring (3422T), Royal Spring (3422U), and Falmouth Spring (3422Z)

John F. Hallas
Wayne Magley, PhD

9/24/08

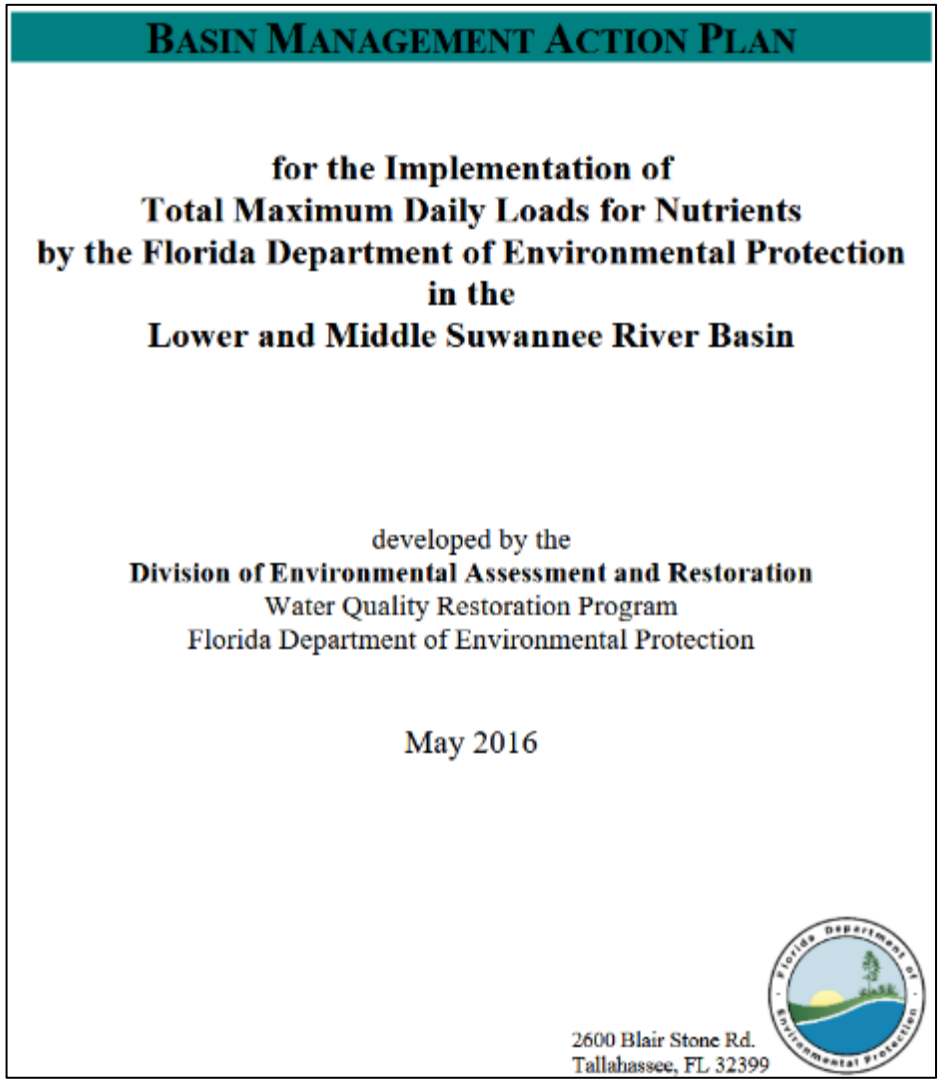
TMDL Waterbodies





Basin Management Action Plans (BMAPs)

- BMAPs are the restoration frameworks for achieving TMDLs
- Often developed for multiple WBIDs
- Springs BMAPs rely on nitrogen source modeling using NSILT
- New 2025 BMAPs allocate loads to entities



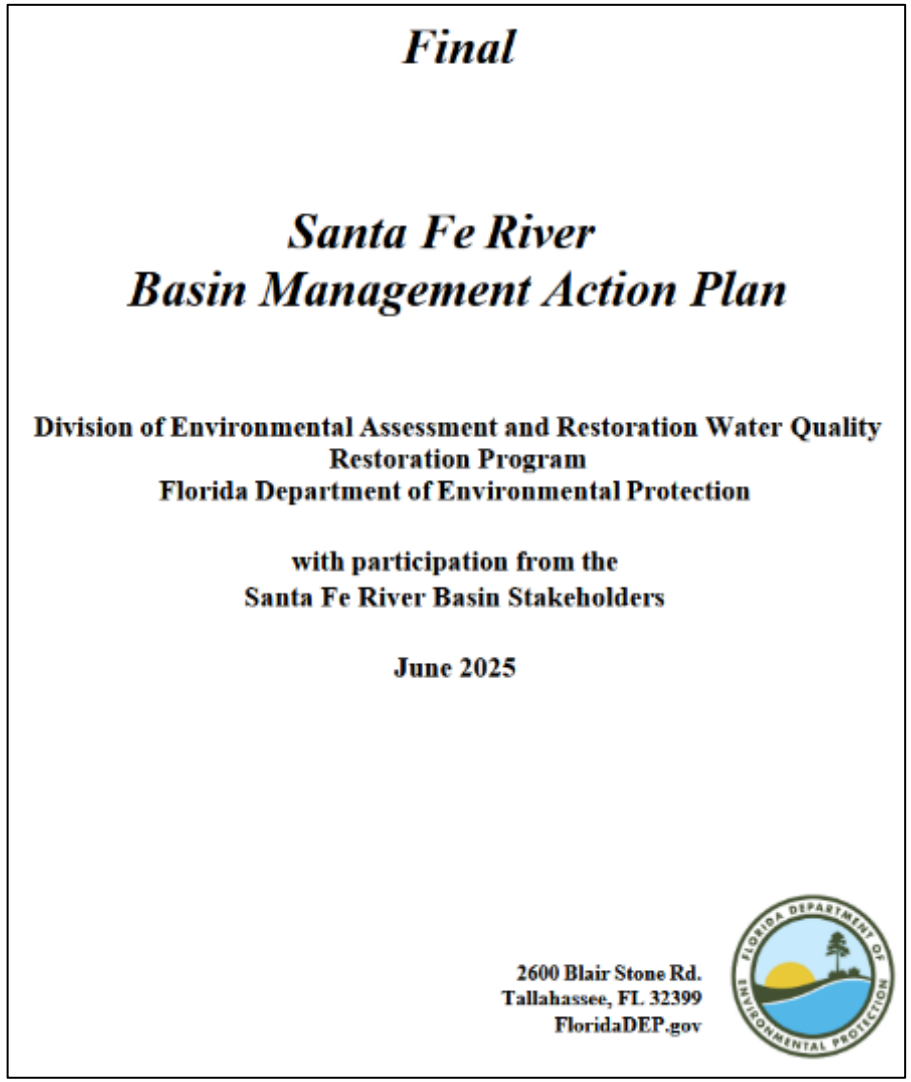
BASIN MANAGEMENT ACTION PLAN

for the Implementation of
Total Maximum Daily Loads for Nutrients
by the Florida Department of Environmental Protection
in the
Lower and Middle Suwannee River Basin

developed by the
Division of Environmental Assessment and Restoration
Water Quality Restoration Program
Florida Department of Environmental Protection

May 2016

2600 Blair Stone Rd.
Tallahassee, FL 32399



Final

Santa Fe River
Basin Management Action Plan

Division of Environmental Assessment and Restoration Water Quality Restoration Program
Florida Department of Environmental Protection

