



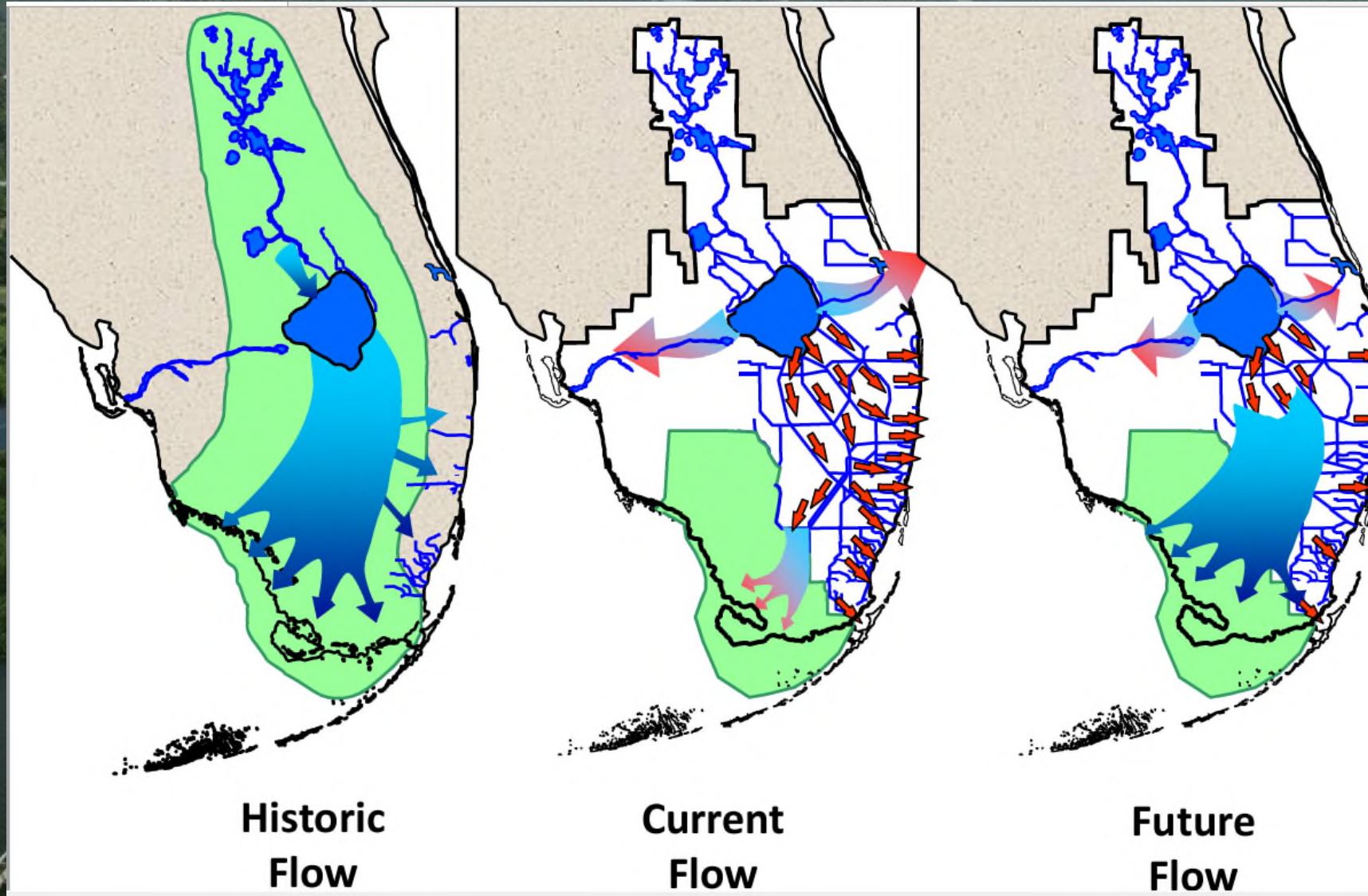
C-43 West Basin Storage Reservoir Water Quality Feasibility Study

September 27, 2019

An aerial photograph of a wide river flowing through a lush, green landscape. The river is the central focus, with its surface reflecting the sky. On either side of the river, there are dense forests and some residential or commercial buildings. The sky is blue with scattered white clouds. A semi-transparent green rectangular box is overlaid on the center of the image, containing the text "Understanding the Big Picture" in white.

