Numeric Nutrient Criteria for Stormwater: Emerging Issues

1. NNC Compliance Options	**Russ Frydenborg**
2. NNC for Ditches	**Scott McCellend**
3. Stormwater Treatment Options	**Gary Serviss**
4. Tracers for Reclaimed Water	**Philip Waller**
5. Class III-Limited Discussion	**Tom Frick**

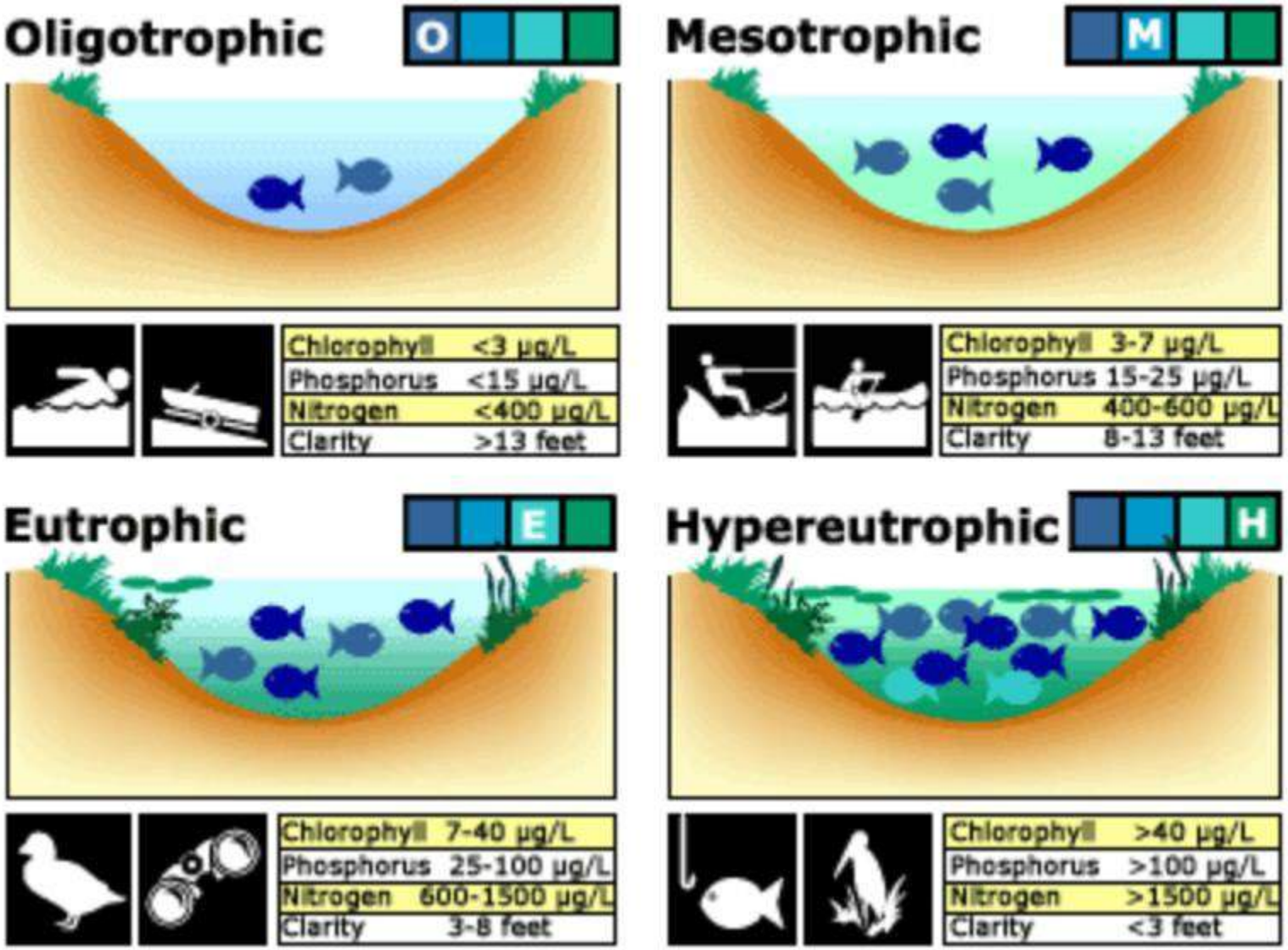
Numeric Nutrient Criteria and Stormwater Compliance Options

Russ Frydenborg
Frydenborg EcoLogic, L.L.C.

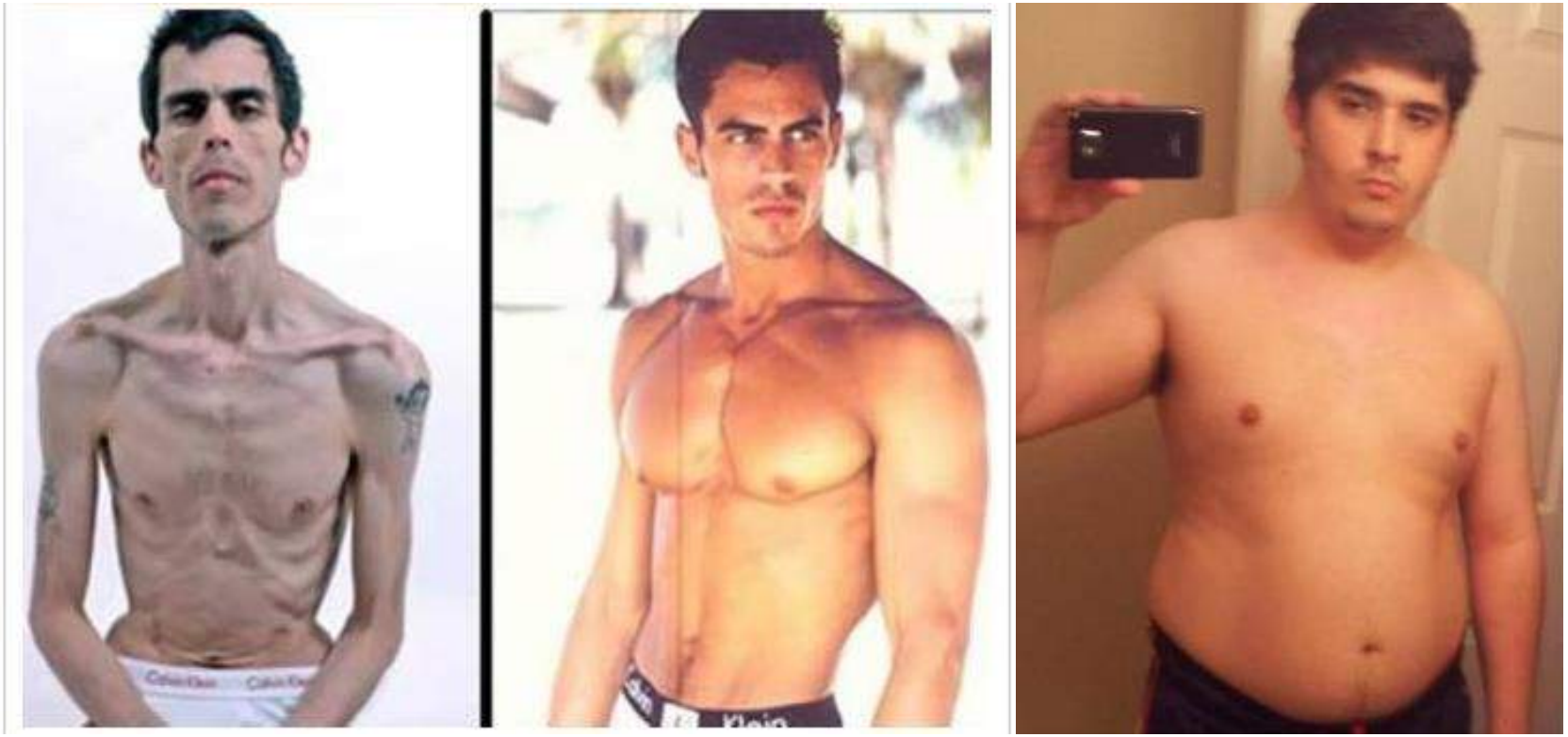
Nutrients: Nitrogen and Phosphorus

- **Naturally present in aquatic systems**
  - **Necessary for the proper functioning of biological communities, NOT toxic**
  - **However, excess nutrients may be problematic**
- **Moderated in how they are expressed by many natural factors**
  - ***e.g.*, light penetration, hydraulic residence time, presence of herbivore grazers and other food web interactions, and habitat considerations**
- **Determining appropriate nutrient regime is site-specific, requiring information about ecologically relevant responses**

Classical Trophic Status



Nutrients: Another Perspective



Oligo-trophic Meso-trophic Eu-trophic

Aquatic Nutrient Imbalances

NNC Legal Background

- Aug 2008- EarthJustice sues EPA over NNC ("mandatory duty")
- Jan 2009- EPA "determines" NNC necessary
- Aug 2009- Settlement agreement with EarthJustice
- Nov 2010- EPA promulgates NNC
- Dec 2011 to 2014- FDEP adopted and EPA approved streams, lakes, springs, and estuary criteria
  - Path Forward legislation
- 2014- Federal Judge Hinkle rules in favor of EPA to end lawsuit
- EPA rescinds federal criteria, FDEP criteria became effective on Oct. 28, 2014

Establishing Effective NNC

- **Florida has had a Narrative criterion since 1970s: "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna"**
- **Must establish when human alterations in nutrients cause biological impairment**
- **Be mindful of confounding factors (habitat, hydrology, natural cycles of grazers responding to other factors, etc.)**

Basic Concept of Florida NNC Rules

- **The narrative nutrient criterion is maintained and numerically interpreted using best available information on a site-specific basis using a systematic, *hierarchical approach***

Hierarchical Approach

Hierarchy 1 (Site-specific)

Level II Water Quality-Based Effluent Limitations, Nutrient Total Maximum Daily Loads, Site Specific Alternative Criteria, Reasonable Assurance Plans, and Estuary-specific Criteria

Lakes/Springs

Cause -Effect Relationships (lakes & springs)

Streams

Reference-based thresholds (streams) combined with biological data (flora and fauna)

Narrative

Ditches/canals used for water conveyance, wetlands, non-perennial streams, tidally fluctuating areas, and South Florida flowing waters

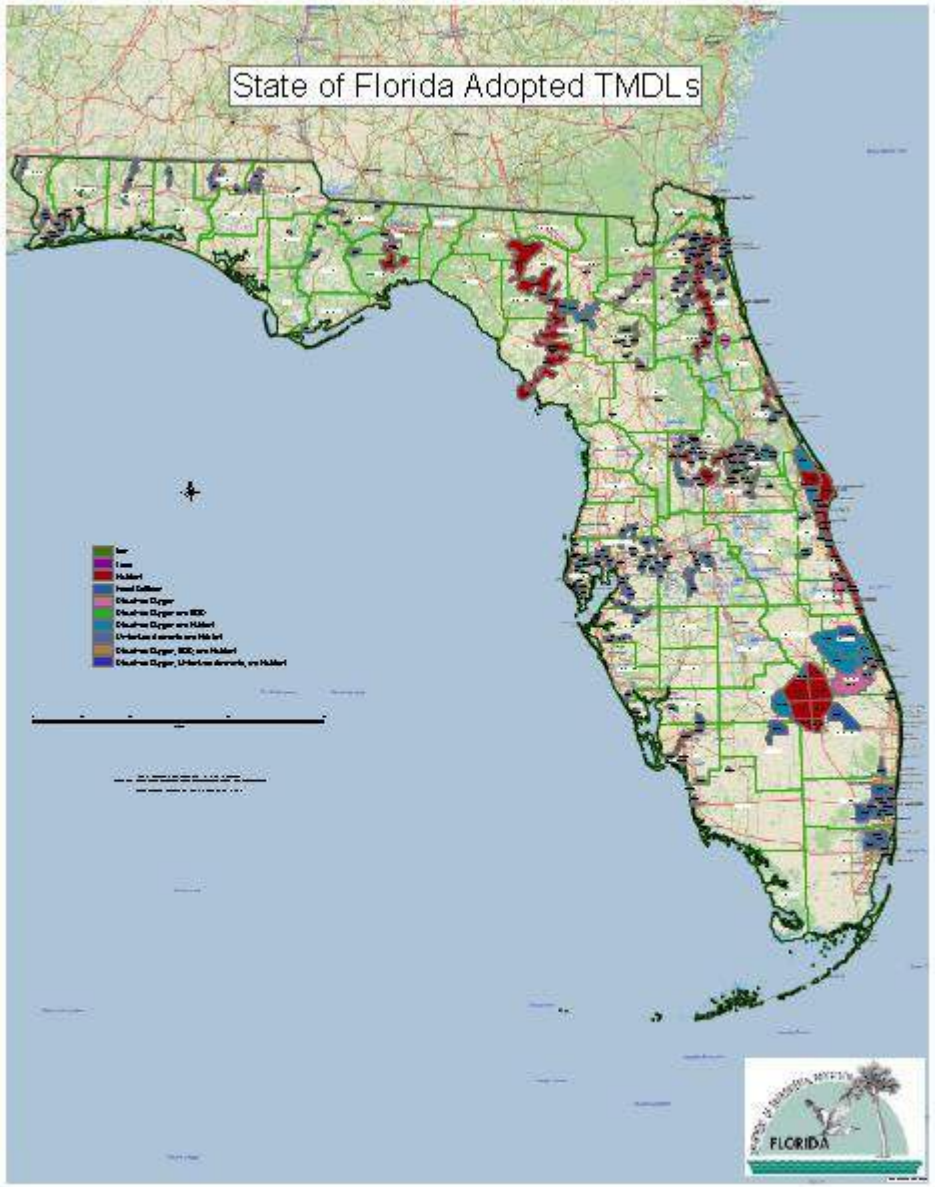
Hierarchy 1

DEP adopted TMDLs, Level 2 Water Quality Based Effluent Limits, Estuary Specific Criteria, Site Specific Alternative Criteria, and Reasonable Assurance Plans

TMDLs as NNC

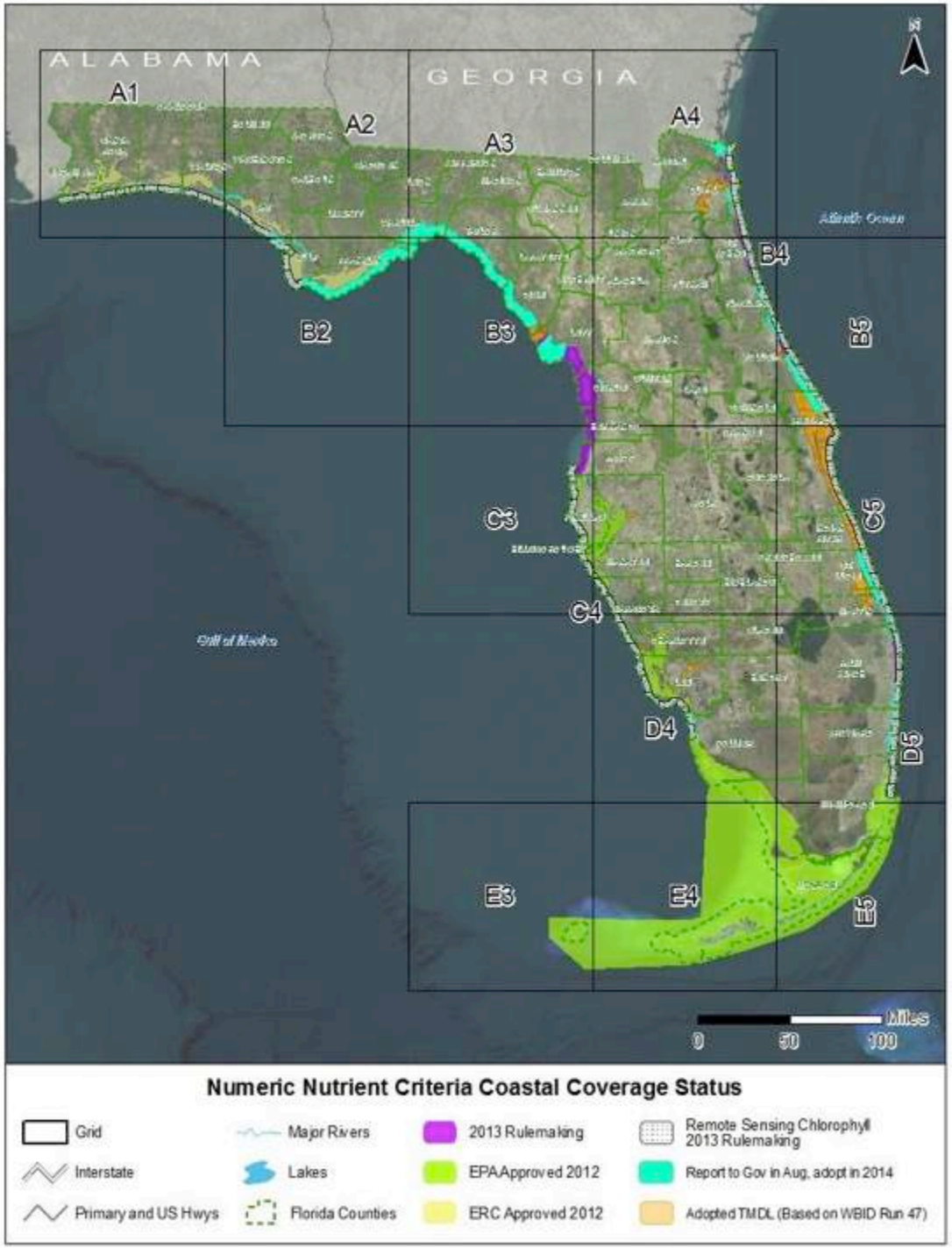
- **TMDL calculates the maximum allowable nutrient load that will maintain designated use (healthy, well balanced community)**
- **TMDL equals sum of all point source loads (Wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and a margin of safety (MOS)**
- **WLAs for NPDES point source discharges are usually maximum pounds/year**
- **WLAs for NPDES MS4 discharges and LAs for other nonpoint sources are usually a percent reduction**