with participation from the
Santa Fe River Basin Stakeholders

June 2025

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Tallahassee, FL 32399
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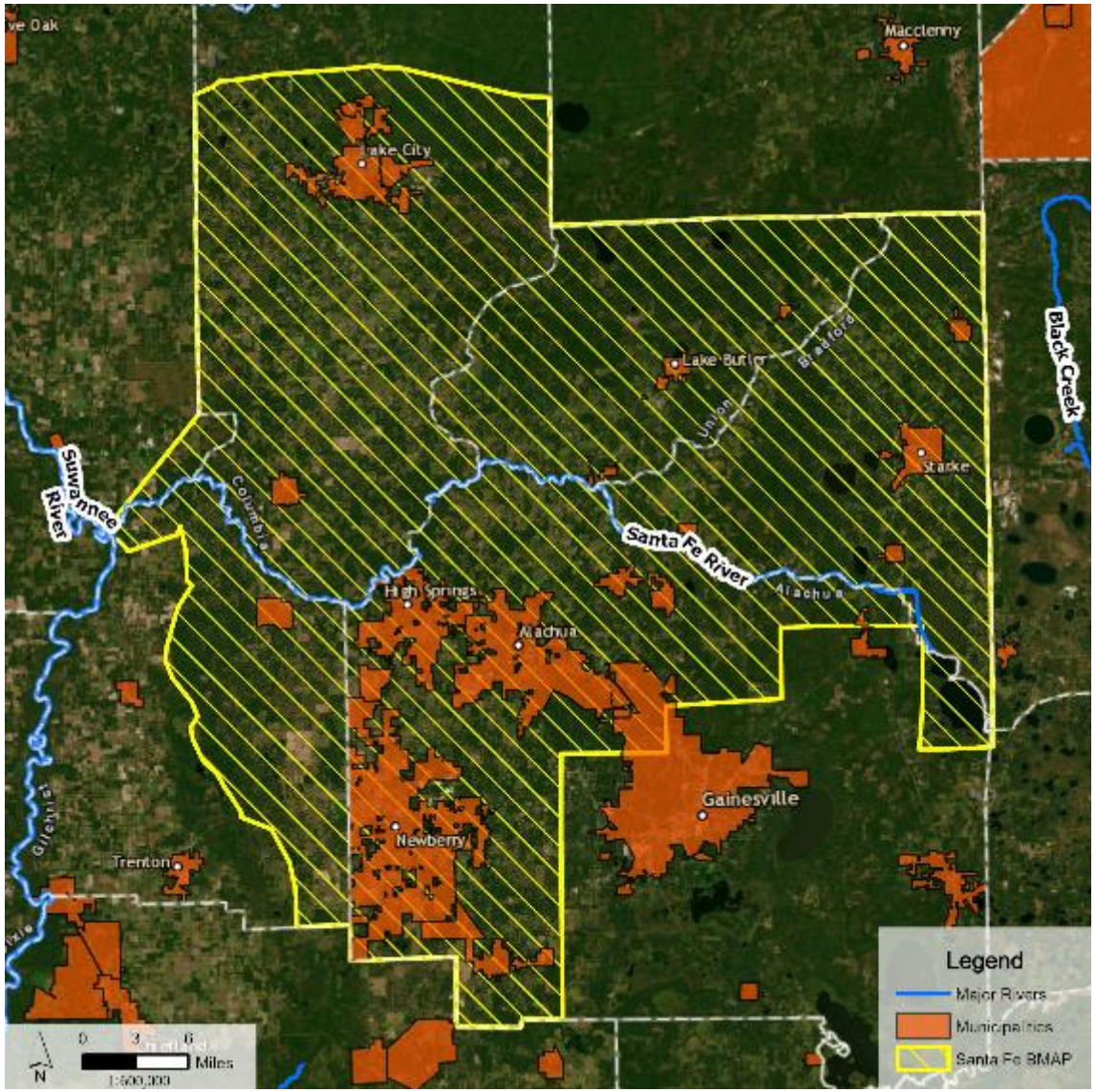
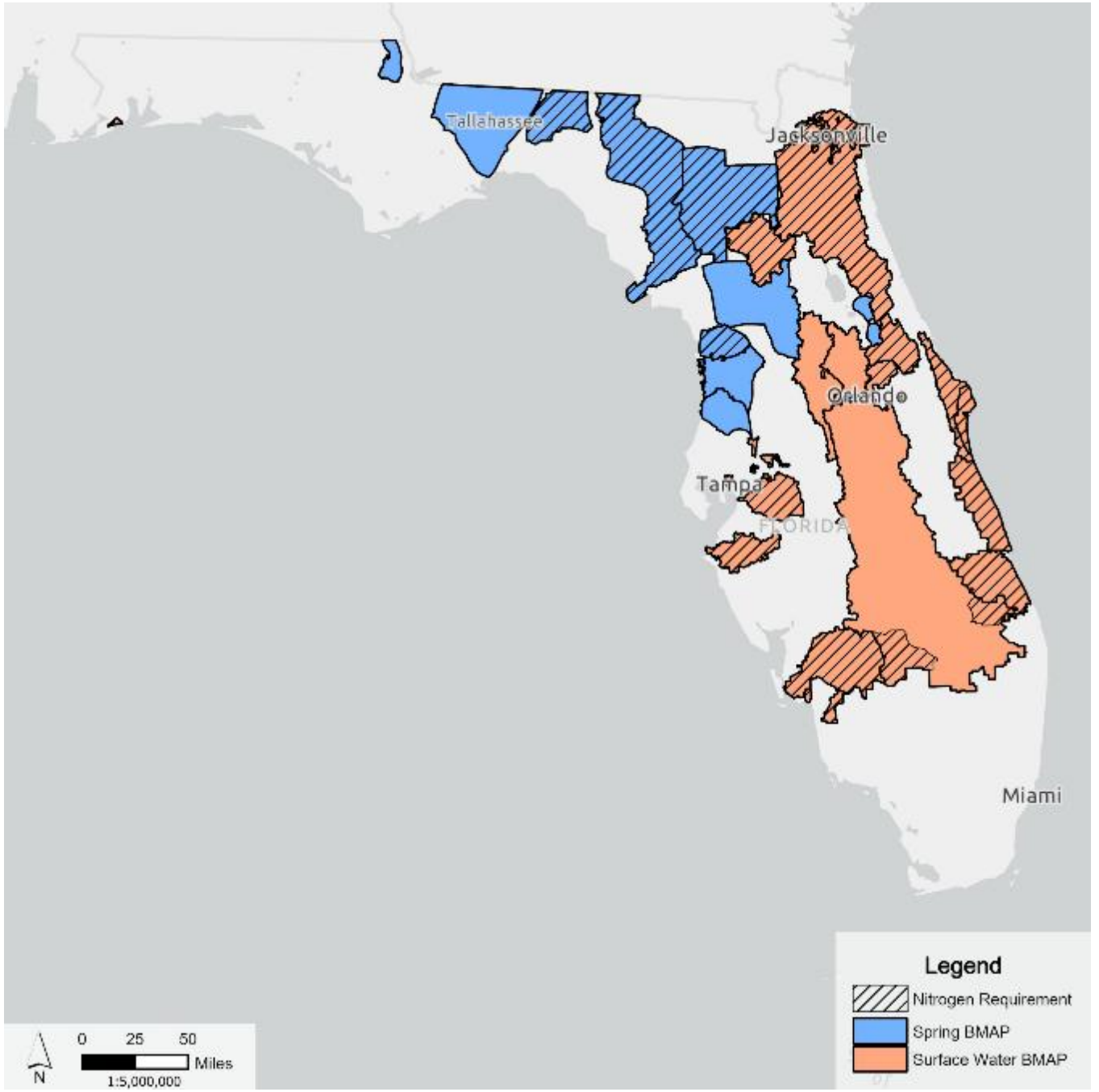
BMAP Areas


Macclenny
Lake City
Lake Butler
Starke
Black Creek
Suwannee River
Santa Fe River
High Springs
Alachua
Gainesville
Newberry
Trenton
Legend
Major Rivers
Municipalities
Santa Fe BMAP
0 3 6
Miles
1:600,000


Tallahassee
Jacksonville
Orlando
Tampa
FLORIDA
Miami
Legend
Nitrogen Requirement
Spring BMAP
Surface Water BMAP
0 25 50
Miles
1:5,000,000

Santa Fe BMAP

- Nitrate water quality target of 0.35 mg/L at the spring vent
- BMAP area: 1,086,774 acres
- Identified reduction of 1,432,101 lb/yr of TN
- Load:
  - 50% farm fertilizer
  - 17% septic
  - 16% livestock waste
  - 11% atmospheric dep.
  - <1% WW
- 2025 BMAP calls for achieving reductions by 2038
  - 2028 30%, 2033 +50%, 2038 +20%