Understanding the Big Picture

Changes in Hydrology



Executive Order 19-12, January 10, 2019

- **Greater protection of Florida's Environment and Water Quality**
- **Harmful Algae Blooms**
- **Provide additional treatment and improve the quality of water leaving the C-43 West Basin Storage Reservoir**

FDEP is Leading the Following Regional Efforts

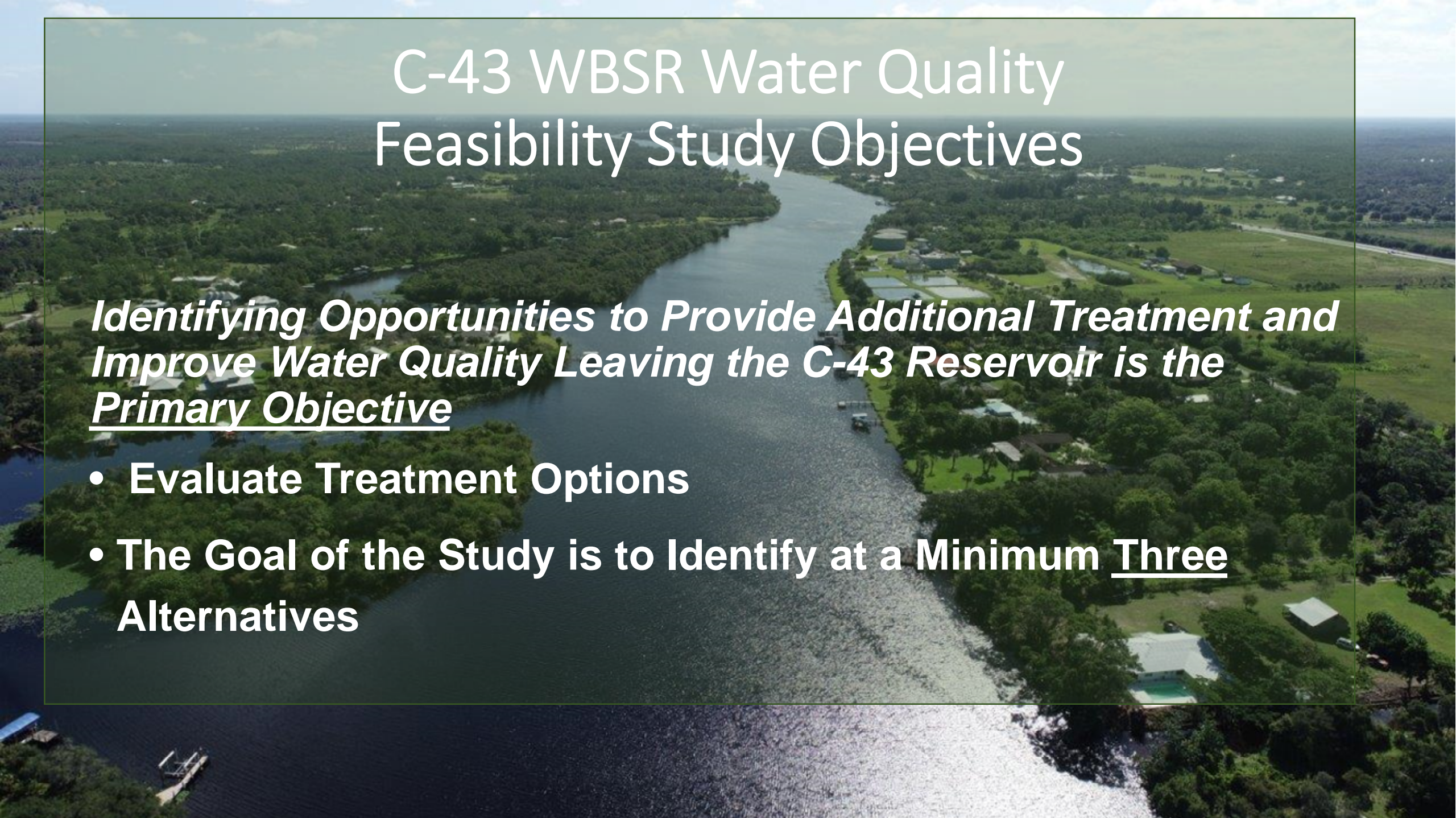
- **Red Algae Task Force**
- **Blue Green Algae Task Force**
- **Caloosahatchee BMAP & RFI**
- **Agricultural BMP's**
- **Working Group for the C-43 WBSR Water Quality Feasibility Study**
- **Technology Library**

http://fldeploc.dep.state.fl.us/tech_portal/tech_library_intro.asp

Working Group Members

- Florida Department of Environmental Protection
- South Florida Water Management District
- Hendry County
- Lee County
- City of Sanibel
- City of Cape Coral
- Lehigh Acres MSID
- J-Tech