FDEP Adopted TMDLs



TMDL Reports Are Found At:

http://www.dep.state.fl.us/water/tmdl/final_tmdl.htm



Estuary Numeric Nutrient Criteria: DEP and local scientists developed estuary-specific nutrient standards

Example of Estuary-Specific Criteria in 62-302.532

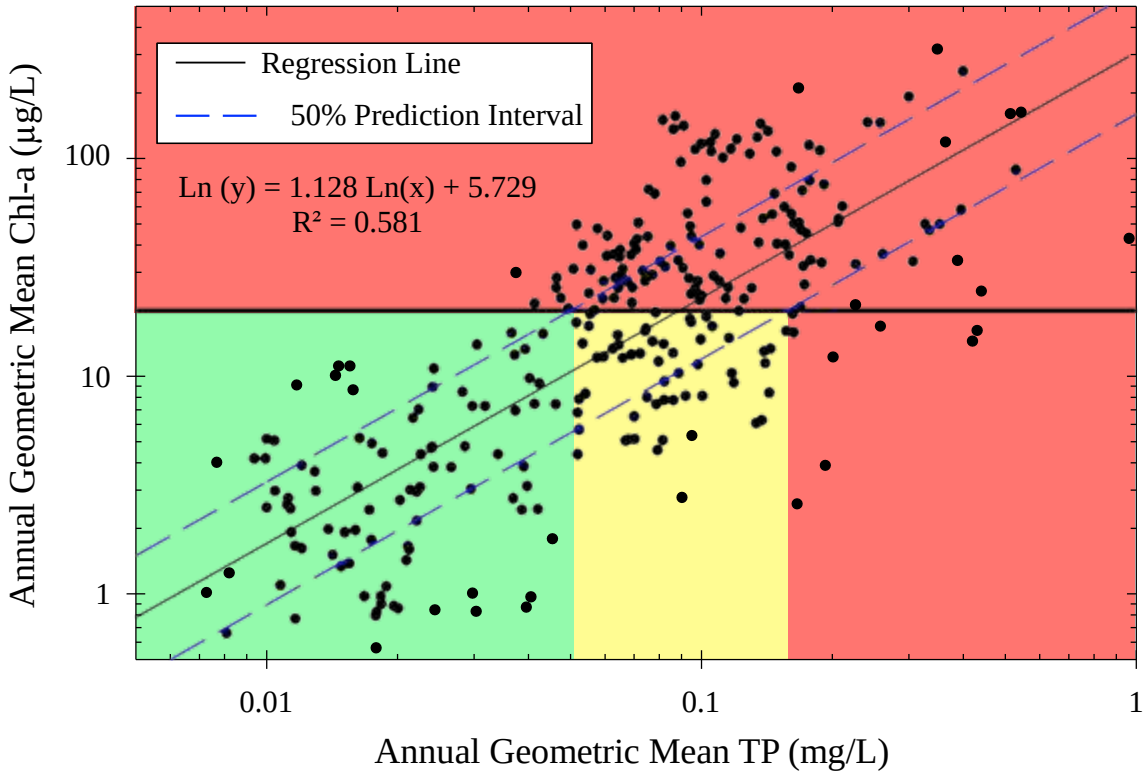
Estuary	Total Phosphorus	Total Nitrogen	Chlorophyll a
(q) Loxahatchee River Estuary	For estuary segments with criteria expressed as annual geometric means (AGM), the values shall not be exceeded more than once in a three year period. For all other estuary segments, the criteria shall not be exceeded in more than 10 percent of the measurements.		
1. Lower Loxahatchee	0.032 mg/L as AGM	0.63 mg/L as AGM	1.8 µg/L as AGM
2. Middle Loxahatchee	0.030 mg/L as AGM	0.80 mg/L as AGM	4.0 µg/L as AGM
3. Upper Loxahatchee	0.075 mg/L as AGM	1.26 mg/L as AGM	5.5 µg/L as AGM
(r) Lake Worth Lagoon	For estuary segments with criteria expressed as annual geometric means (AGM), the values shall not be exceeded more than once in a three year period. For all other estuary segments, the criteria shall not be exceeded in more than 10 percent of the measurements.		
1. Northern Lake Worth Lagoon	0.044 mg/L as AGM	0.54 mg/L as AGM	2.9 µg/L as AGM
2. Central Lake Worth Lagoon	0.049 mg/L as AGM	0.66 mg/L as AGM	10.2 µg/L
3. Southern Lake Worth Lagoon	0.050 mg/L as AGM	0.59 mg/L as AGM	5.7 µg/L as AGM
(s) Halifax River Estuary	For estuary segments with criteria expressed as annual geometric means (AGM), the values shall not be exceeded more than once in a three year period.		
Lower Halifax River Estuary	0.142 mg/L as AGM	0.72 mg/L as AGM	6.2 µg/L as AGM
(t) Guana River/Tolomato River/ Matanzas River (GTM) Estuary	Criteria for all estuary segments are expressed as annual geometric mean values not to be exceeded more than once in a three year period.		
1. Tolomato	0.105 mg/L as AGM	0.65 mg/L as AGM	6.6 µg/L as AGM
2. North Matanzas	0.110 mg/L as AGM	0.55 mg/L as AGM	4.0 µg/L as AGM
3. South Matanzas	0.111 mg/L as AGM	0.53 mg/L as AGM	5.5 µg/L as AGM

Site Specific Alternative Criteria Can Be NNC

- **Type I SSAC based on natural background conditions (reference-based approach)**
- **Type II SSAC acknowledges human influence, but requires demonstration that the criterion would provide for the water quality necessary to fully maintain and protect human health and all designated uses**
- **Type III SSAC for nutrients, and requires a demonstration of healthy flora and fauna at given nutrient regime**

Hierarchy 2- Lakes and Springs

Cause-effect Example: Lakes



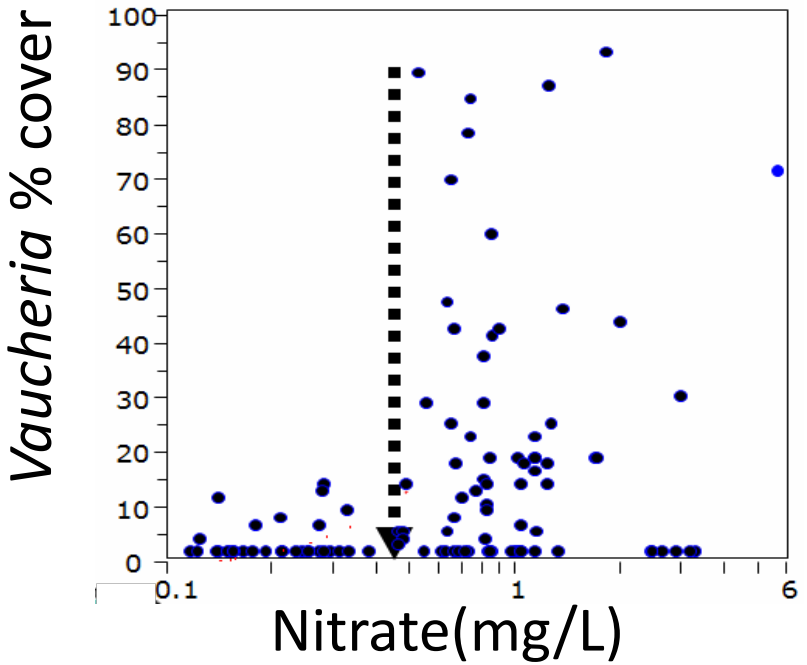
Criteria based on limiting phytoplankton growth (chlorophyll) for natural groupings of lakes, and allow range of TN and TP if biology is healthy

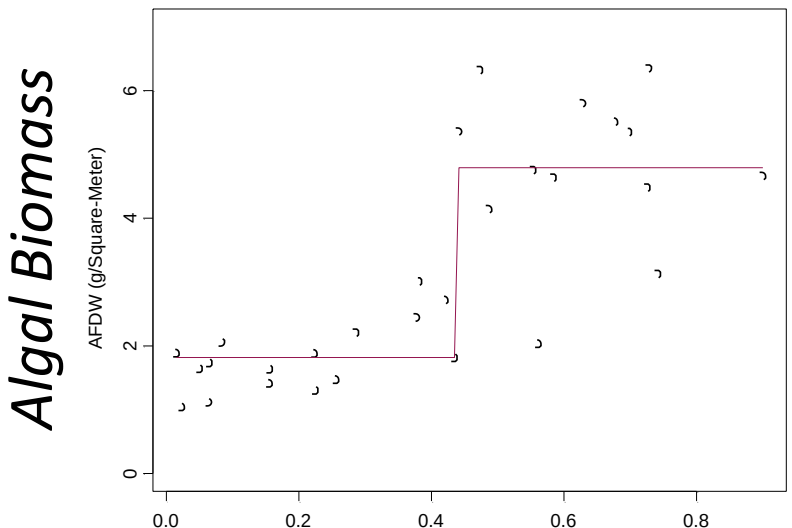
NNC for Lakes

Long Term Geometric Mean Lake Color and Alkalinity	Annual Geometric Mean Chlorophyll *a*	**Minimum** Annual Geometric Mean Total **Phosphorus**	**Maximum** Annual Geometric Mean Total **Phosphorus**	**Minimum** Annual Geometric Mean Total **Nitrogen**	**Maximum** Annual Geometric Mean Total **Nitrogen**
> 40 Platinum Cobalt Units	**20 µg/L**	**0.05 mg/L**	**0.16 mg/L[1]**	**1.27 mg/L**	**2.23 mg/L**
≤ 40 Platinum Cobalt Units and > 20 mg/L $CaCO_3$	**20 µg/L**	**0.03 mg/L**	**0.09 mg/L**	**1.05 mg/L**	**1.91 mg/L**
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L $CaCO_3$	**6 µg/L**	**0.01 mg/L**	**0.03 mg/L**	**0.51 mg/L**	**0.93 mg/L**

[1] For lakes with color > 40 PCU in the West Central Region, the maximum TP limit is 0.49 mg/L

Cause-effect Example: Springs



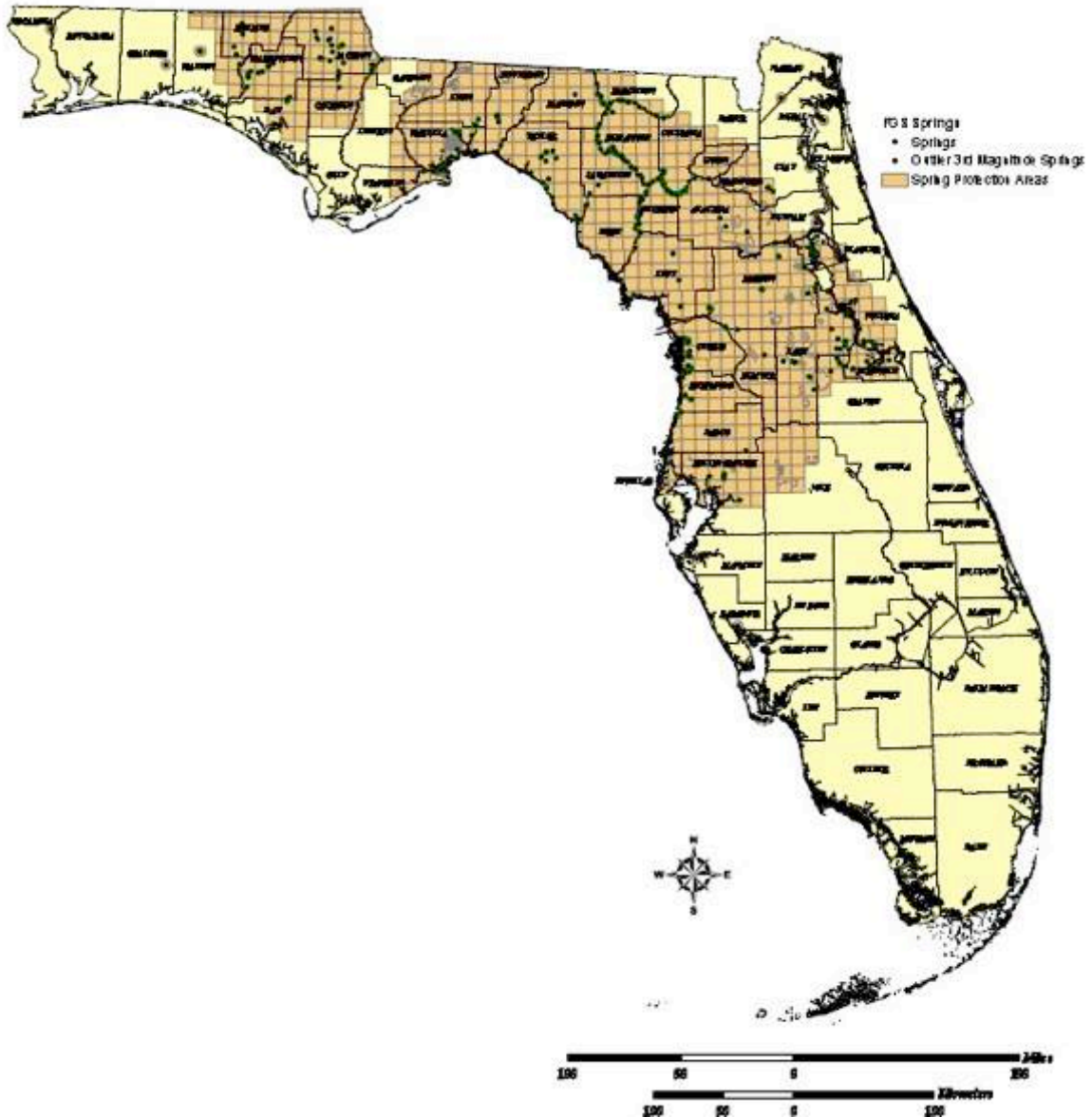


Based on an analyses of concentrations where excess algal biomass occurred, including application of a safety factor, springs criterion is 0.35 mg/L Nitrate/nitrite

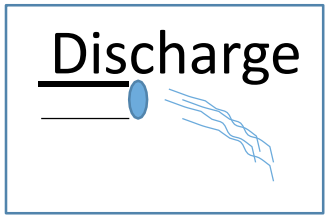
Weeki Wachee, 1950s;
Nitrate < 0.1 mg/L, Eel grass

Weeki Wachee, 2001:
Nitrate ~ 0.7 mg/L, Lyngbya mats

Springs Protection Areas



Discharge to Groundwater to Spring



Direct Receiving Water: Sprayfield/Rapid Infiltration Basin

Groundwater criteria (nitrate < 10 mg/L)

Downstream Waters: Spring NNC or TMDL (spring TMDLs have been established as concentration)

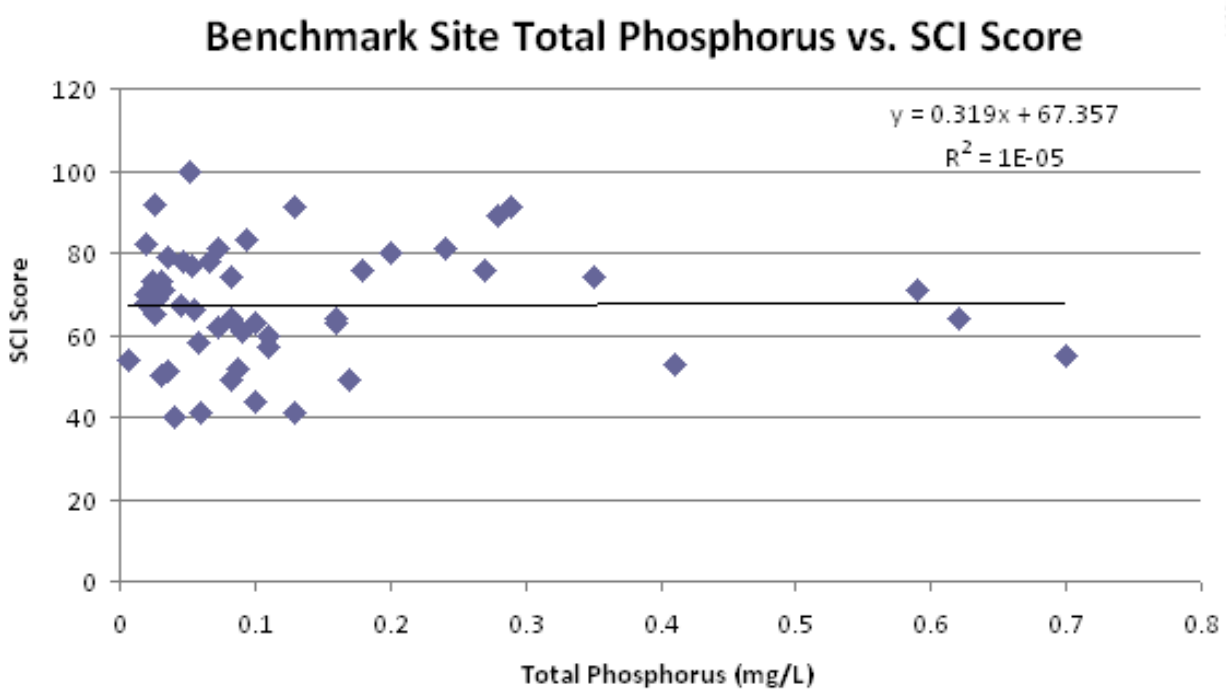
WQBEL or BMAP to achieve the specific nitrate levels for the spring , taking into account dilution and any expected transformations