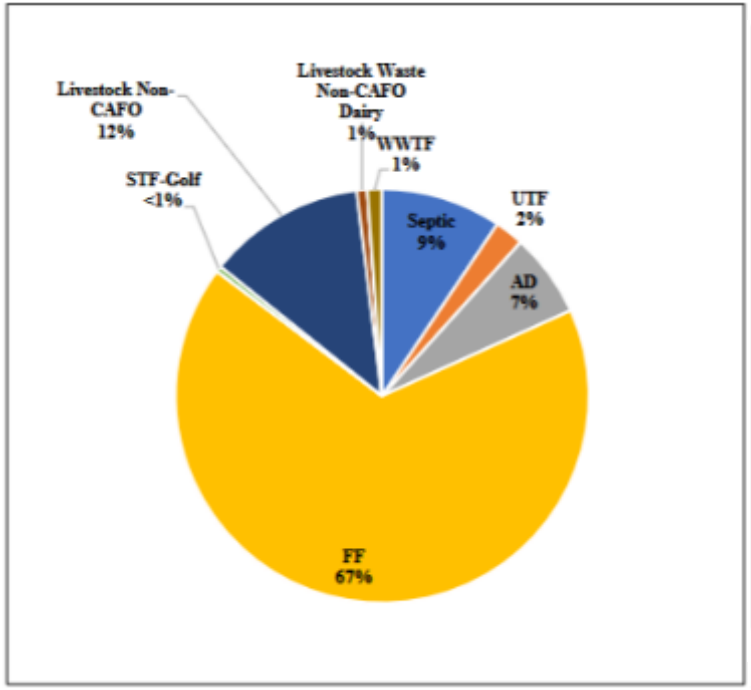


Figure 3. Loading to groundwater by source in the Hornsby springshed

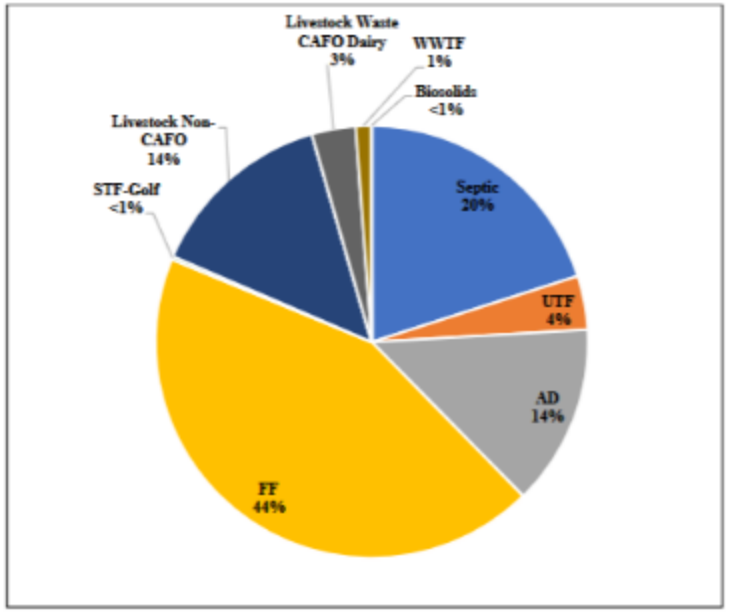


Figure 5. Loading to groundwater by source outside the springshed area

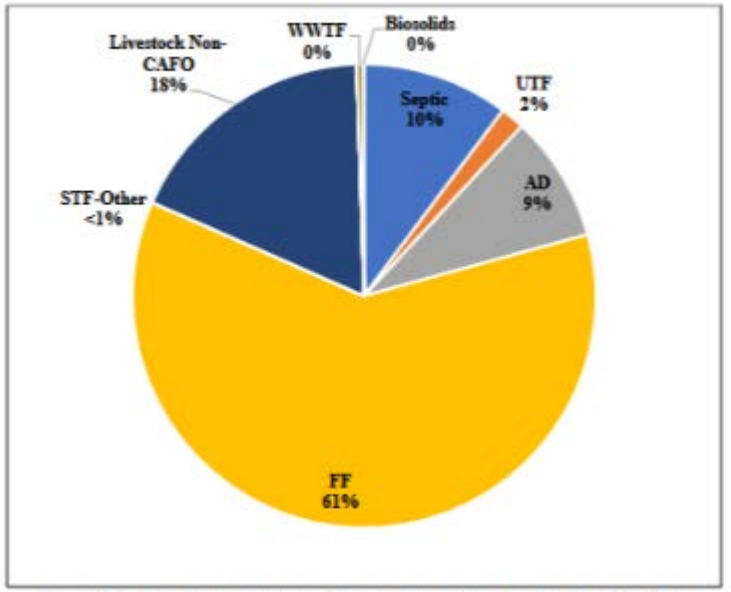


Figure 2. Loading to groundwater by source in the Devil's Ear

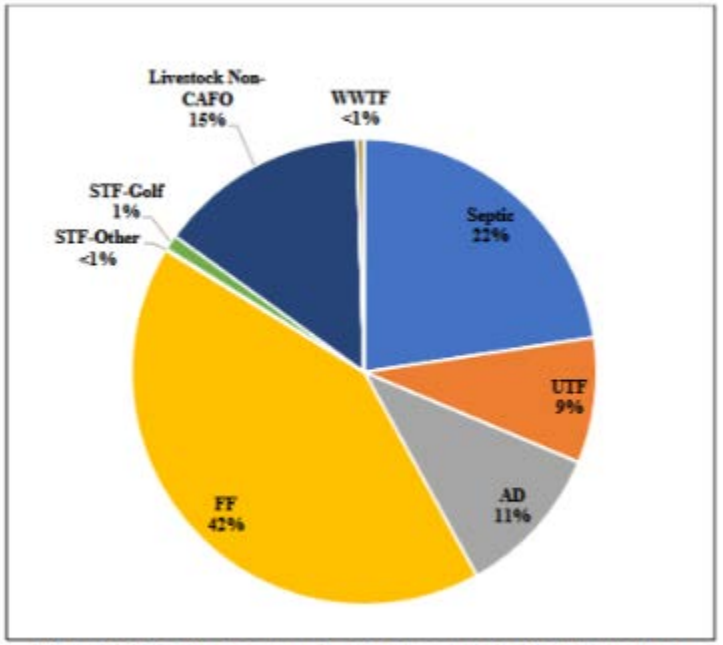


Figure 4. Loading to groundwater by source in the Ichetucknee

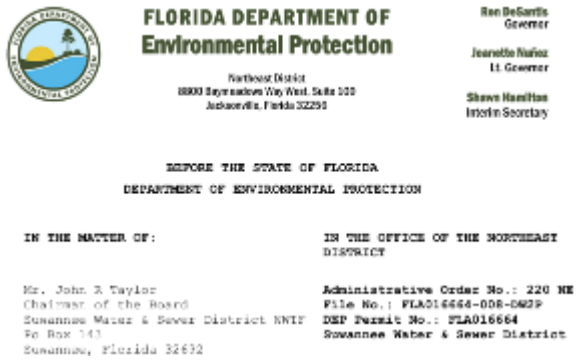
Why this matters to you

- Administrative Orders (AOs) are being issued for WWTFs in BMAPs
- Wastewater goal is based on achieving advanced wastewater treatment (AWT)
- AWT is a Florida WW standard:
  - 5 mg/L TSS, 5 mg/L BOD, 3 mg/L TN, 1 mg/L TP
- Challenging and expensive to comply with TN of 3 mg/L for small facilities with variable flows, loads, old equipment/infrastructure, and limited staffing

Nitrogen effluent limits for wastewater facilities

Facility Capacity (gpd)	Surface Water Discharges (mg/L)	WWTFs Not Listed in Appendix G — Rapid Rate Land Application Effluent Disposal System (mg/L)	WWTFs Not Listed in Appendix G — All Other Disposal Methods, Including Reuse (mg/L)
Greater than 100,000	3	3	3
20,000 to 100,000	3	3	6
Less than 20,000	3	6	6

AOs are the New Normal in Springs BMAP Areas



FLORIDA DEPARTMENT OF
Environmental Protection

Northeast District
8800 Baymeadows Way West, Suite 100
Jacksonville, Florida 32256

Ron DeSantis
Governor

Jeanette Nuñez
Lt. Governor

Shawn Hamilton
Interim Secretary

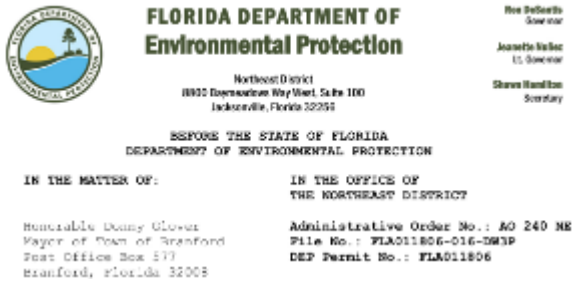
BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

Mr. John B Taylor
Chairman of the Board
Suwannee Water & Sewer District WWTF
Po Box 147
Suwannee, Florida 32692

IN THE OFFICE OF THE NORTHEAST DISTRICT

Administrative Order No.: 220 NE
File No.: FLA016664-008-DW2P
DEP Permit No.: FLA016664
Suwannee Water & Sewer District



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Shawn Hamilton
Secretary

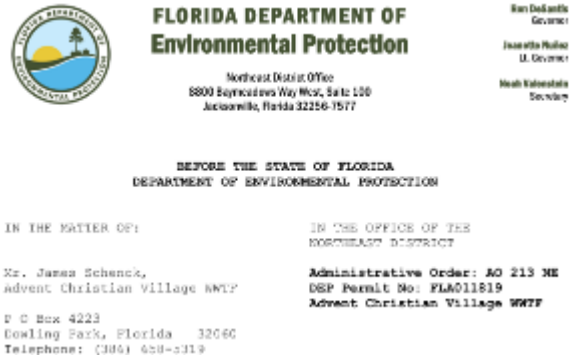
BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

Honorable Donny Glover
Mayor of Town of Branford
Post Office Box 577
Branford, Florida 32008

IN THE OFFICE OF
THE NORTHEAST DISTRICT

Administrative Order No.: AO 240 NE
File No.: FLA011806-016-DW3P
DEP Permit No.: FLA011806