C-43 WBSR Water Quality Feasibility Study Objectives

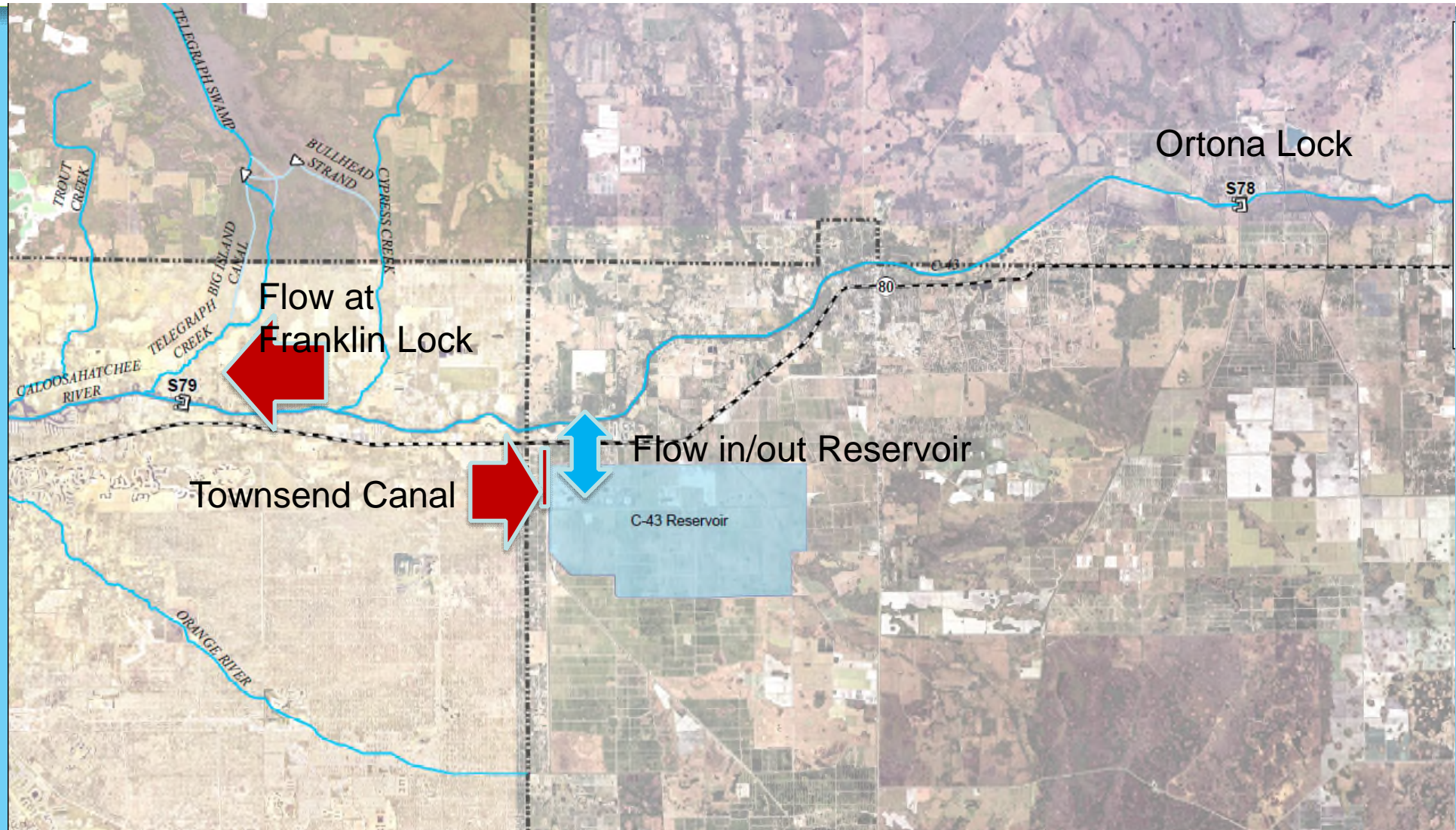
Identifying Opportunities to Provide Additional Treatment and Improve Water Quality Leaving the C-43 Reservoir is the Primary Objective