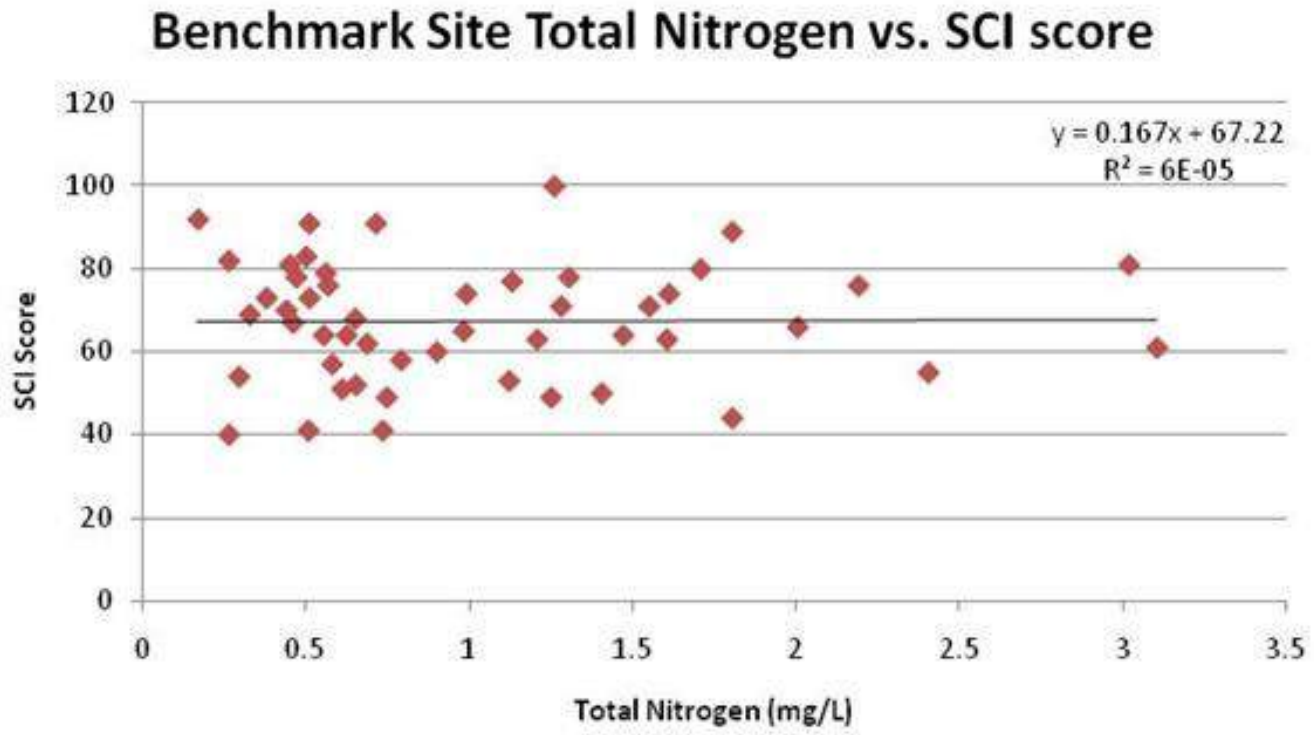
Hierarchy 3

Streams

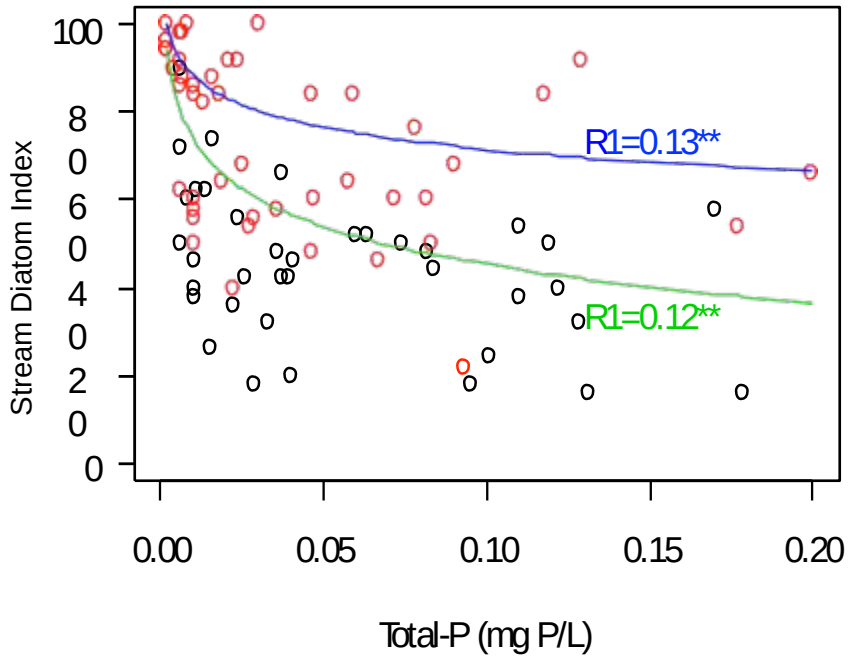
No Cause-effect: Streams

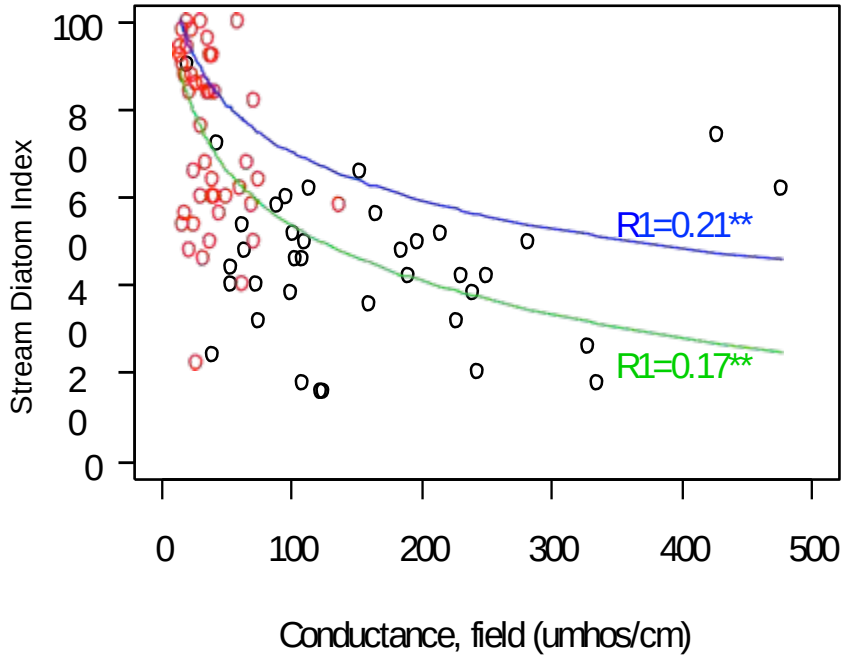
Healthy Biology was found over a wide range of TN and TP, with NO correlation





Weak Cause-effect: Streams





Only very weak statistical relationships with nutrients were observed in streams algae, HOWEVER

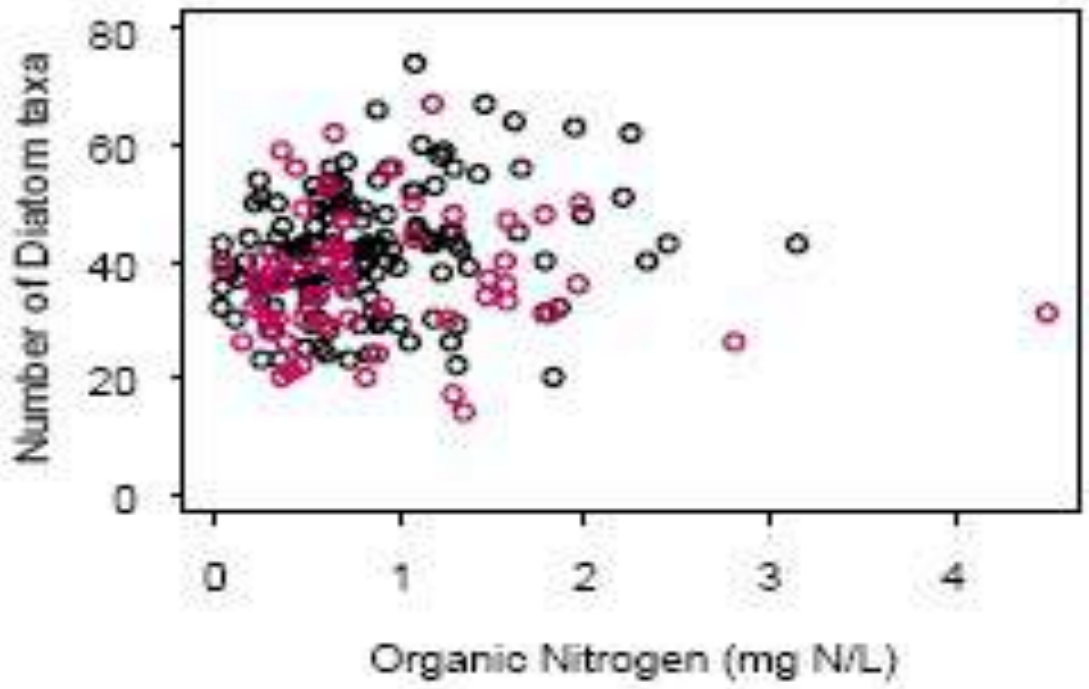
Confounding factors (e.g., pH, color, **conductivity**), prevented establishing thresholds needed for nutrient criteria

NNC for Streams: Reference-based Thresholds and Biological Response

This is why DEP criteria Include biology (EPA now supports DEP approach)

FDEP PLAN B:

- **Established <u>numeric thresholds</u> based on "reference approach", but because there is no link to impairment, Florida established an evaluation of flora <u>and</u> fauna to determine if a stream's nutrient concentrations are protective**



NNC in Streams Achieved IF:

- **Flora are healthy; AND EITHER**
- **The Nutrient Thresholds are achieved, OR**
- **Fauna are healthy**

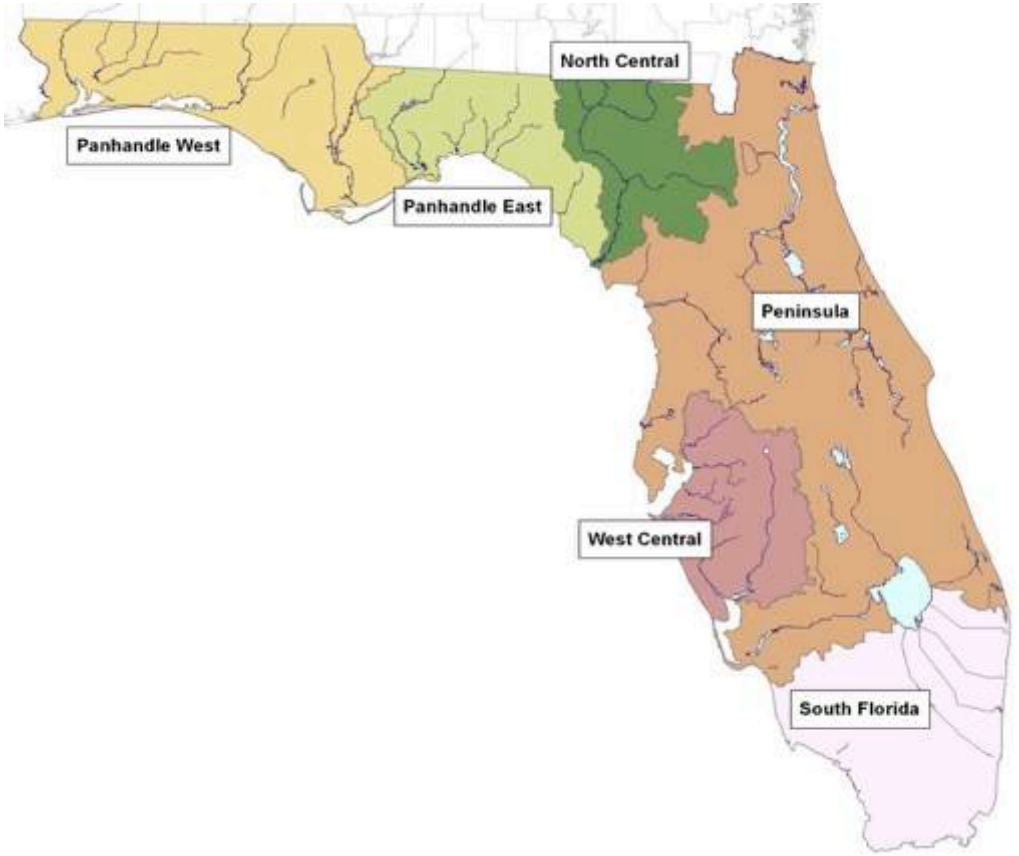
Measures of Flora and Fauna

Methods to measure healthy (or impaired) flora and fauna:

- Attached algae: Rapid Periphyton Survey
- Vascular Plants: Linear Vegetation Survey
- Phytoplankton: Chlorophyll a
- Benthic Invertebrates: Stream Condition Index

Streams Nutrient Thresholds

Nutrient Region	Total Phosphorus Threshold	Total Nitrogen Threshold
Panhandle West	0.06 mg/L	0.67 mg/L
Panhandle East	0.18 mg/L	1.03 mg/L
North Central	0.30 mg/L	1.87 mg/L
Peninsula	0.12 mg/L	1.54 mg/L
West Central	0.49 mg/L	1.65 mg/L
South Florida	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.	



Stream Biological Metrics

Linear Vegetation Survey	Invasive exotic aquatic vegetation not greater than 25% Mean C of C score greater than 2.5
Rapid Periphyton Survey	Benthic algae coverage of 6 mm or greater not more than 25% Benthic algae species is not nuisance or undesirable (if more than 20% coverage observed)
Annual Geometric Mean Chlorophyll-*a*	Not greater than 20 µg/L Between 3.2 and 20 µg/L: site specific conditions must indicate nutrients not an issue No increasing trend observed
Stream Condition Index	Average SCI score greater than 40 Neither of the two most recent scores less than 35

Example of >50% rank 4-6 RPS

Examples of Invasive Exotics in LVS

Stream NNC Data Quality and Quantity Objectives

- **Need at least two temporally independent (> 3 months apart) sets of bioassessment information for the receiving waters**

- **Representative sampling!!!!!**
- **Must sample during appropriate hydrologic conditions**
- **Must sample in areas that answer questions concerning water quality issues (*e.g.*, control for confounding variables such as habitat and hydrology)**

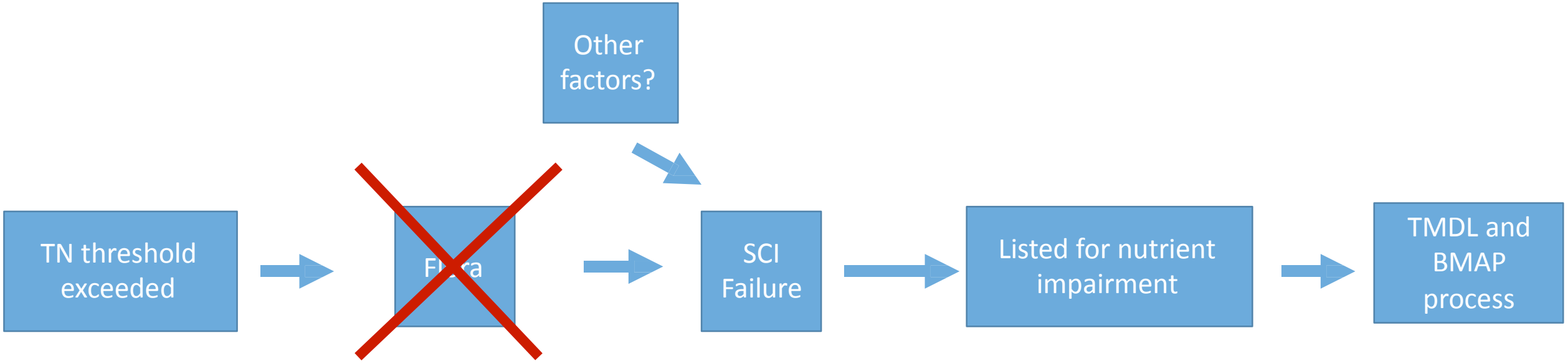
But Most Urban Systems Look Like This:

Is it reasonable that such physically altered and hydrologically modified systems will exhibit a biological community similar to an undisturbed reference stream?

The Urban Stormwater Predicament

Default position: Guilty Until Proven Innocent!