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Northeast District Office
8800 Baymeadows Way West, Suite 100
Jacksonville, Florida 32256-7577

Ron DeSantis
Governor

Jeanette Nuñez
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Noah Valenstein
Secretary

BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

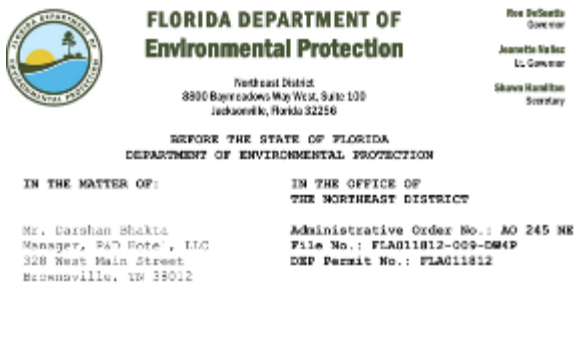
IN THE MATTER OF:

Mr. James Schenck,
Advent Christian Village WWTF

P O Box 4223
Bowling Park, Florida 32060
Telephone: (386) 658-3319

IN THE OFFICE OF THE
NORTHEAST DISTRICT

Administrative Order: AO 213 NE
DEP Permit No: FLA011819
Advent Christian Village WWTF



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Lt. Governor

Shawn Hamilton
Secretary

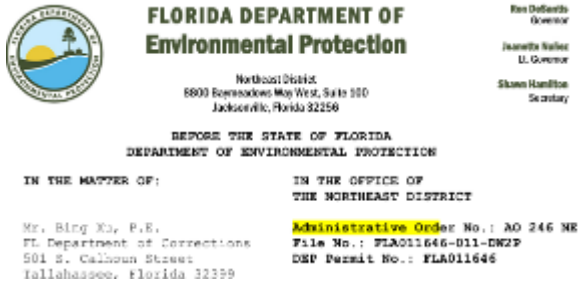
BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

Mr. Darshan Shukla
Manager, PAT Hotel, LLC
328 West Main Street
Brownsville, TN 38012

IN THE OFFICE OF
THE NORTHEAST DISTRICT

Administrative Order No.: AO 245 NE
File No.: FLA011812-009-DW4P
DEP Permit No.: FLA011812



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Shawn Hamilton
Secretary

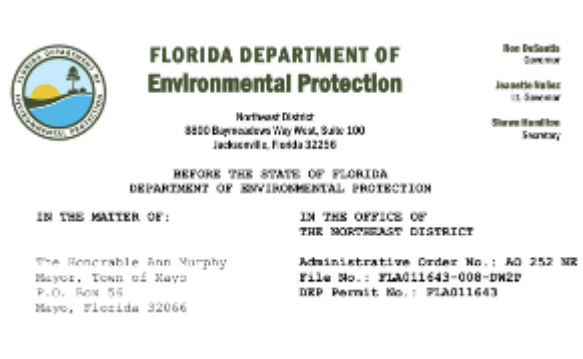
BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

Mr. Bing Xi, P.E.
FL Department of Corrections
501 S. Calhoun Street
Tallahassee, Florida 32399

IN THE OFFICE OF
THE NORTHEAST DISTRICT

Administrative Order No.: AO 246 NE
File No.: FLA011646-011-DW2P
DEP Permit No.: FLA011646



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Lt. Governor

Shawn Hamilton
Secretary

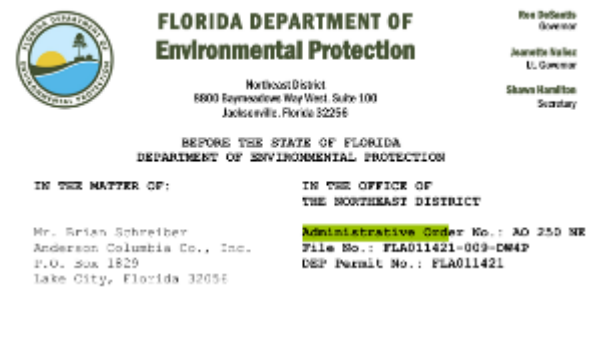
BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

The Honorable Ann Murphy
Mayor, Town of Mayo
P.O. Box 56
Mayo, Florida 32066

IN THE OFFICE OF
THE NORTHEAST DISTRICT

Administrative Order No.: AO 252 NE
File No.: FLA011643-008-DW2P
DEP Permit No.: FLA011643



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Jacksonville, Florida 32256

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Lt. Governor

Shawn Hamilton
Secretary

BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

Mr. Brian Schreiber
Anderson Columbia Co., Inc.
P.O. Box 1829
Lake City, Florida 32056

IN THE OFFICE OF
THE NORTHEAST DISTRICT

Administrative Order No.: AO 250 NE
File No.: FLA011421-009-DW4P
DEP Permit No.: FLA011421

FLORIDA DEPARTMENT OF
Environmental Protection

Northeast District
8800 Baymeadows Way West, Suite 100
Jacksonville, Florida 32256

Ron DeSantis
Governor

Jeanette Nuñez
Lt. Governor

Shawn Hamilton
Secretary

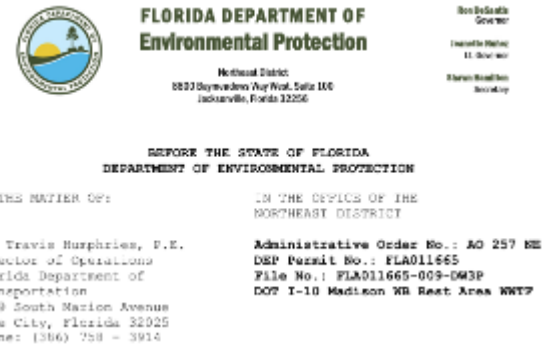
BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

Laura Cain
Interim City Manager
City of Chiefland
214 E Park Ave.
Chiefland, Florida 32626-902
Telephone: (352)493-6711

IN THE OFFICE OF THE
NORTHEAST DISTRICT

Administrative Order: AO 221 NE
DEP Permit No: FLA011648-015
City of Chiefland WWTF
Levy County



FLORIDA DEPARTMENT OF
Environmental Protection

Northeast District
8800 Baymeadows Way West, Suite 100
Jacksonville, Florida 32256

BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF:

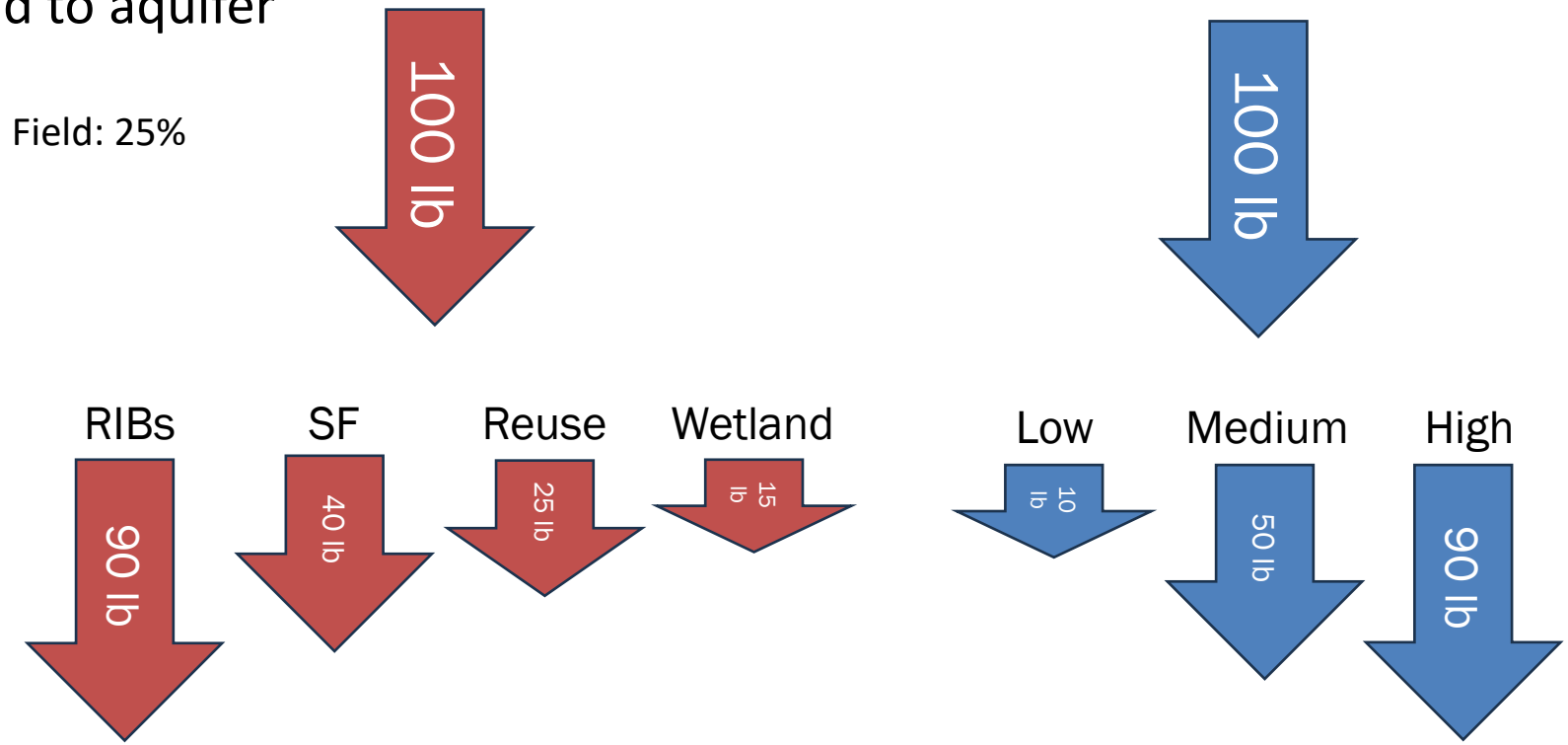
Mr. Travis Humphries, P.E.
Director of Operations
Florida Department of
Transportation
1109 South Marion Avenue
Lake City, Florida 32025
Phone: (386) 758 - 3914

IN THE OFFICE OF THE
NORTHEAST DISTRICT

Administrative Order No.: AO 257 NE
DEP Permit No.: FLA011665
File No.: FLA011665-009-DW3P
DOT I-10 Madison WB Rest Area WWTF

Nitrogen Modeling

- Nitrogen Source Inventory Loading Tool (NSILT) used to determine nitrogen loads from each source and to attribute allocations
- Estimates nitrogen applied at the surface and attenuation during infiltration and in the aquifer during travel to a spring vent
- Two factors impact load to aquifer
  - Attenuation Rate
    - WWTF – RIBs/Absorption Field: 25%
    - WWTF – Sprayfield: 60%
    - WWTF – Reuse: 75%
    - WWTF – Wetland: 85%
  - Recharge Rate
    - Low: 10%
    - Medium: 50%
    - High: 90%



Nitrogen Load Examples

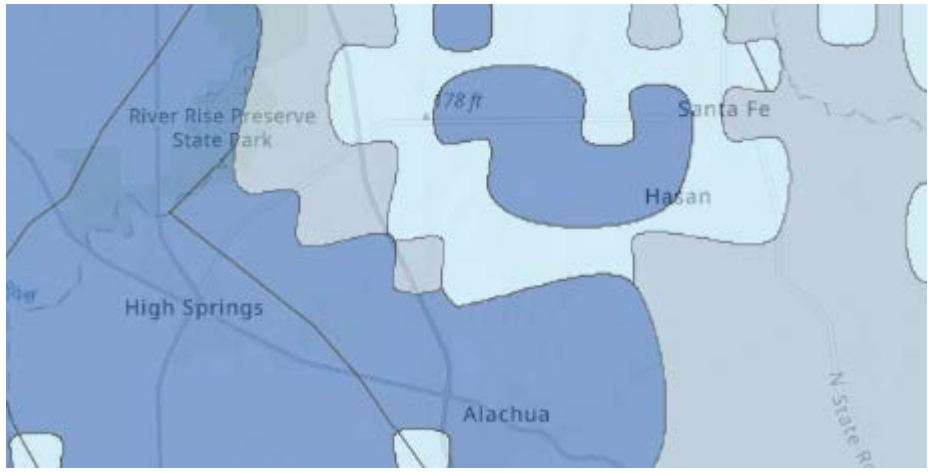
- WWTF – 18,265 lb/yr TN load (1 MGD @ 6 mg/L TN)

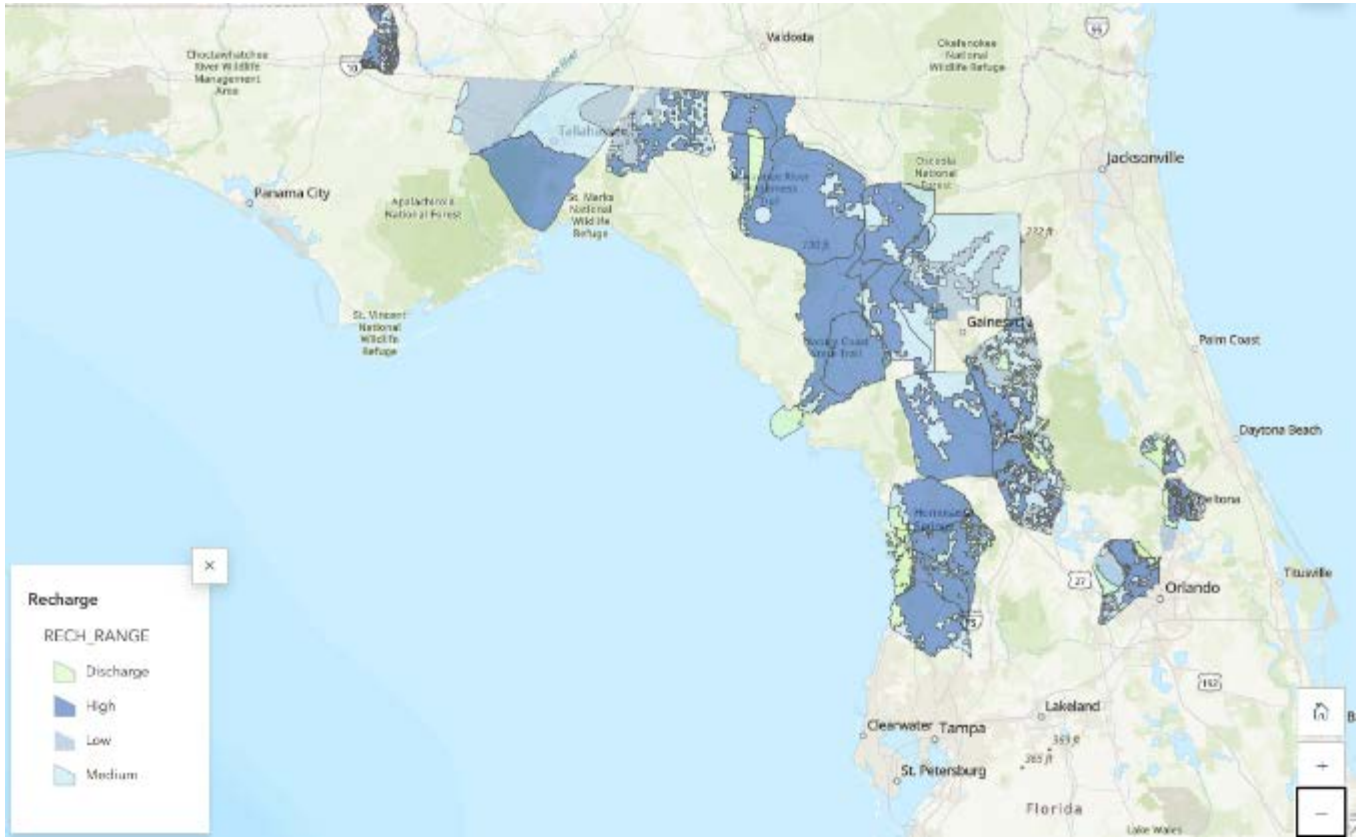
1. Low Recharge & Wetland
   - 18,265 x 10% = 1,827 x 15% = 274 lb/yr