- **Even if factors other than nutrients are responsible for failed Biological Health Assessments, the assumption is that nutrients are automatically responsible for any adverse biological effects until it is proven otherwise**



NNC Compliance Options

NNC Compliance Options

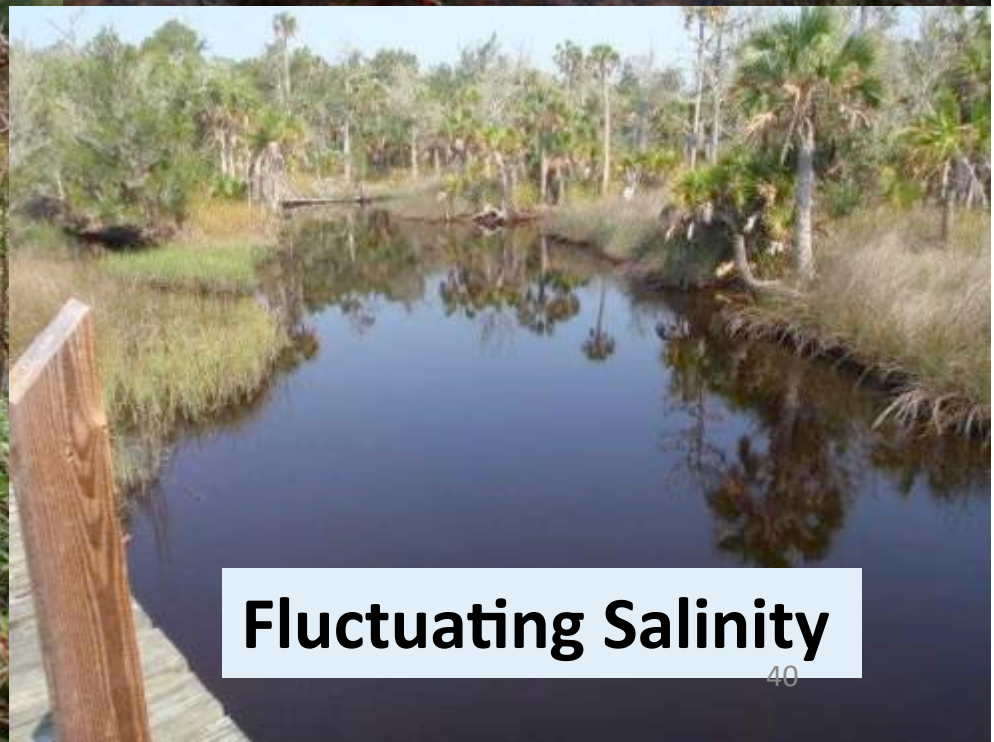
1. **Achieve the stream flora metrics, and either:**
   - **Achieve the fauna metric, or**
   - **Achieve the reference stream-based nutrient thresholds**
2. **Demonstrate the ditch (or other) exception and no imbalances**
3. **If MS4, change location of MS4 outfalls and demonstrate compliance at new locations**
4. **Change to Class III-Limited classification and establish nutrient (and potentially other) Site Specific Alternative Criteria**
5. **Stressor Identification Study shows factors other than nutrients are responsible for biological issues**

Is There Any Other Relief?

- **Rule 62-302.531, FAC, allows a Stressor Identification Study to be conducted to reasonably demonstrate the physical or chemical cause for failed Biological Health Assessments**
  - **Failures may be more influenced by habitat limitations and hydrologic modifications than by nutrients**
- **Further, Rule 62-303, FAC, actually requires that the causative pollutant be accurately identified to place waterbodies on the verified list of Impaired Waters for failed biology**

Exceptions to NNC as a Compliance Option

Excluded waters where the narrative applies:



Maintained Conveyance

This would likely qualify for narrative criterion

Discharge to Excluded Water to Stream to Estuary

Discharge

Direct Receiving Water: Ditch/ canal, wetland, intermittent stream

Narrative applies to excluded waterbody

Downstream Waters: Nearfield stream and then **estuary**

Healthy flora AND thresholds achieved OR healthy flora AND healthy fauna (SCI >40)?

Yes

Reasonable Assurance

No

Level II WQBEL

Analysis to ensure specific TN and TP levels/loads and chlorophyll *a* target for the estuarine segment during **all** years

Reasonable Assurance

If flora and fauna are healthy, then existing levels of TP and TN are OK (even if they exceed regional thresholds)

Nutrient loading from facility must be consistent with achieving downstream estuary TP, TN, and chlorophyll

Option: Reclassification to Class III-Limited

Surface Waters Eligible for Class III - Limited

- **Wholly artificial waters**
  - **Upland ditches**
  - **Reservoirs**
  - **Canals**
- **Altered waterbodies dredged or filled prior to November 28, 1975**
  - **Altered to the extent that they exhibit separate and distinct hydrologic and environmental conditions**

Reclassification

- **Reclassification (Class III-Limited) should involve discussions with DEP before proceeding**
- **This option is most expensive (see list of required items below)**
- **This option would require significant public input and written commitment (resolution) from the local government**

Reclassification Discussion

- **Must collect and analyze appropriate and scientifically defensible water quality, biological, hydrological, and habitat studies and analyses, as well as environmental, social, and economic studies to demonstrate that:**

- **None of the uses being removed are existing uses;**
- **The uses to be removed would not be attained by implementing required TBEL effluent limits and reasonable best management requirements for nonpoint source pollution control;**

Reclassification Discussion

- **The reclassification is clearly in the public interest;**
- **Water quality standards in downstream waters will be fully protected; and**
- **One or more of the criteria from Paragraph 62-302.400(11)(c), F.A.C., apply (next slide)**

Criteria from Paragraph 62-302.400(11)(c), F.A.C

1. Naturally occurring concentrations of substances prevent the attainment of the use;
2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met;
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;
4. **Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use**;
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by sections 301(b) and 306 of the Federal Clean Water Act would result in substantial and widespread economic and social impact. Perform necessary studies to complete the UAA. See Chapter 4 on Waterbody Assessments Relevant to Reclassification to Class III-Limited and Chapter 5 on Economic Analysis for UAAs.

Site Specific Water Quality Criteria

- **Alternative criteria for Class III-Limited is restricted to:**
  - **Nutrients**
  - **Bacteria**
  - **Dissolved Oxygen**
  - **Alkalinity**
  - **Specific Conductance**
  - **Transparency**
  - **Turbidity**
  - **Biological Integrity**
  - **pH**

Use Attainability Analysis

- **The information in a UAA report must be acceptable to both DEP and EPA before it can be used as the basis of adding or modifying a use**
- **The waterbody survey and assessment must address the following items (after FDEP 2010):**
  - **Identify the current classification and designated uses;**
  - **Identify the existing use;**
  - **Determine if the currently applicable water quality criteria are being met, and which of the parameters eligible for a SSAC are not attained;**
  - **Identify the highest attainable use, and demonstrate that one or more of the six factors in Paragraph 62-302.400(11)(c), F.A.C., applies**

UAA Data Requirements

- **Physical Indicators**
  - **Ecoregional setting**
  - **Soils, Slopes, Physiography**
  - **Habitat (where applicable, use DEP habitat Standard Operating Procedures (SOPs))**
  - **Climate/Meteorology**
  - **Hydrology (where applicable, use DEP hydrological modification form)**
  - **Geomorphology (*e.g.*, Rosgen or Kiefer methods)**

UAA Data Requirements

- **Chemical/Water Quality Indicators**
  - **Water quality data, including:**
  - **Organic, inorganic, and physical/chemical parameters (*e.g.*, pH, and DO), shall be provided for the waterbody;**
  - **Water quality criteria in Rule 62-302.530, F.A.C.;**
  - **Water quality analyses should focus on the criteria that are expected to be different from the existing criteria**

UAA Data Requirements

- **Biological Indicators**
  - **Algae composition and biomass;**
  - **Macrophyte community structure and function (where possible, use DEP SOPs, *e.g.*, LVI, LVS);**
  - **Invertebrate community structure and function (where possible, use DEP SOPs, *e.g.*, SCI, BioRecon);**
  - **Fish and Vertebrate wildlife community structure and function**

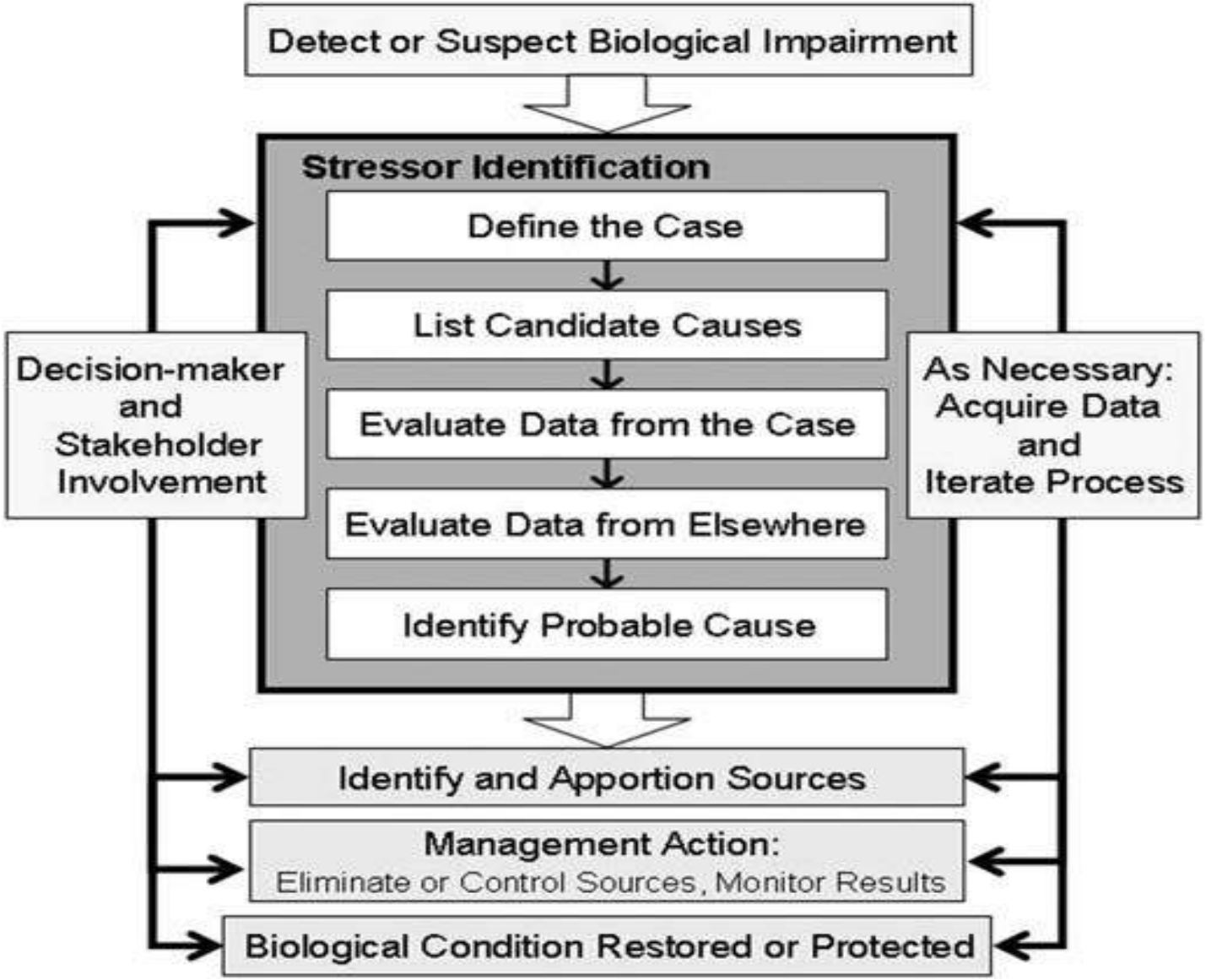
Option: Stressor Identification Study

What is a Stressor ID Study?

- **A systematic method to gather appropriate data and analyze the most probable causes for biological failures**

- **Evaluate stressors following EPA CADDIS approach:**
  1. **Develop conceptual model**
  2. **Evaluate data from the case, data from elsewhere**
  3. **Draw conclusions using a weight of evidence approach**

Causal Analysis/Diagnosis Decision Information System (CADDIS)



What is the role of SIS for NNC Compliance?

- **If the 2 most recent SCIs fail, the water is placed on the Study List (Cat. 4d) for biology to conduct a Stressor Identification (SI) study to determine causative pollutant(s).**
- **If the SI study determines that factors other than a pollutant (habitat, hydrology, etc.) is responsible for the biological impairment, the water would not be placed on the verified list**
  - **FDEP has no legal authority to implement a TMDL for failed biology unless a causative pollutant is identified**

How can Stressor ID Study Help?

- **Determine the primary stressor(s) causing biological impairment, and allow for resources to be properly spent mitigating the responsible stressor(s)**

- **Help prevent stakeholder being mistakenly held responsible for an impaired waterbody if other factors outside the control of stakeholder are responsible**

- **Prevent waterbody being listed as impaired for the incorrect reason**
  - **Why spend $ and not fix anything?**

Summary: NNC is Now a Reality

How are Non-point Source Discharges Affected?

- **TMDL Program**
  - **If direct receiving or downstream waters are deemed impaired, you will be affected**
  - **Nutrient reductions mandated**

- **Basin Management Action Plan (BMAP) process will determine specific improvements/Best Management Practices (BMPs) you must implement**
  - **May be more stringent than your current BMPs**

Being Proactive Saves $$$

- **Once waters are listed as impaired, a mandatory regulatory process takes place**
- **If a listing error occurs, stakeholders pay the price**

- **By compiling and collecting necessary data, your interests are better protected**

- **Your potential risk/exposure to increased regulations is dependent on verified impairments in direct or downstream waters**

What Can I Do?

- **Collecting and analyzing biological information requires specific hydrologic conditions (must avoid floods and droughts), so plan ahead**
- **Proactive approach can overcome past QA issues (failed biological metrics that were not collected during appropriate conditions)**
- **Determine if there are excluded waters (ditch, non-perennial, tidal, or wetland), as these require different demonstration: no imbalances in flora or fauna**
- **Stressor Identification Study may help**

NNC Conclusions

- **Florida's NNC are very complex and comprehensive**
- **Allow for site-specific science and biologically relevant responses**
- **Used for Impaired Waters Rule, point source discharge permitting, and watershed restoration**
- **Non-point sources are controlled through the Basin Management Action Plan process**
- **The entire process is data driven**
  - **Valid information may protect your interests**

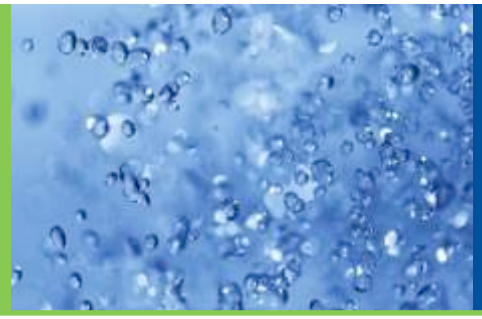
Questions? www.frecologic.com

Florida's NNC

Water Management Conveyances

Scott McClelland
Vice President

July 8, 2015



CDM Smith

WATER + ENVIRONMENT + TRANSPORTATION + ENERGY + FACILITIES

Florida's NNC – Approved by EPA

- FDEP NNC become effective in October 2014
- NNC includes "Implementation of Florida's Numeric Nutrient Standards" (April 2013)
- As part of the rule, the NNC apply to, among other things, "streams".
- Stormwater practitioners want to know: Is a stormwater ditch considered a stream for the purposes of NNC?

Definition of What a Stream Is

- Stream means, for the purpose of interpreting the narrative standard:
  - Predominantly fresh water
  - Perennial flow in a defined channel with banks during typical (regional) climatic and hydrologic conditions
    - During periods of drought, portions have a dry bed, but wetted pools still present

Rule 62-302.200(36)

Criteria for Streams

- Rule 62-302.530(47)(a)

The discharge of nutrients shall continue to be limited as needed to prevent violations of other water quality standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions in 62-302.300 [Findings & Antidegradation], 62-302.700 [Special Protection, OFW] and 62-4.242 [Antidegradation, OFW, ONRW, Equitable Abatement].

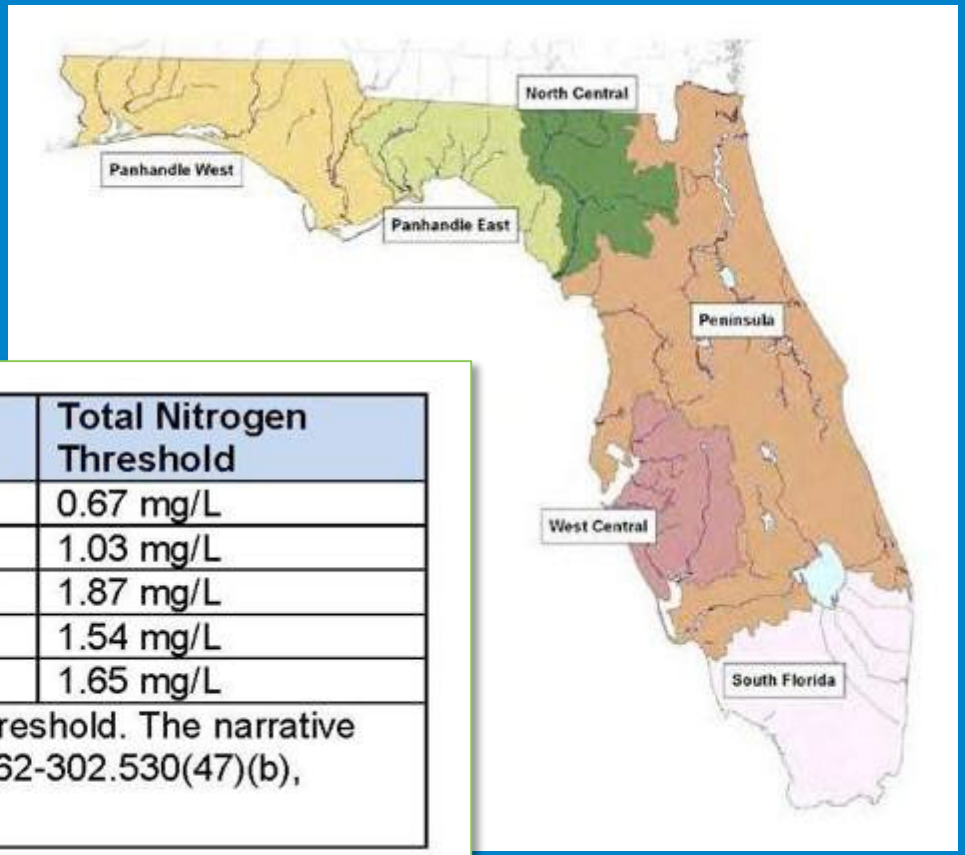
- Rule 62-302.530(47)(b)

In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna."

- Rule 62-302.531 Numerically Interprets Rule 62-302.530(b) – this is really what we call the NNC

Numeric Interpretation of Narrative

If it is a “stream” then these thresholds may apply if no other site-specific ones are defined.



Nutrient Region	Total Phosphorus Threshold	Total Nitrogen Threshold
Panhandle West	0.06 mg/L	0.67 mg/L
Panhandle East	0.18 mg/L	1.03 mg/L
North Central	0.30 mg/L	1.87 mg/L
Peninsula	0.12 mg/L	1.54 mg/L
West Central	0.49 mg/L	1.65 mg/L
South Florida	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.[2]	

Annual Geometric Mean Exceeded No More Than Once in 3 Consecutive Years

Definition of What a Stream Is Not

- Streams do not include:
  - "Non-perennial segments where fluctuating hydrologic conditions" usually result in:
    - Wetland and/or terrestrial taxa;
    - Wetlands;
    - Exhibit lake characteristics (e.g., long residence time); OR
    - Tidally influenced (fluctuate between marine and freshwater).

Rule 62-302.200(36)(a)

Definition of What a Stream Is Not

- AND Streams do not include:
  - Ditches, Canals and Other Conveyances
    - Man-made OR Predominantly Channelized OR Predominately Physically Altered; AND
      - Primarily used for water management purposes (e.g., flood protection, stormwater management, irrigation or water supply) AND
      - Have marginal or poor stream habitat (e.g., lack of habitat or biologically limited substrate) because the conveyance :
        - » Is predominantly trapezoidal
        - » Has armored banks OR
        - » Maintained primarily for water conveyance.

Rule 62-302.200(36)(b)

May Not Be “Streams” for NNC Purposes

Hickory Ditch, Brevard Co.

Ditch #5, Pinellas Co.

McCord Park Tributary, Tallahassee

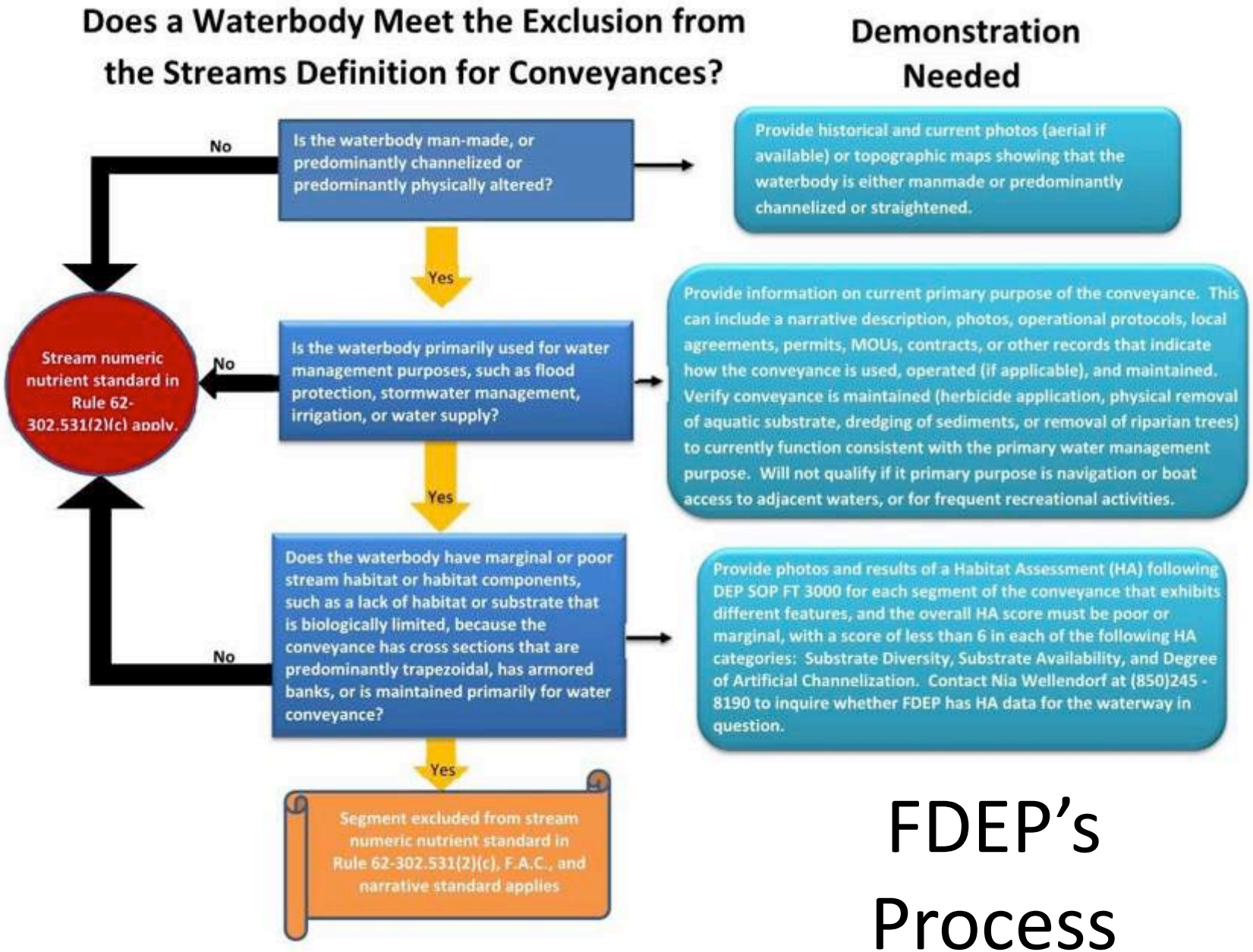
Ditch Exclusion

- Define Segments for Exclusion (Map)
- Pictures
  - Man-made, or
  - Predominantly Channelized, or
  - Predominantly Physically Altered
- Primary Use = Water Management
  - Options: Flood Protection, Irrigation, Water Supply, etc.
  - Design Drawings, Permits, Maintenance Plans/Agreements

Ditch Exclusion (continued)

- Alteration Limits Habitat
  - DEP SOP FT3000 – Habitat Assessment is Poor or Marginal
  - Photography

http://www.dep.state.fl.us/water/sas/sop/sops.htm



FDEP's Process

Now What?

- Watch for Other Community Ditch Exemptions (2 submitted, none approved)
- Check Any Nutrient Data Compared to NNC Thresholds and Downstream TMDLs
- Prepare:
  - Map
  - Take Pictures
  - Define Use (Plans, Permits, Agreements)
  - Do Habitat Assessment
  - Consider Alternative Nutrient Criteria

Questions?

Biological Treatment and Volume Reduction Options

to Address Numeric Nutrient Criteria in Stormwater

Presented by
Gary Serviss, Principal Scientist

Biological Treatment

- Vegetative/Algal
  - Swales
  - Bioswales
  - Littoral Shelves
  - Floating Islands
  - Wetland Treatment
  - Green Roofs
- Microbial
  - Biofiltration
  - Rain Gardens

Swales

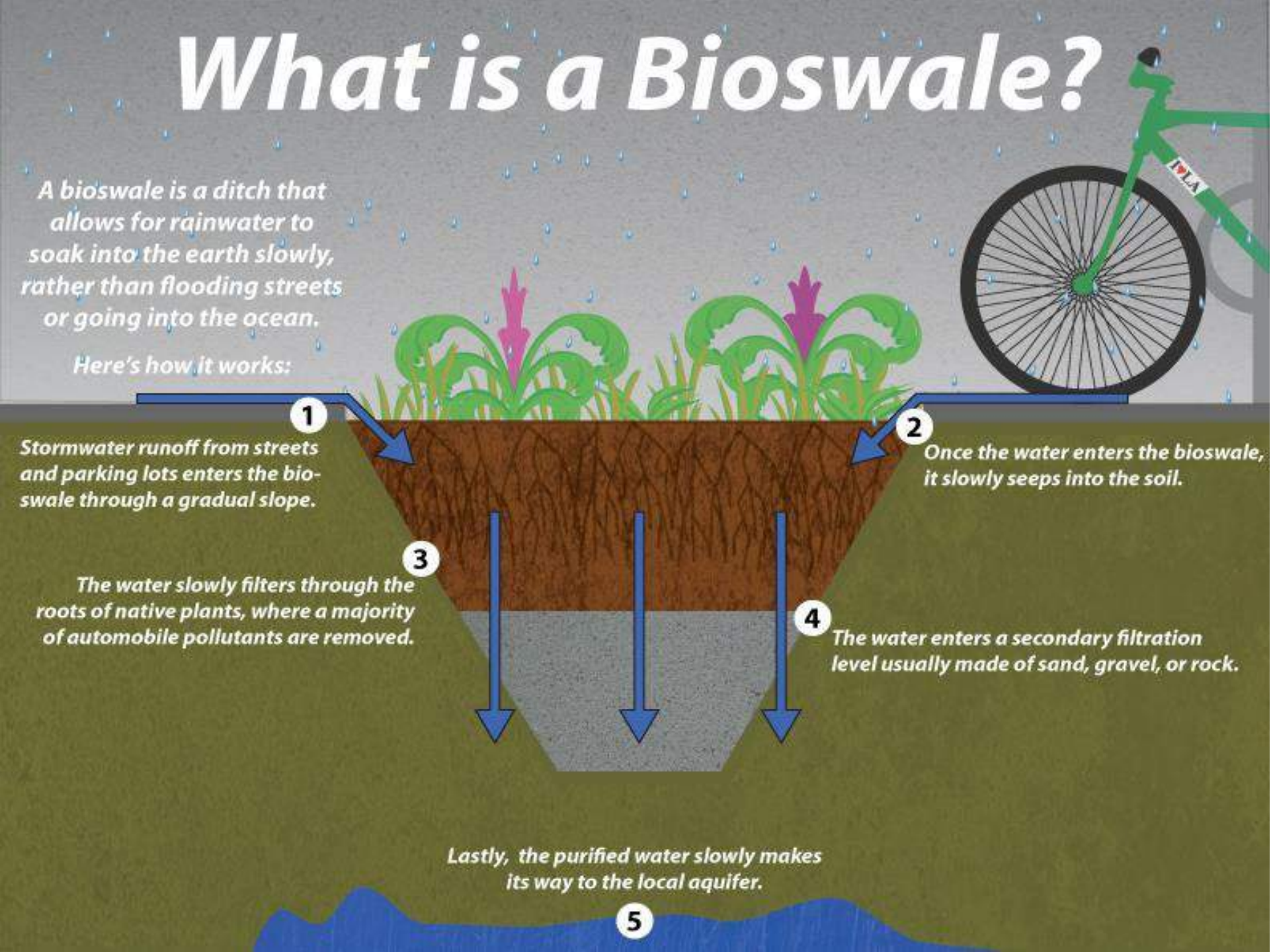
- Conveyence
- Treatment
- Vegetated Natural Buffer
- First Line of Defense

Removal Efficiency based upon Infiltration Volume

Bioswales

- Shallow Bioretention or Swales with a twist!
- Upland Bioswales
- Wetland Bioswales

What is a Bioswale?



After

Littoral Shelves

- Associated with wet detention ponds
  - Shallow area below Normal Water Level
  - Planted with emergent vegetation or natural colonization
  - 30% of pond area
  - Concentrated at outfall
  - Wildlife habitat
  - Removal Efficiency – 10% TN and 10% TP

Floating Islands

- Managed Aquatic Plant Systems (MAPS)
- Commercially available
- Floating plant trays
- Anchored with exclusion netting
- 5% of pond surface area
- 12% removal
- 20-40% removal credit for TN and TP

Floating Islands

- Advantages
  - Away form homeowner
  - Shape, size and species are customizable
  - Greater removal efficiency credit than littoral shelves
- Disadvantages
  - Similar nuisance/ exotic species control
  - Annual biomass harvesting and replanting

Lake Eola

Wetland Treatment

- Part of treatment train
- Isolated and wholly owned
- Pre-treatment required
- Maintain natural fluctuation range
- Maximize sheet flow, minimize channelization
- Off-line system if natural, may be in-line if man-made
- Maintain plant assemblages

Wetland Nutrient Removal

- Limited removal by rooted plants
- Periphyton/algae
- Bacteria
- Varies by season
- 1.0 mg/L TN limit
- Removal based on retention volume or removal efficiency data
- True Value is underestimated

Nitrogen Loads

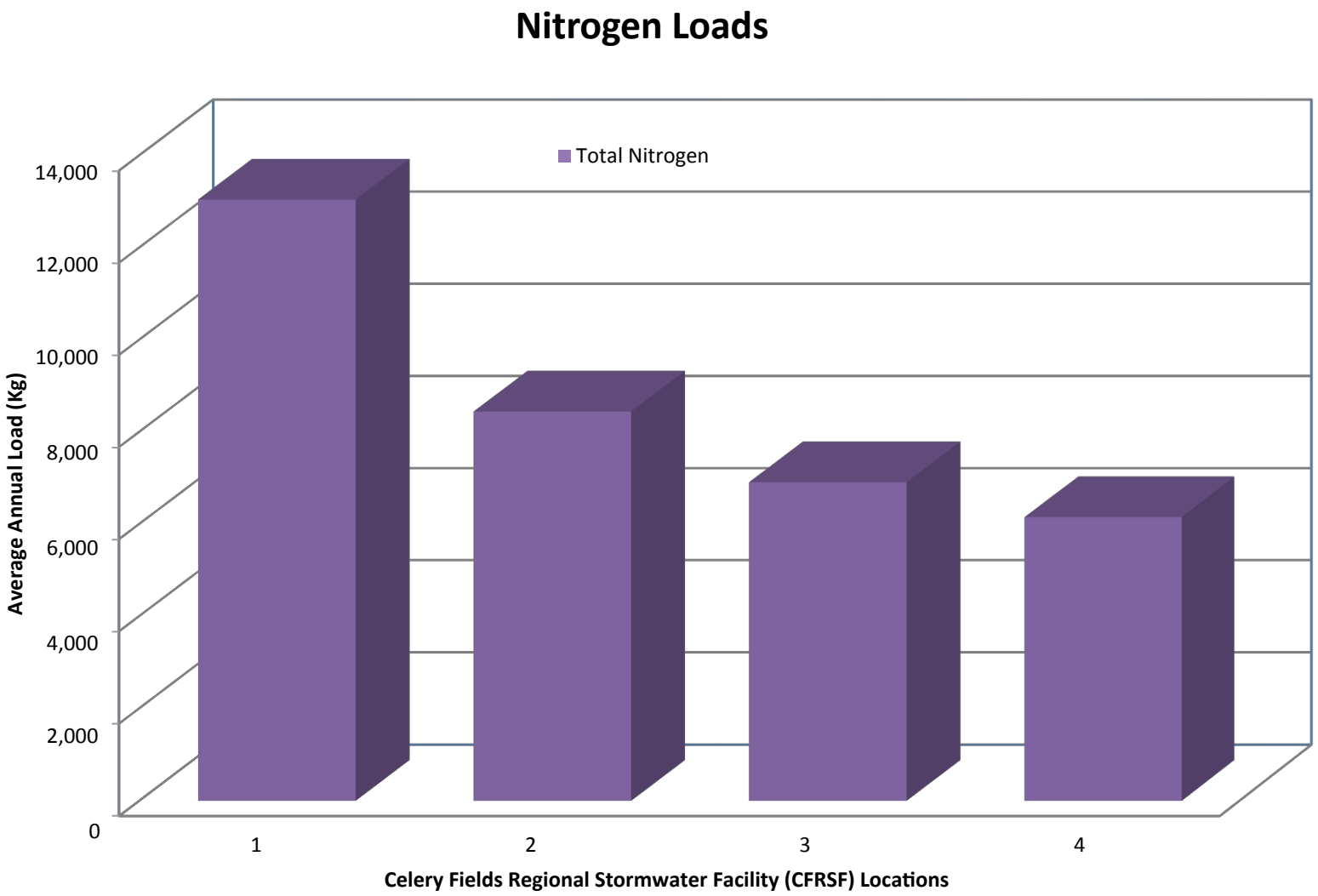


Figure 15. Average annual TN loads for the duration of the study for each of the cells.