2. High Recharge & RIBs
   - 18,265 x 90% = 16,439 x 75% = 12,329 lb/yr

3. Medium Recharge & RIBs
   - 18,265 x 50% = 9,133 x 75% = 6,850 lb/yr

4. Low Recharge & RIBs
   - 18,265 x 10% = 1,827 x 75% = 1,370 lb/yr





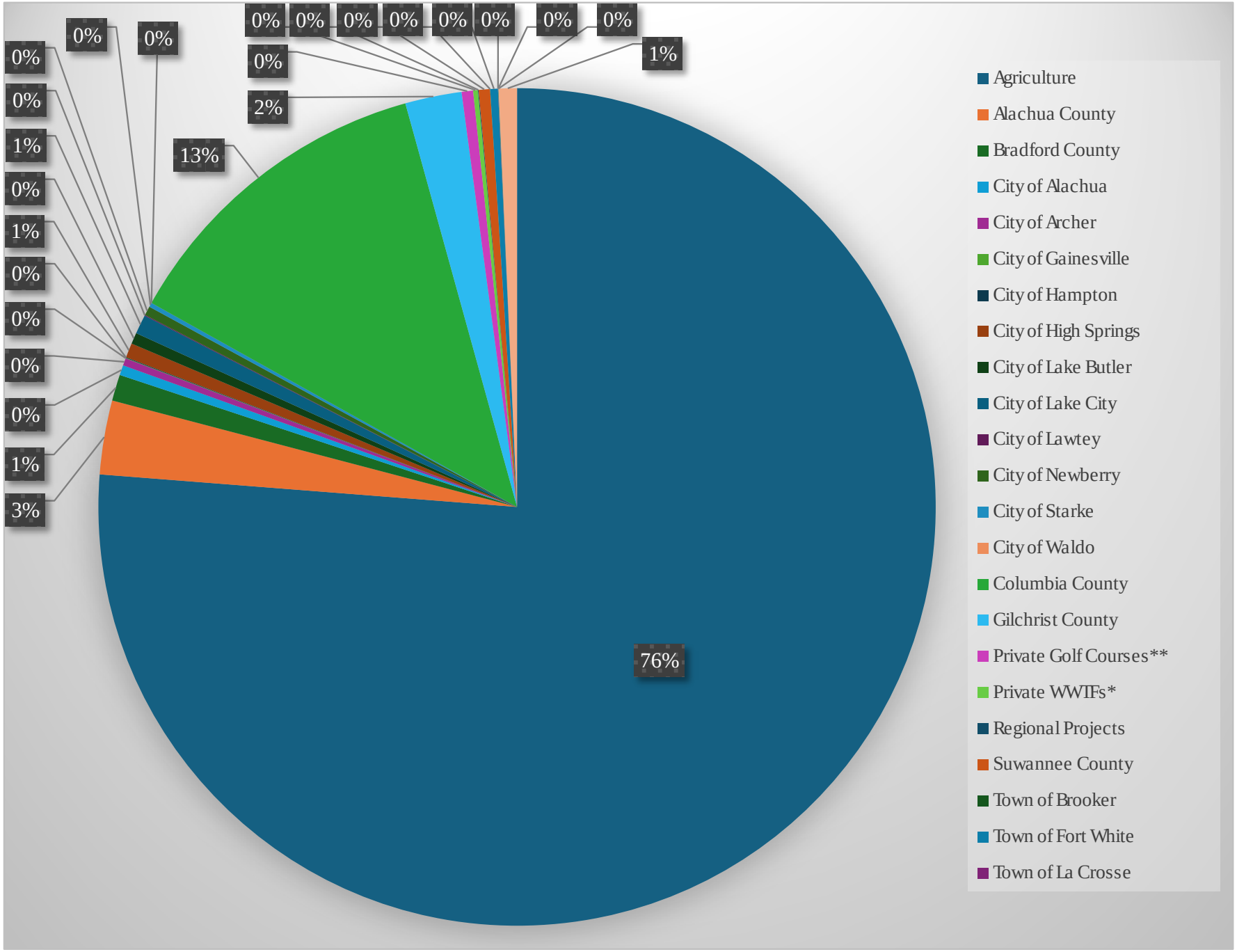
Load Allocations

- Pre-2025 BMAPs did not allocate loads to specific entities
- Updated 2025 BMAP updates did allocate loads
- Allocations were based on:
  - Wastewater facilities
  - Septic systems (OSTDSs)
  - Urban turf fertilization (UTF)
  - Sports turf fertilization (STF)
- Allocations are determined based on municipal boundaries
  - Towns/cities allocated all septic systems within their boundaries + UTF + STF + WW
  - Counties allocated all septic systems not within a municipality + UTF + STF + WW
- Loads can be allocated in more than one springshed in a single BMAP or extend across BMAPs!

Santa Fe Allocations

Total Nitrogen Load Reduction (lb/yr)	2028	2033	2038
Agriculture	296,425	790,465	988,083
Alachua County	11,088	29,568	36,961
Bradford County	3,935	10,494	13,118
City of Alachua	1,506	4,016	5,020
City of Archer	1,099	2,931	3,664
City of Gainesville	66	177	221
City of Hampton	109	291	364
City of High Springs	2,177	5,806	7,257
City of Lake Butler	1,682	4,486	5,608
City of Lake City	2,870	7,653	9,566
City of Lawtey	125	334	418
City of Newberry	1,367	3,645	4,557
City of Starke	641	1,710	2,137
City of Waldo	2	5	7
Columbia County	48,997	130,658	163,323
Gilchrist County	8,483	22,623	28,278
Private Golf Courses**	1,717	4,579	5,724
Private WWTFs*	718	1,919	2,398
Regional Projects	101	270	338
Suwannee County	1,691	4,508	5,636
Town of Brooker	25	67	84
Town of Fort White	1,151	3,069	3,836
Town of La Crosse	36	97	121
Town of Raiford	48	127	159
Town of Worthington Springs	24	64	80
Union County	2,720	7,253	9,067
Total	**388,803**	**1,036,815**	**1,296,025**

Santa Fe BMAP Allocations



Wastewater is a Primary Focus of Reductions

- AOs are pushing facilities to 3 mg/L for TN
- Need to address BMAP loads is pushing even further
  - Combination of septic to sewer and facility upgrades

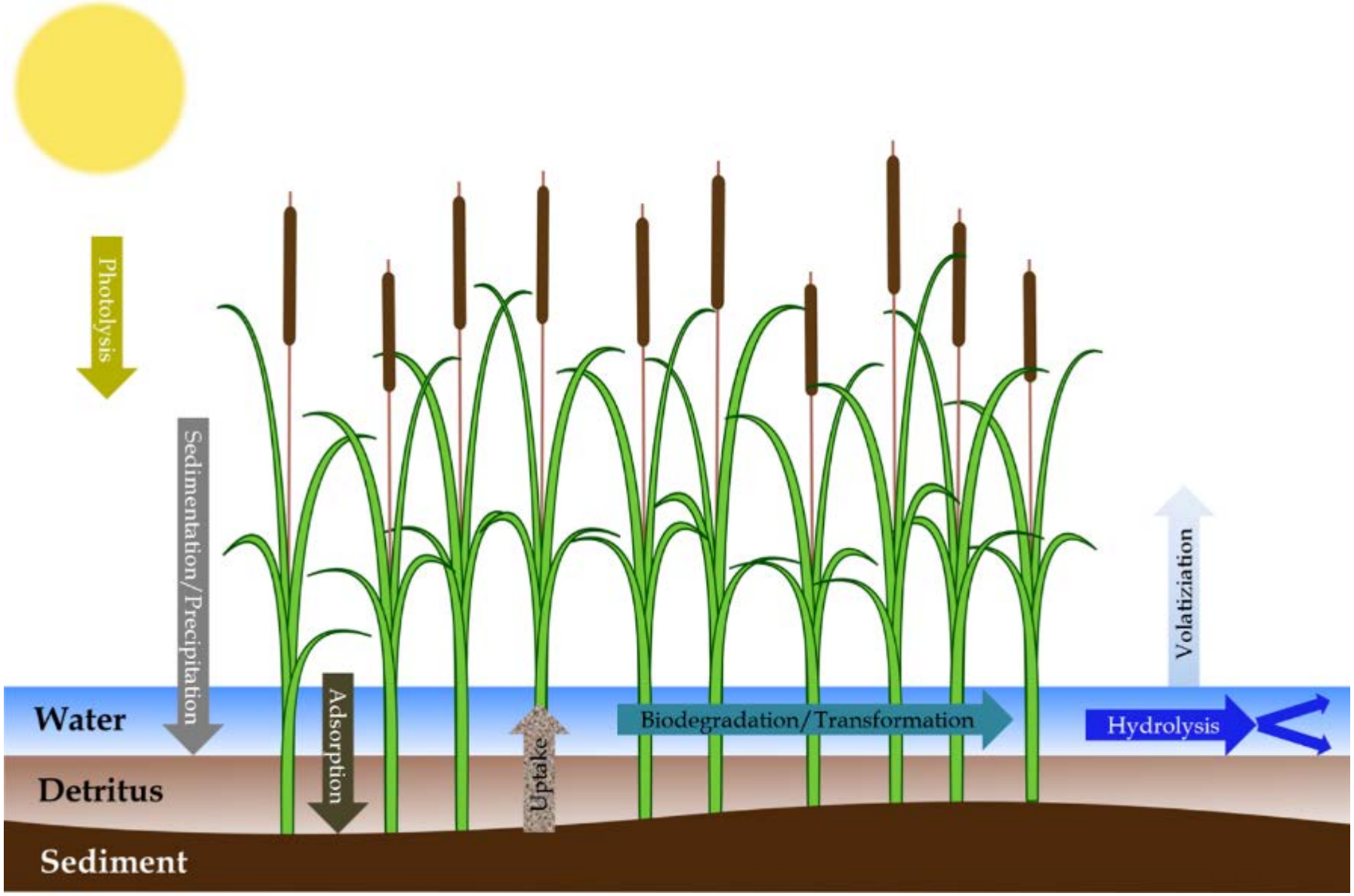
Compliance Alternatives for AOs

- Upgrade to AWT or build new AWT facility
  - $40-60M per MGD for new AWT facility
  - $10M per MGD for AWT upgrade if existing facility can be upgraded
  - $8-10M per MGD for AWT wetland treatment