Nitrogen Loads

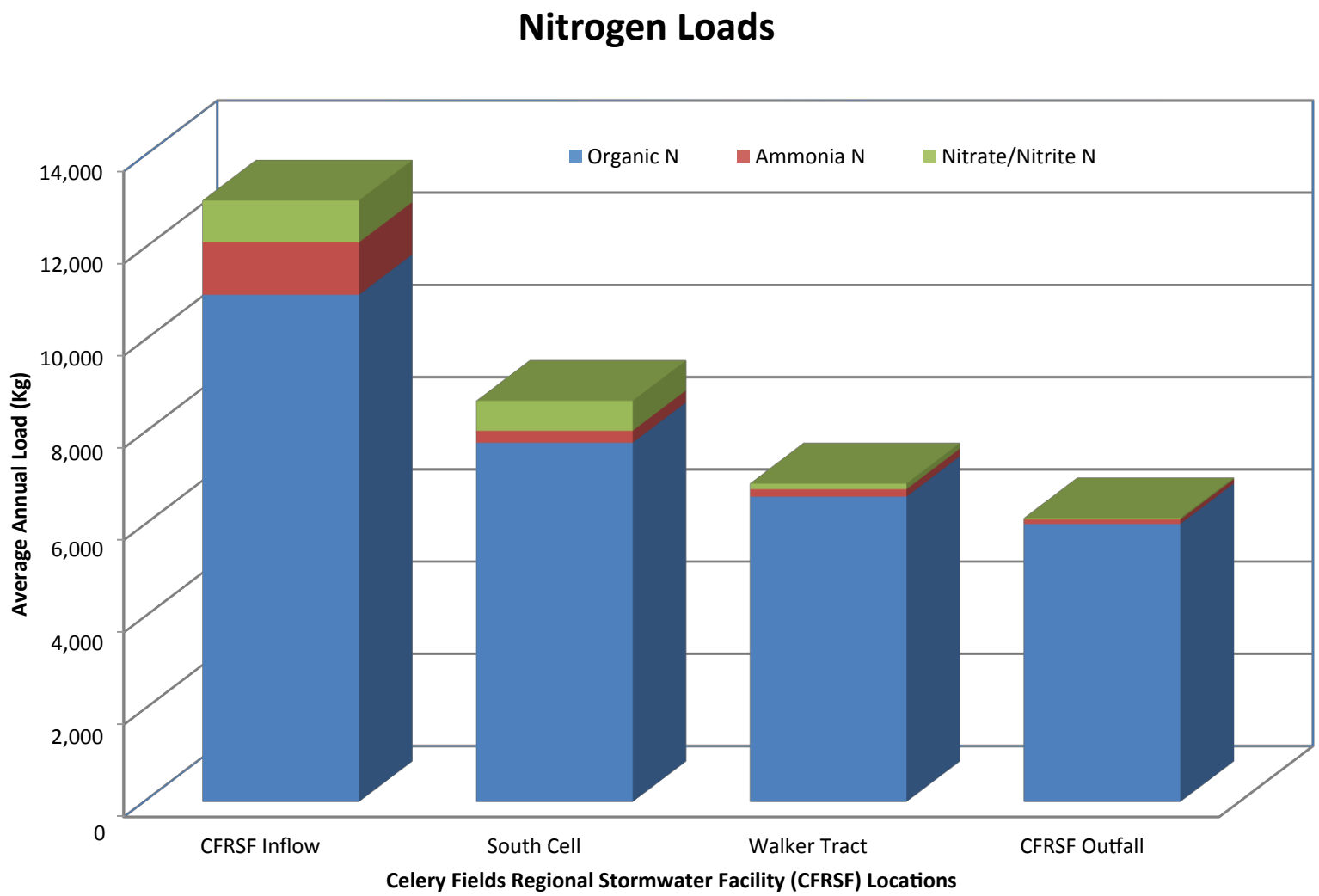


Figure 15. Average annual TN loads for the duration of the study for each of the cells.

Green Roofs

- Vegetation
- Growth media, pollution-control media
- Cistern
- Effectiveness based upon volume captured and reused

Biofiltration

- Microbial and soil treatment
- Associated with bioswales, and rain gardens
- Detention system with lined underdrain
- Soil elements may be incorporated into Underdrain Filtration requirements
- 80% TN and TP removal efficiency

Biofiltration

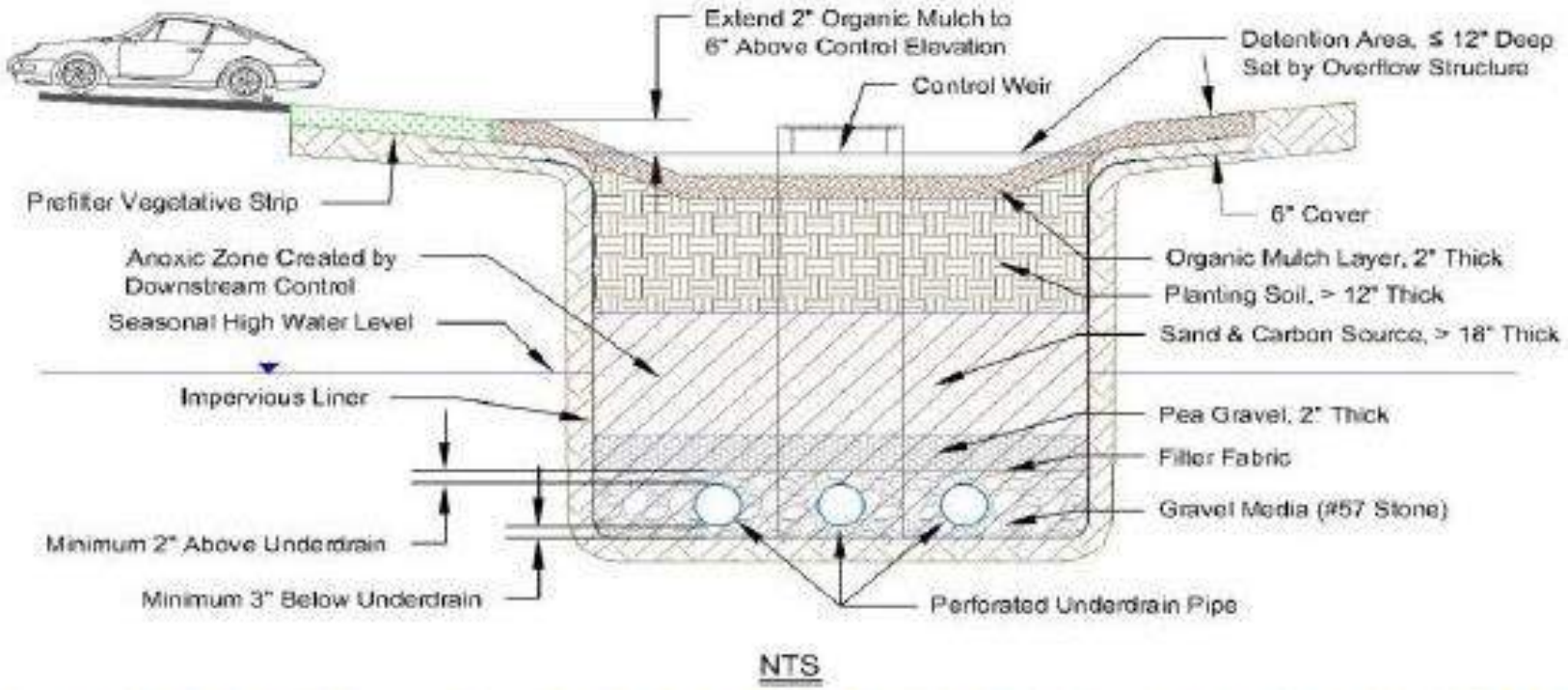


Figure 3.6-2 Cross Section View of a Detention System with Biofiltration

Rain Gardens

- Rainwater Vs. Stormwater Runoff
- Variation of a Bioswale for rainwater
- Can include biofiltration or retention
- Removal efficiency based upon volume removed or treated

Volume Reduction

- NNCs are concentrations, but loads are more critical
- Load = concentration x volume
- Don’t assume that everything run offs
- Evaporation, transpiration and infiltration

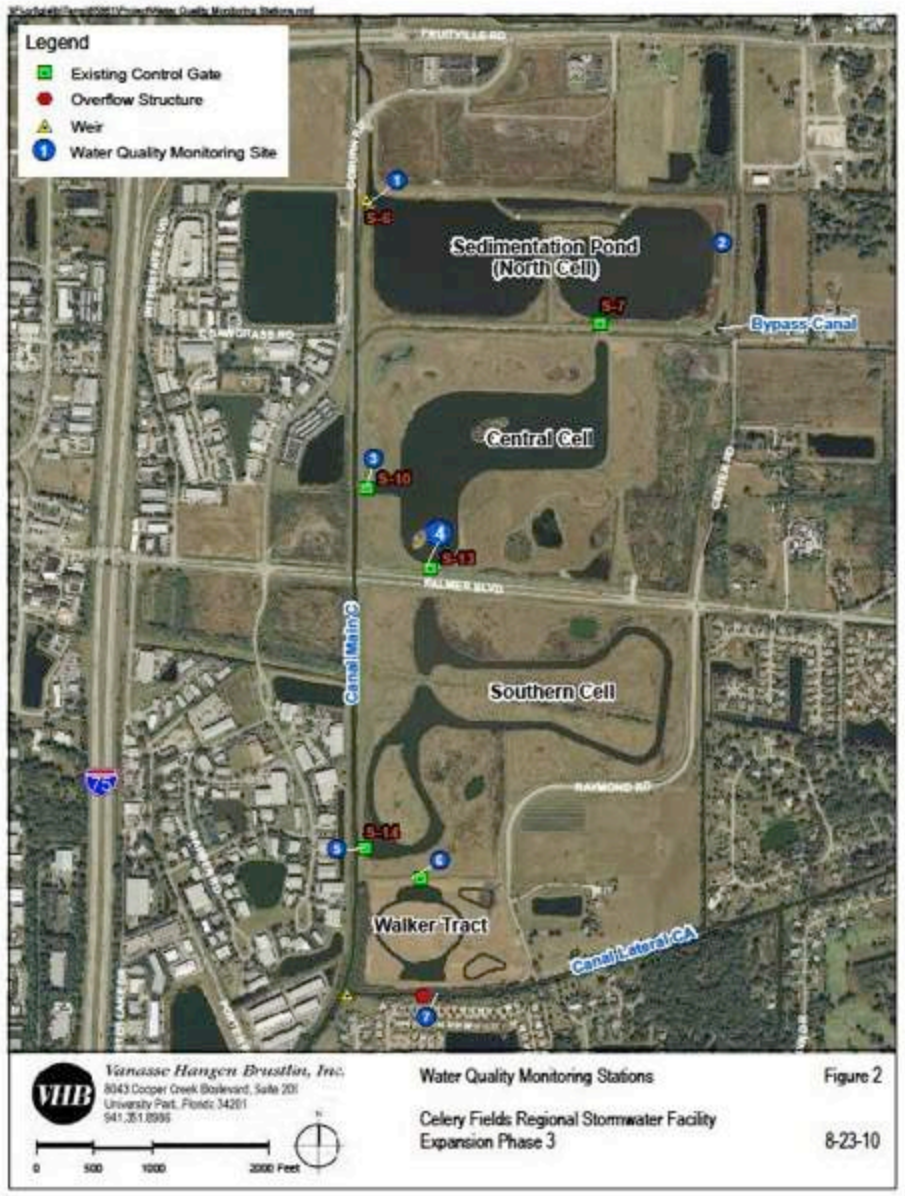
McIntosh Park

- Two year storm event study
- 5,600 acre+ watershed
- Three BMPs (Sump, Wetland, Alum) in series
- 54% volume reduction

Figure 1-2
Overview Map, McIntosh Park ESTW Project, Hillsborough County, Florida

Celery Fields

- Two year storm event study
- 3,965 acre watershed
- Treatment train (ponds, pond with littoral shelves, wetlands)
- 34% volume reduction



Rainwater Harvesting

- Rain Barrels
- Cisterns/Vaults
- Irrigation
- Gray water/ Reuse

Stormwater Harvesting

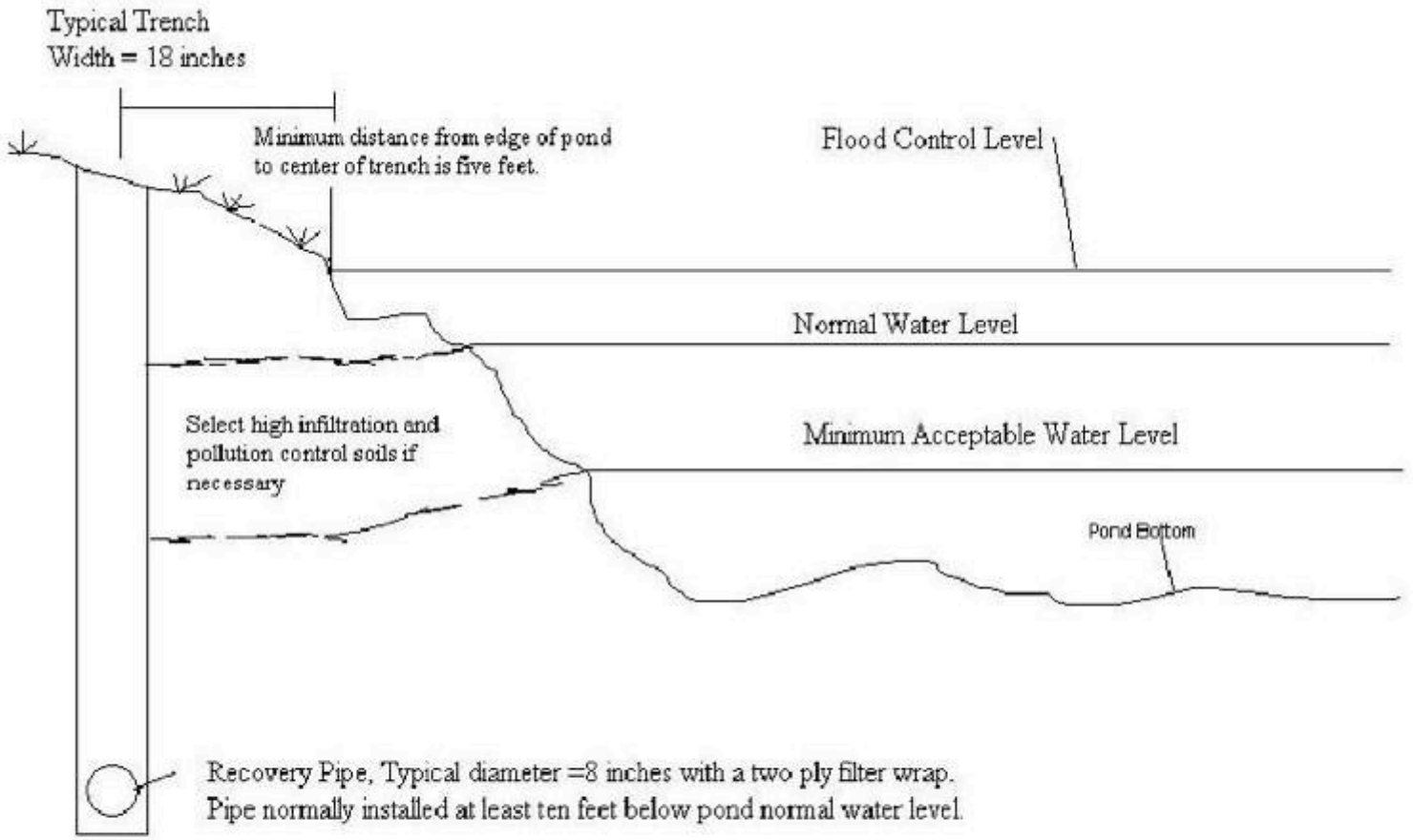


Figure 3.3-3 Horizontal Well Construction Details

Questions ?

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Offices located throughout the east coast

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Developing Tools for Surface Water Nutrient Loading Attributable to Reclaimed Water

MWH®

Project Participants

- FDEP
- SWFWMD
- SFWMD
- SJRWMD
- City of Naples
- Palm Beach County
- City of Orlando
- Orange County
- Pasco County
- TOHO Water Authority
- Pinellas County
- Hillsborough County

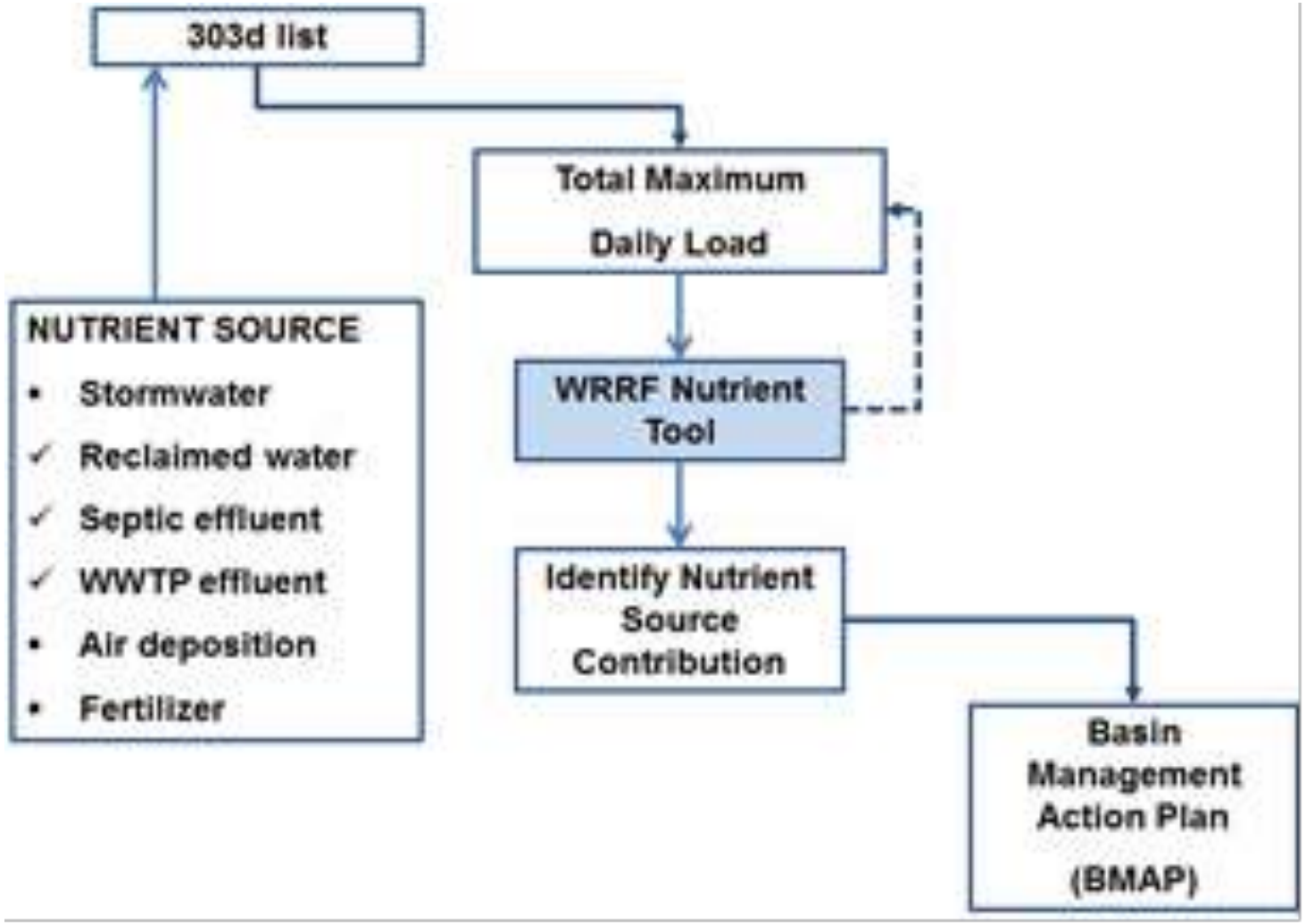
Background

- Nutrients contribute toward impairment of Florida surface waters.
- Florida relies heavily on using reclaimed water for non-potable purposes to secure the State's future water resources.
- ***Need to better understand water reuse impact relative to other nonpoint sources in causing nutrient impairment.***

Basin Management Action Plan (BMAP)

- BMAP is Florida's TMDL implementation plan.
- Establishes load reduction strategies of responsible parties.
- Targets collective pollutant load ≤ assimilative capacity of impaired water body.
- ***Uncertainty lies in establishing source to load relationships for different sources.***
- Some source categories such as reclaimed water lack data on source loading behavior.

Source Load Nutrient Tool Concept

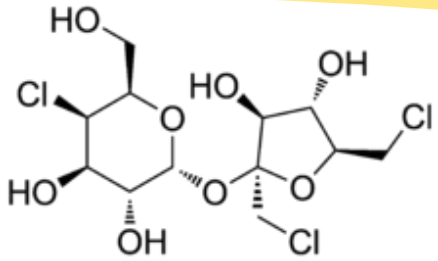


Ideal Marker Characteristics

- Sufficient analytical sensitivity
- Source-specific signature
  - Presence / Absence (source / treatment differences)
  - Parent / Metabolite (treatment differences)
  - Compound Ratios (treatment differences)
  - Disinfection Byproducts (treatment differences)
- Environmental Stability (i.e., low photolysis)

Earlier Project Markers

- Sucralose



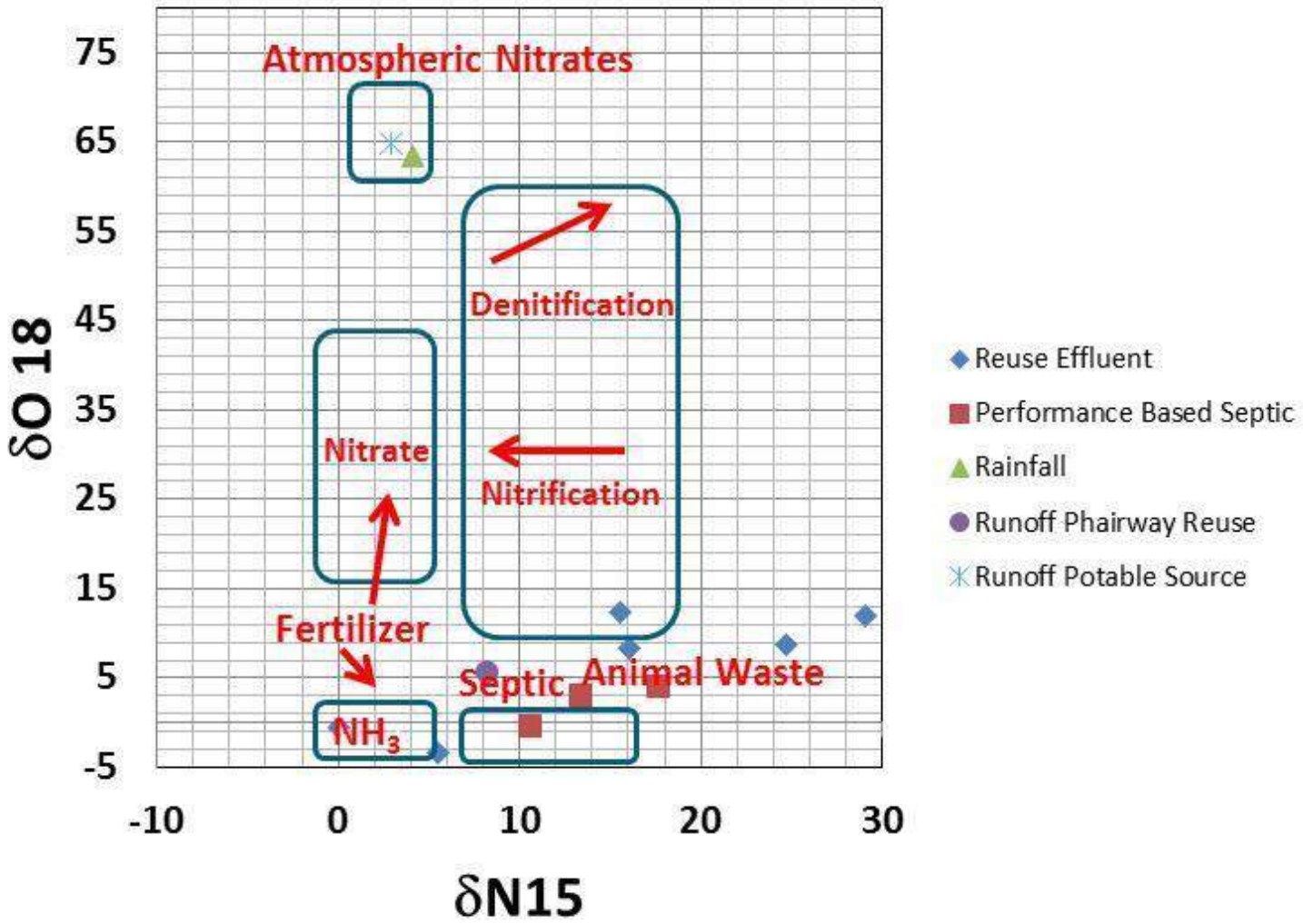
- Musk fragrances (galaxolide, tonalide)
- Mood stabilizers (carbamazepine)
- Beta blockers (atenolol)
- Contrast media (iohexol, Gd anomaly)
- Herbicide (dalapon)
- Fecal steroid (coprostanol)
- Stable isotopes (N, O, C)

Prior Study Results - Chemicals (ng/L units)

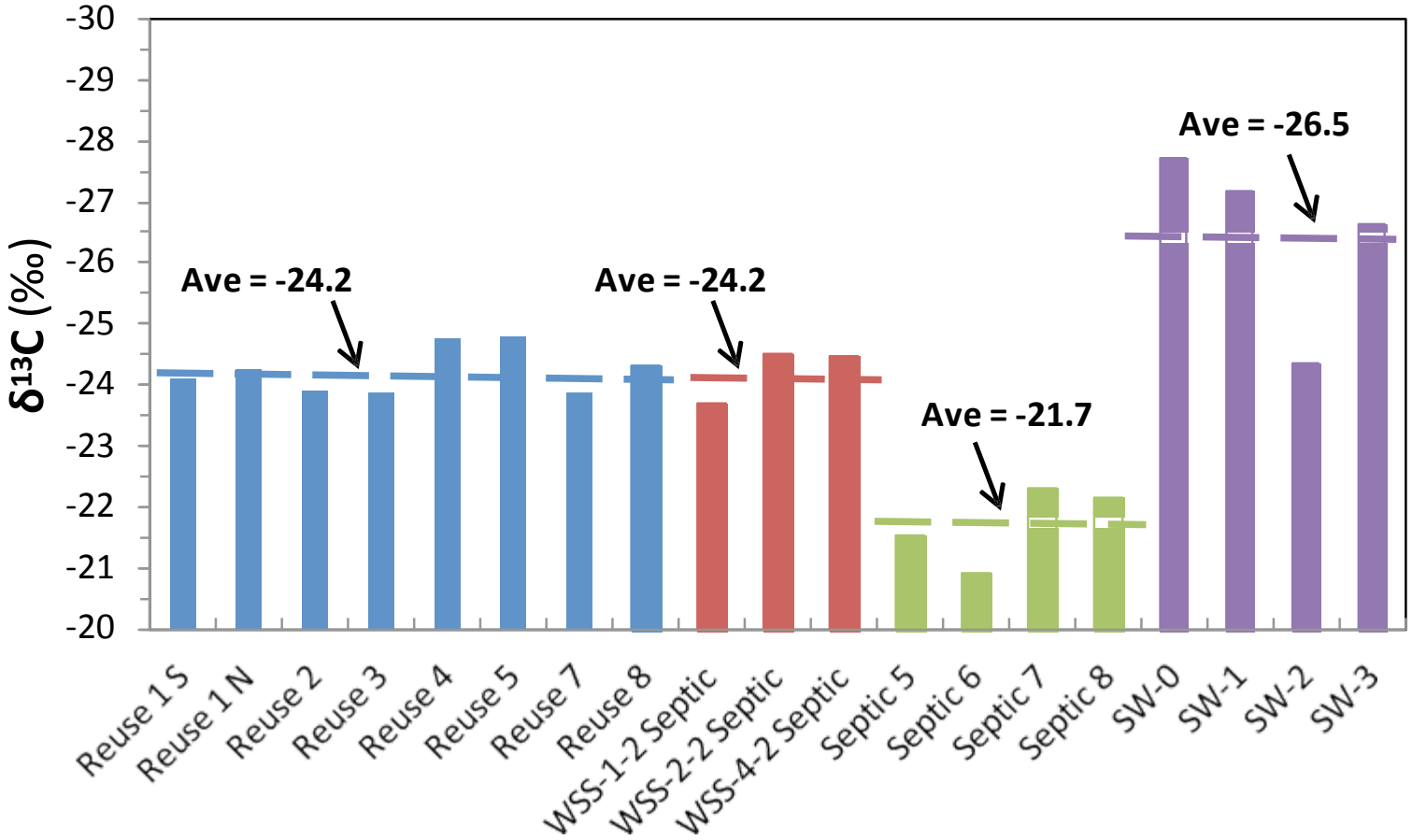
Compound	Reuse Effluents	Septic Tank	Stormwater	Fertilizer*
Atenolol	1270 ± 882	< 8.1 ± 6.3	<6.2 ± 2.4	36
Carbamazepine	230 ± 8	< 15.6 ± 20.1	<5 ± 0.0	<5
Gd Anomaly	60 ± 37.5	1.5 ± 1.3	1.2 ± 0.6	6
Iohexol	5440 ± 3540	<10.4 ± 0.7	<10.5 ± 1.0	<10
Sucralose	24,000 ± 4100	40,000 ± 24700	<112 ± 25	<100
Coprostanol	1400 ± 1900	Not Analyzed	Not Analyzed	Not Analyzed
Dalapon	<1220 ± 1040	Not Analyzed	Not Analyzed	Not Analyzed
Galaxolide	2300 ± 800	2690 ± 2710	<50 ± 0.0	<50
Tonalide	240 ± 100	Not Analyzed	Not Analyzed	Not Analyzed

* Equivalent to TKN concentration of 670 mg/L

Prior Study Results – N & O Isotopes



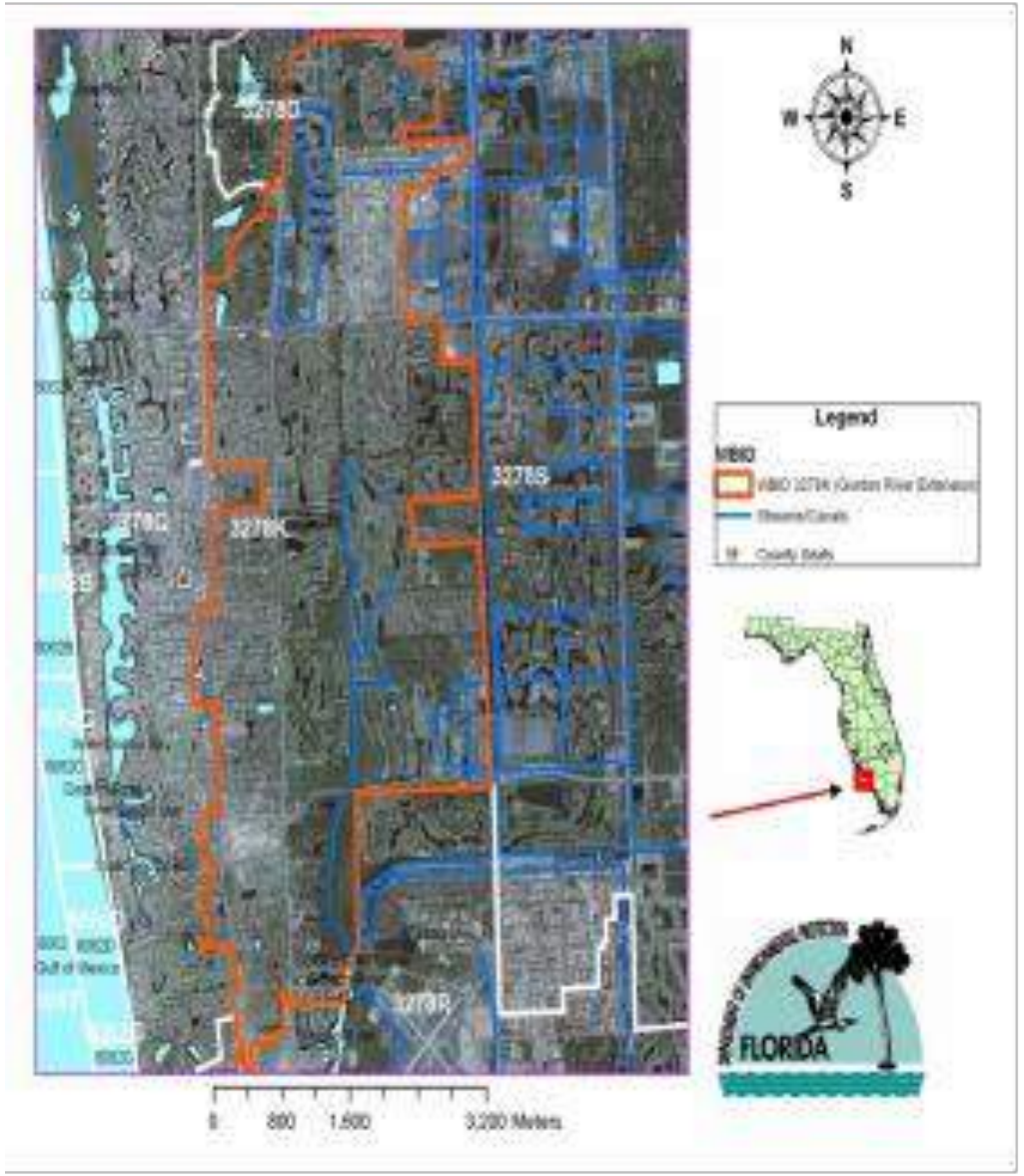
Prior Study Results – C Isotopes



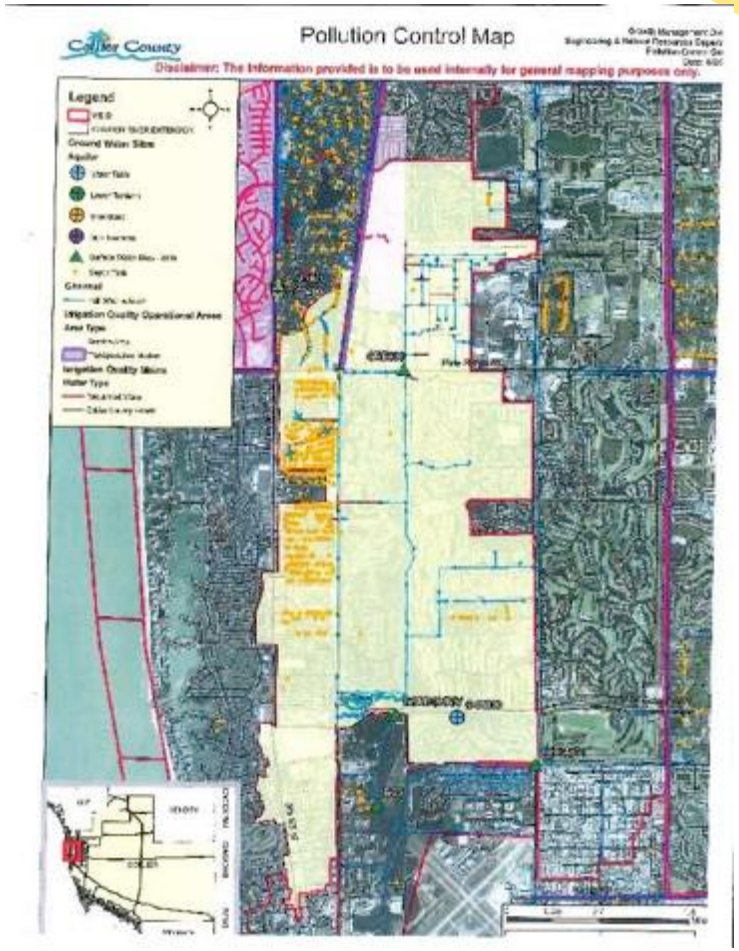
Present Study Goal & Objectives

- Further develop and utilize markers from an earlier study to utlize within the context of a Florida BMAP.
  - Understand nutrient fate and transport processes relevant to water reuse loading conditions.
  - Further develop markers to distinguish water reuse volumetric loading and distinguish septic influences.
  - Integrate project nutrient tool development into a Florida BMAP.