Lined Wetlands for TN Compliance

- Constructed wetlands can provide an alternative unit process for achieving TN less than 3 mg/L
- Sizing is based on current wastewater facility performance and treatment target
- Liners are used to prevent any infiltration during wetland treatment

Why Wetlands

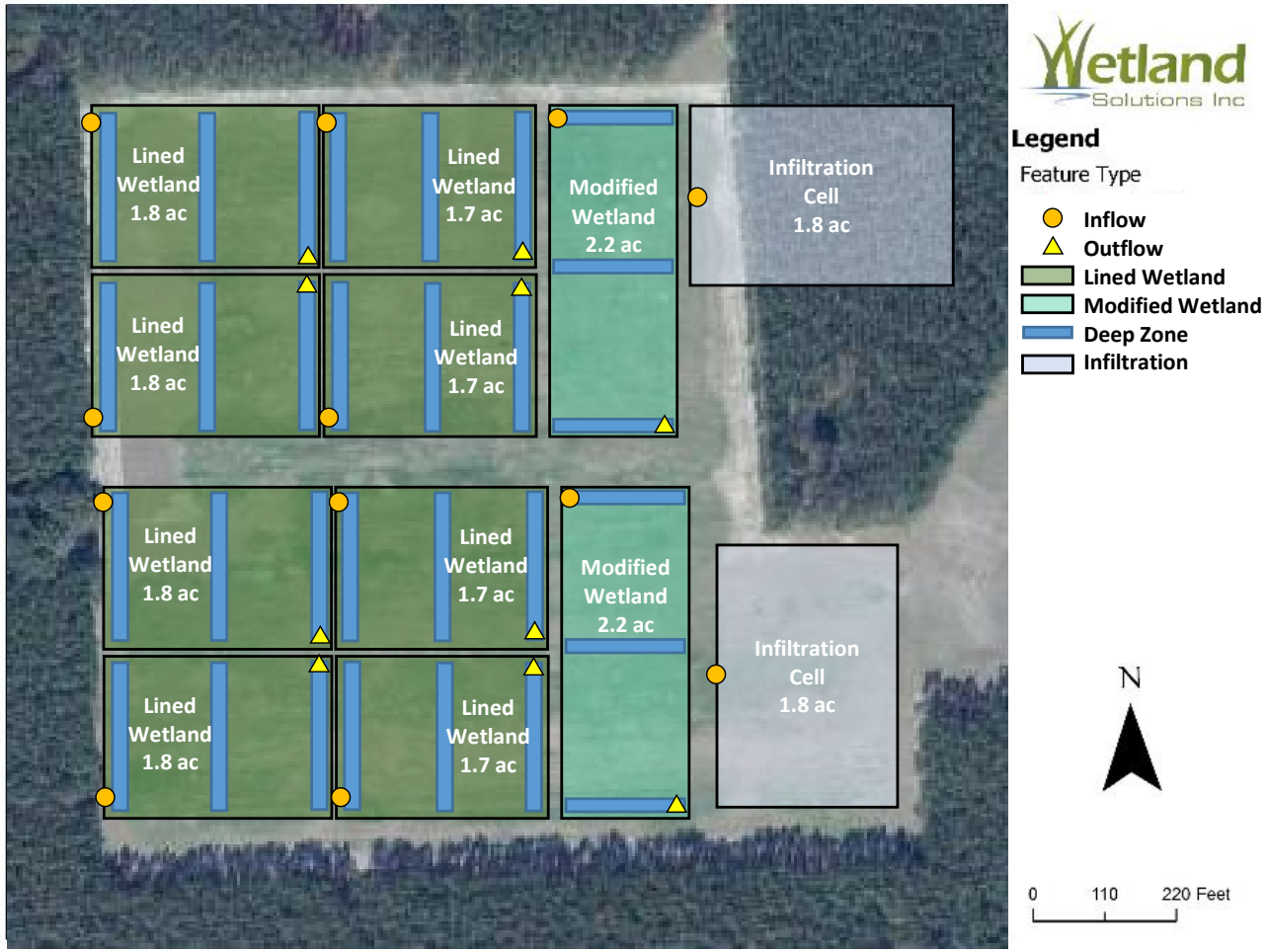


Case Study – High Springs

- High Springs was evaluating wastewater upgrades to achieve <3 mg/L of TN
- Existing disposal was to a sprayfield
- Selected alternative to reliably achieve BMAP requirement was a lined treatment wetland followed by unlined cells
- Lined wetlands designed for going from 12 mg/L to <3 mg/L of TN

High Springs Wetland Project

- $3M for 0.5 MGD
- 4,870 lb/yr TN estimated reduction



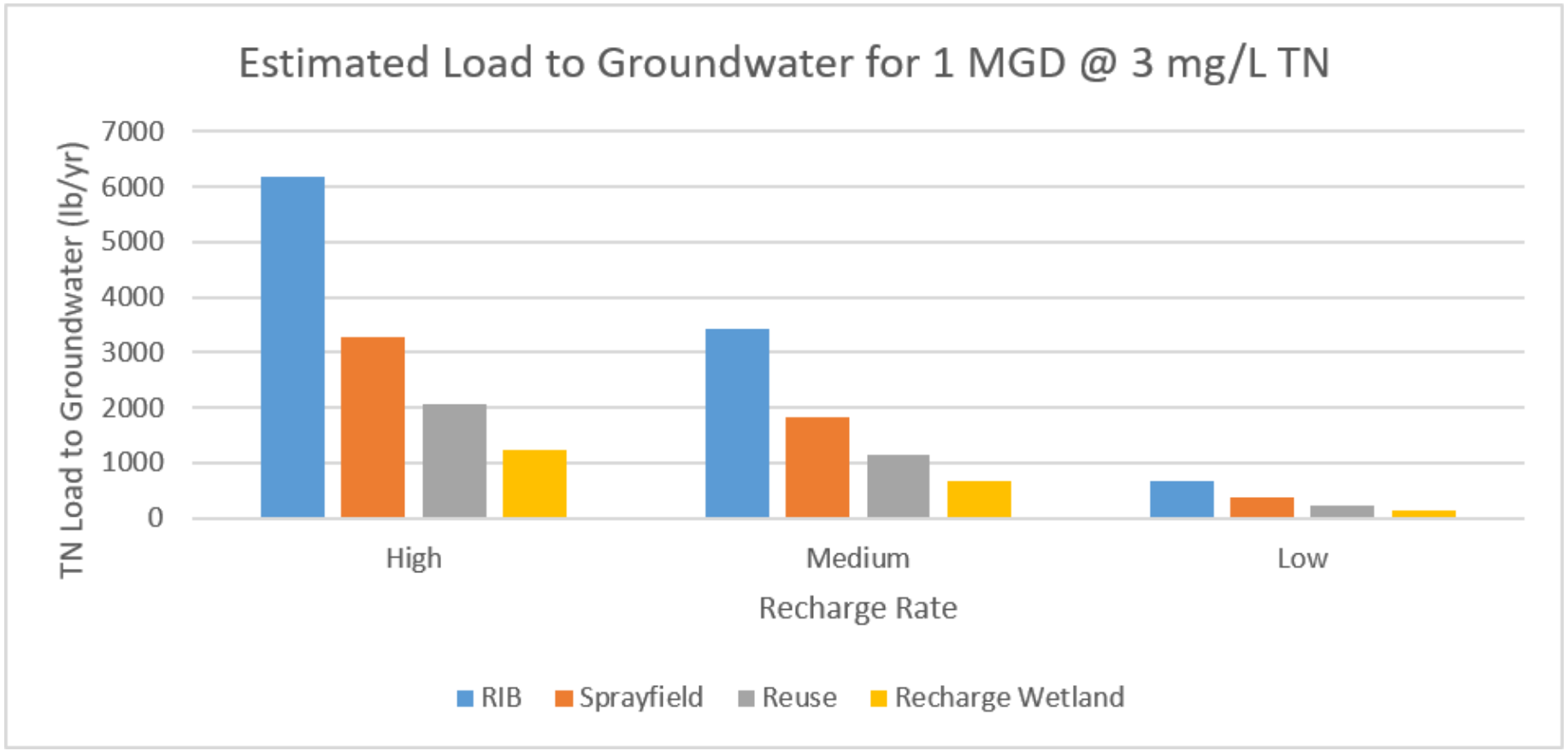
Why Allocations are Hard to Meet

- Load reduction is attenuated load, not the load to surface!
- Does not include future anticipated growth
- Best-case scenario for additional load reduction is high recharge (90% pass-through) with RIBs (75% pass-through), 67.5% credit
- Worst-case scenario for additional load reduction is low recharge (10% pass-through) with wetlands (15% pass-through), 1.5% credit