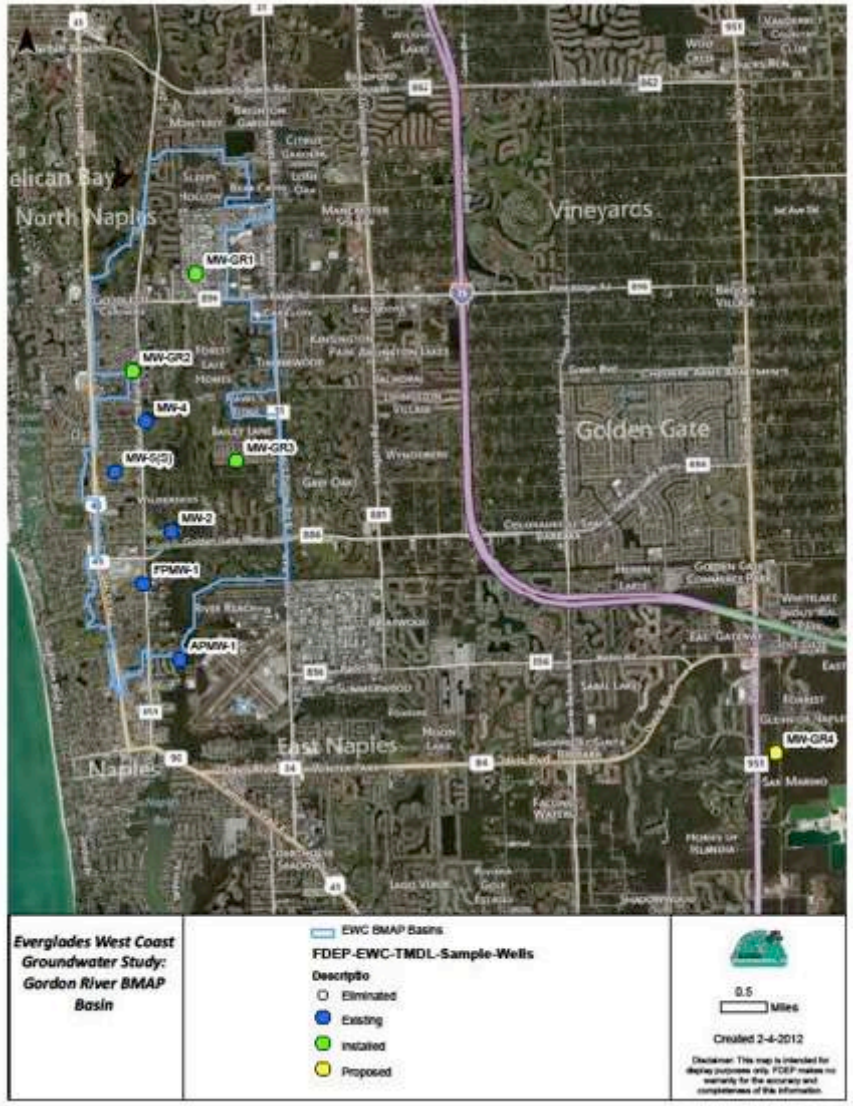
Location of Study Site in Florida



Gordon River Extension Septic System Locations

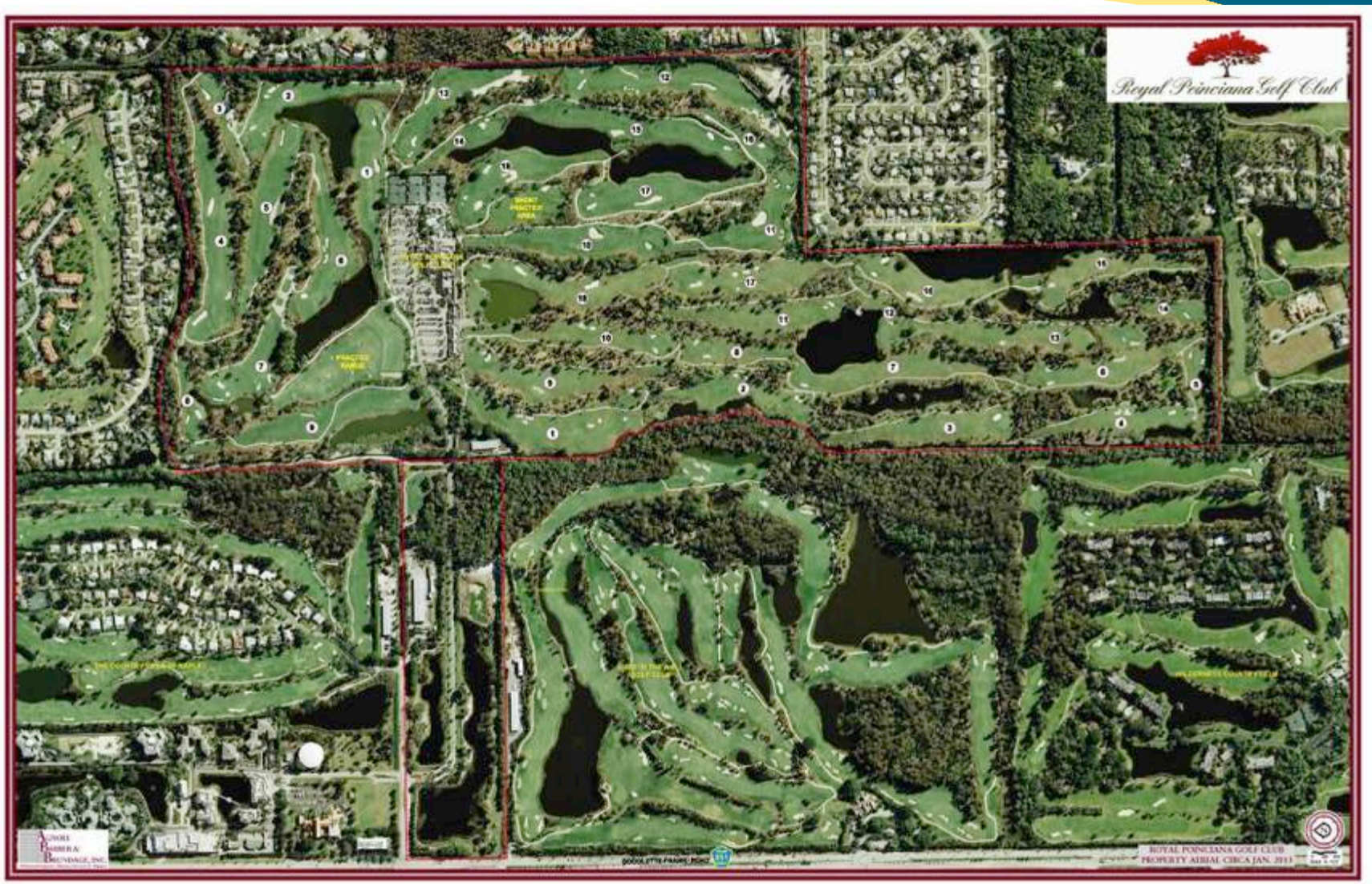


Location of FDEP Monitoring Wells



Sucralose observed in certain wells

Reclaimed Water Use at Golf Courses



Gordon River Extension

Reuse vs Septic (Presence/Absence)

- Chlorination applied in reuse and not in septic may create unique DBPs in reuse water.
- Nitrification may be enhanced in reuse and offers more co-metabolism of PPCPs due to ammonia oxidizing bacteria (AOB) which possess ammonia oxygenase.
- Denitrification process appears to offer little benefit in PPCP degradation and therefore less distinguishing capabilities.

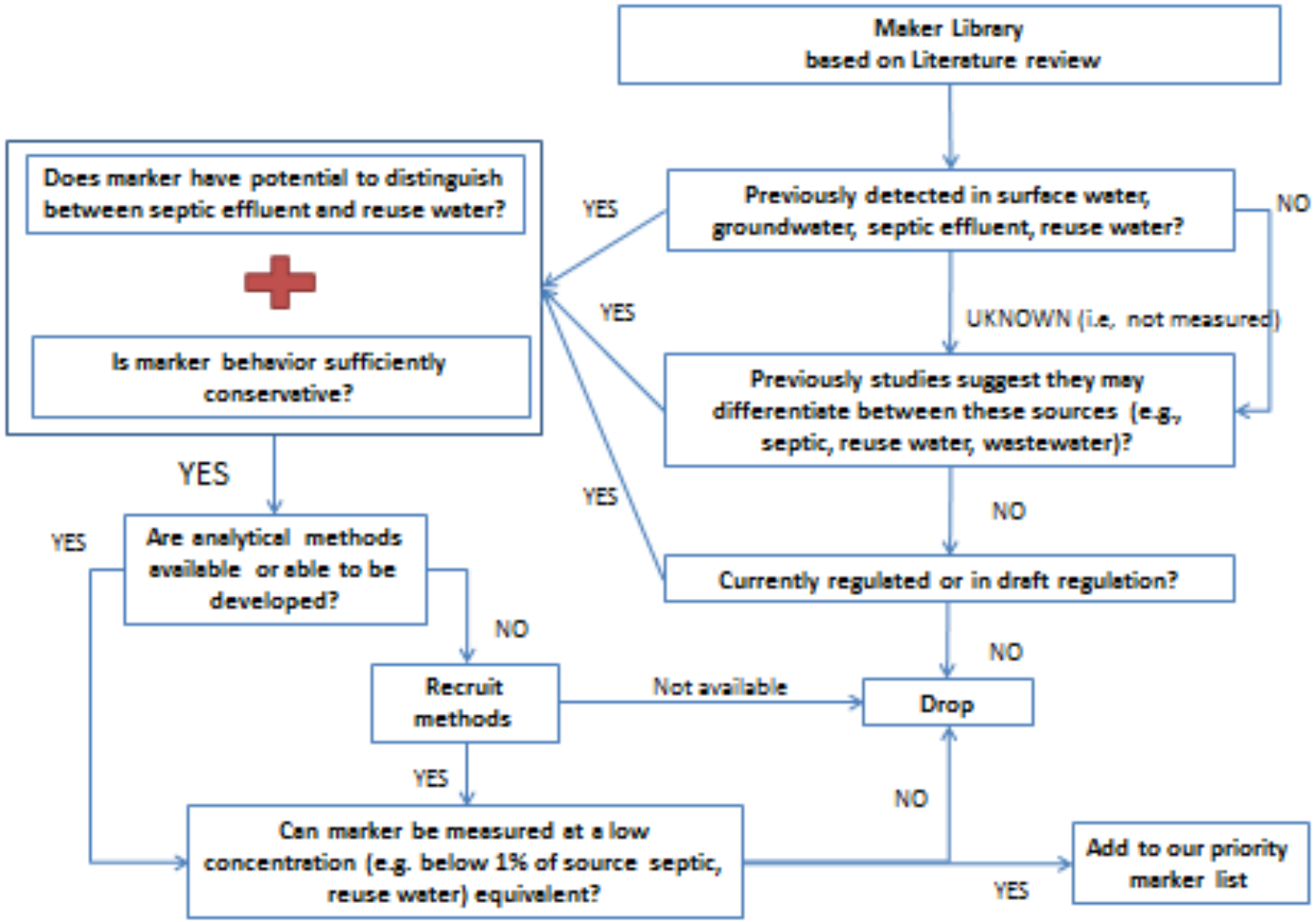
Potential Candidates to Distinguish Reuse, Septic, GW

- Reuse Presence & Septic Absence
  - Medical facility chemicals
  - Chlorinated transformation products
- Septic Presence & Reuse Absence
  - Common household usage, not fully degraded under leach field conditions (e.g., caffeine, NSAIDs, cimetidine, D-limonene, methyl salicylate)
- Legacy Pollutants in Groundwater
  - Banned chemicals with previous widespread use (e.g., MSMA)
- Other Reported Differences
  - Bacteriophage, ARB

Septic System Factors Influencing Transport

- Redox Conditions
  - Vadose / subsurface zones
    - Ibuprofen degradation by heterotrophic bacteria
    - Diclofenac degradation unclear & complex
- Aquifer Materials
  - Transport limited by higher aquifer surface area & carbon content
- System Design
  - Higher loading rates reduce attenuation
  - Less depth to groundwater reduces attenuation

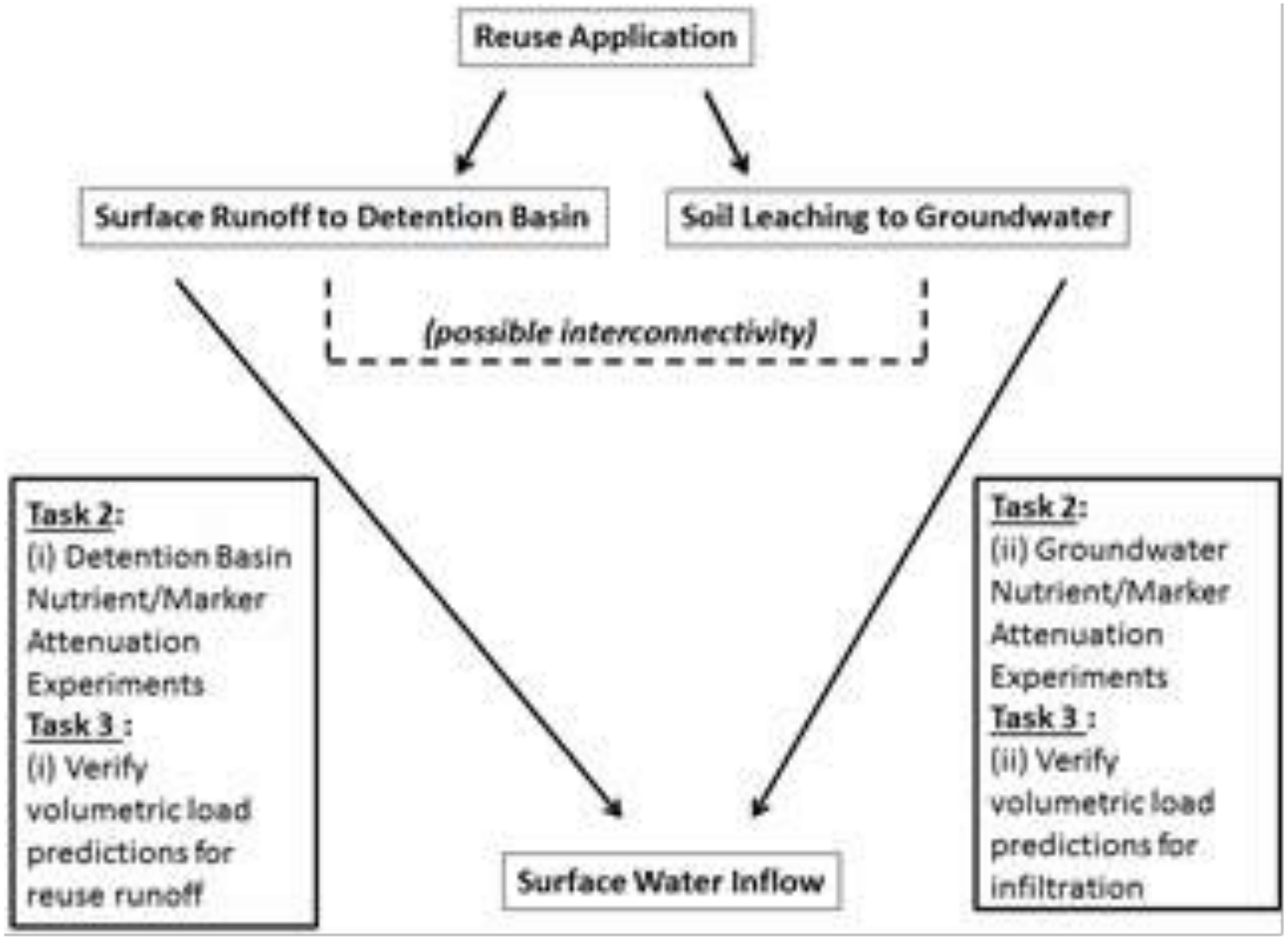
How Marker List Selection will be Finalized



Missing Information – Sampling & Bench Studies

- Verification of markers in reuse effluent
  - Pre and post chlorination concentrations
- Watershed specific information:
  - Performance levels of septic tank systems
  - Leach field characteristics
  - Soil profiles
  - Depth to groundwater
- Fate and transport data specific to final marker list

Bench Studies & Field Analyses



Project Schedule for Deliverables