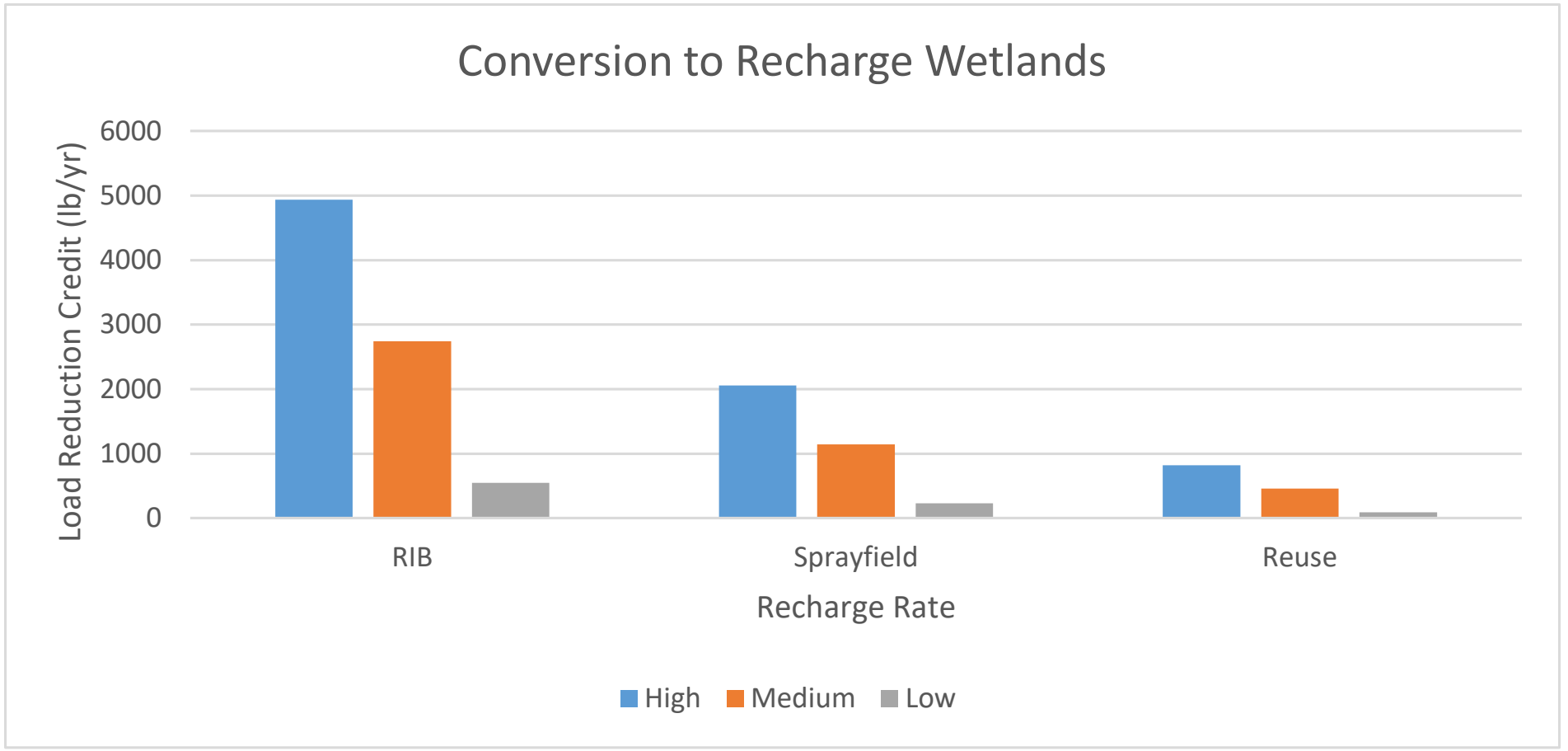
Disposal Load Reductions

- Disposal changes can provide automatic benefits
- Nutrient pass-through decreases RIBs → Sprayfields → Reuse → Wetlands



Conversion to Wetlands for Disposal

- Just conversion of disposal yields substantial benefits



Recharge Wetlands for Load Reductions

- Recharge or infiltreatment wetlands provide a disposal alternative for facilities currently disposing of water to sprayfields or RIBs
- Wetland cells are unlined and take water at the site average infiltration rate unless soils are amended
- Wetlands provide additional nutrient removal during infiltration and increase credit from 25-60% to 85%

Case Study – Lake City

Lake City Wetland Project Timeline

- 2006 – Concept proposed
- 2013 – SRWMD submitted project for FDEP “Springs Funding”
- 2014/15 – RFP, Design and Permitting
- 2015/17 – Construction
- 2017 to Present – Operation

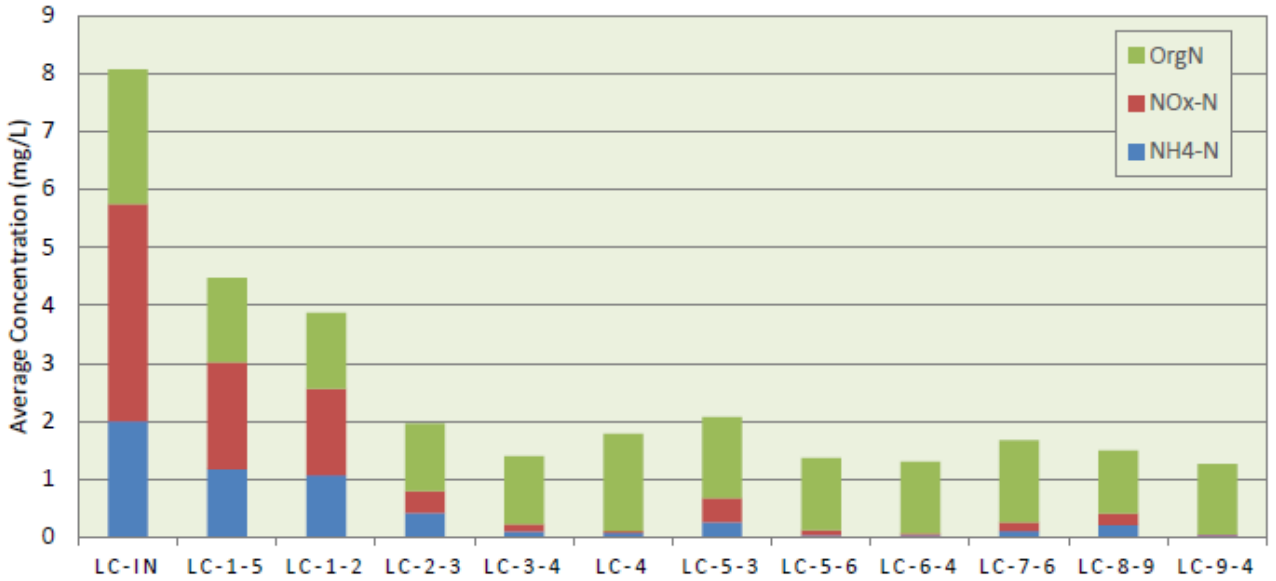
Phase 1 - $5.3 M

Phase 2 - $9.6 M

Phase 3 - $17.3 M

Lake City Project Performance

- Phase 1 (120 acres)
  - Reduced TN from 8.0 mg/L to <2.0 mg/L
  - Reduced NOX-N from 3.0 mg/L to <0.1 mg/L
  - Removed 39,000 lbs TN (2024)
  - Removed 4,300 lbs TP (2024)
  - Removed 245,000 lbs TN (2017-2024)
  - Removed 36,000 lbs TP (2017-2024)
  - Recharged ~4.9 billion gallons of RW and ~1.5 billion gallons of rainfall
  - ~500,000 GPD increase in recharge
- Phase 2 (~50 acres)
  - Includes lined wetland unit process
  - Reduces TN load by additional 5,000 lbs/yr
  - Increases recharge by 225,000 GPD
- Phase 3 (~80 acres)
  - Includes lined wetland unit process
  - Reduces TN load by additional 13,000 lbs/yr
  - Increases recharge by 660,000 GPD



Wetland Operation and Management

- Primary maintenance is mowing and structure inspections
- Less frequent maintenance may include controlling woody vegetation on berm edges
- Wetlands run on substantially less pressure than sprayfields saving money in pumping
- Little to no internal vegetation management is recommended for constructed wetlands unless desired for aesthetics
- Structures may need cleared if they become blocked
- Water level adjustment is typically minimal
- Re-planting is generally unnecessary

Wetland Mythology

Fiction

- Wetlands are full of mosquitos!
- You have to harvest plants to remove nutrients.
- You have to clean wetlands out.

Fact

- Generally, wetlands have balanced ecosystems that naturally control mosquitos.
- Removing vegetation is an ineffective way to remove nutrients (TN 2-4%, TP <1%, DRY!) and undesirable.
- Sediment removal in wetlands is very rarely needed.

Questions?

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