- **Evaluate Treatment Options**
- **The Goal of the Study is to Identify at a Minimum Three Alternatives**

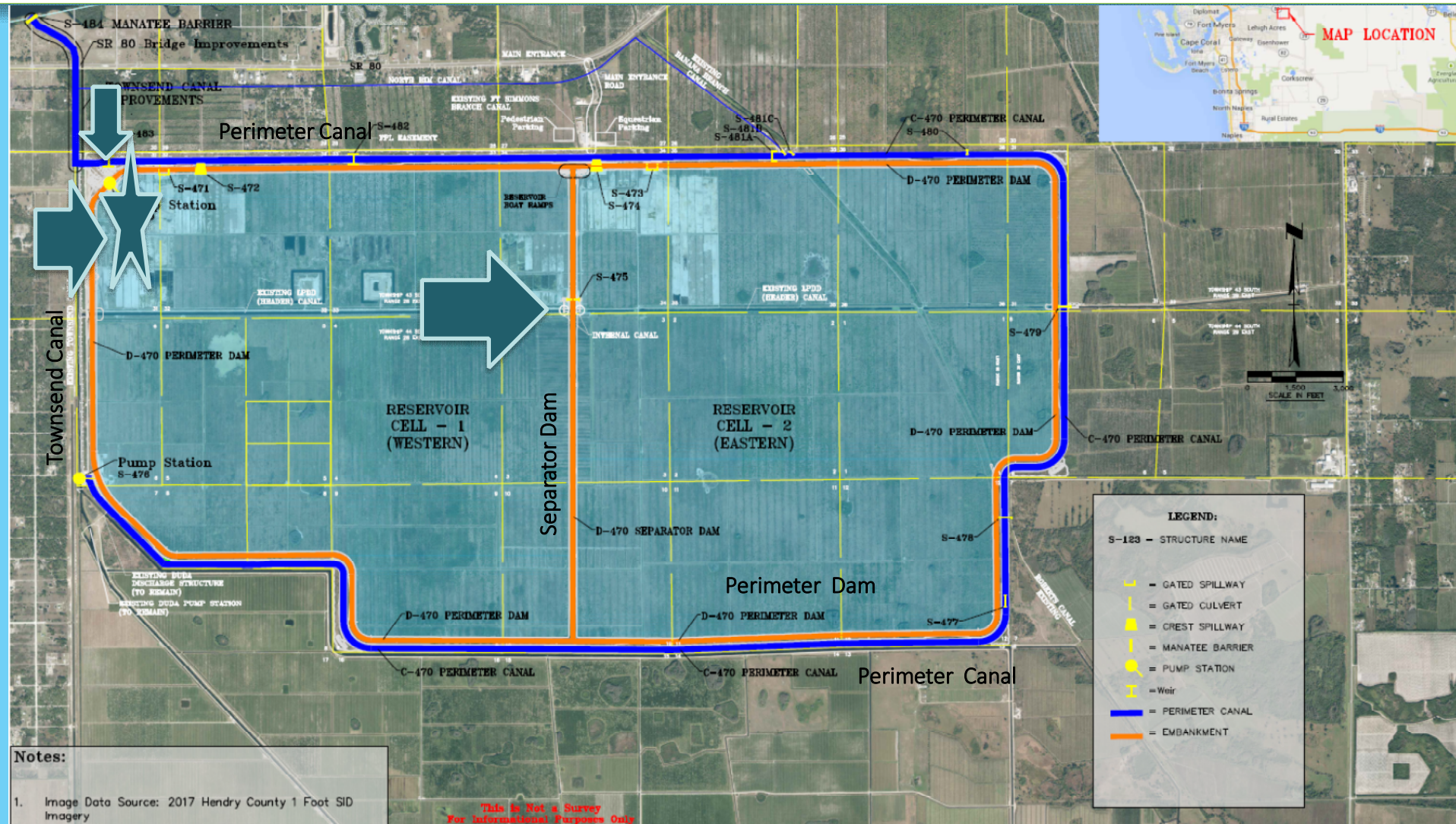
An aerial photograph of a large reservoir, identified as The C-43 Reservoir. The water is dark blue and reflects the sky. The reservoir is surrounded by lush green trees and vegetation. In the foreground, there are several small islands and peninsulas. To the right, there are some buildings and a swimming pool. The background shows a vast expanse of land with more trees and some distant structures. The sky is blue with scattered white clouds.

The C-43 Reservoir

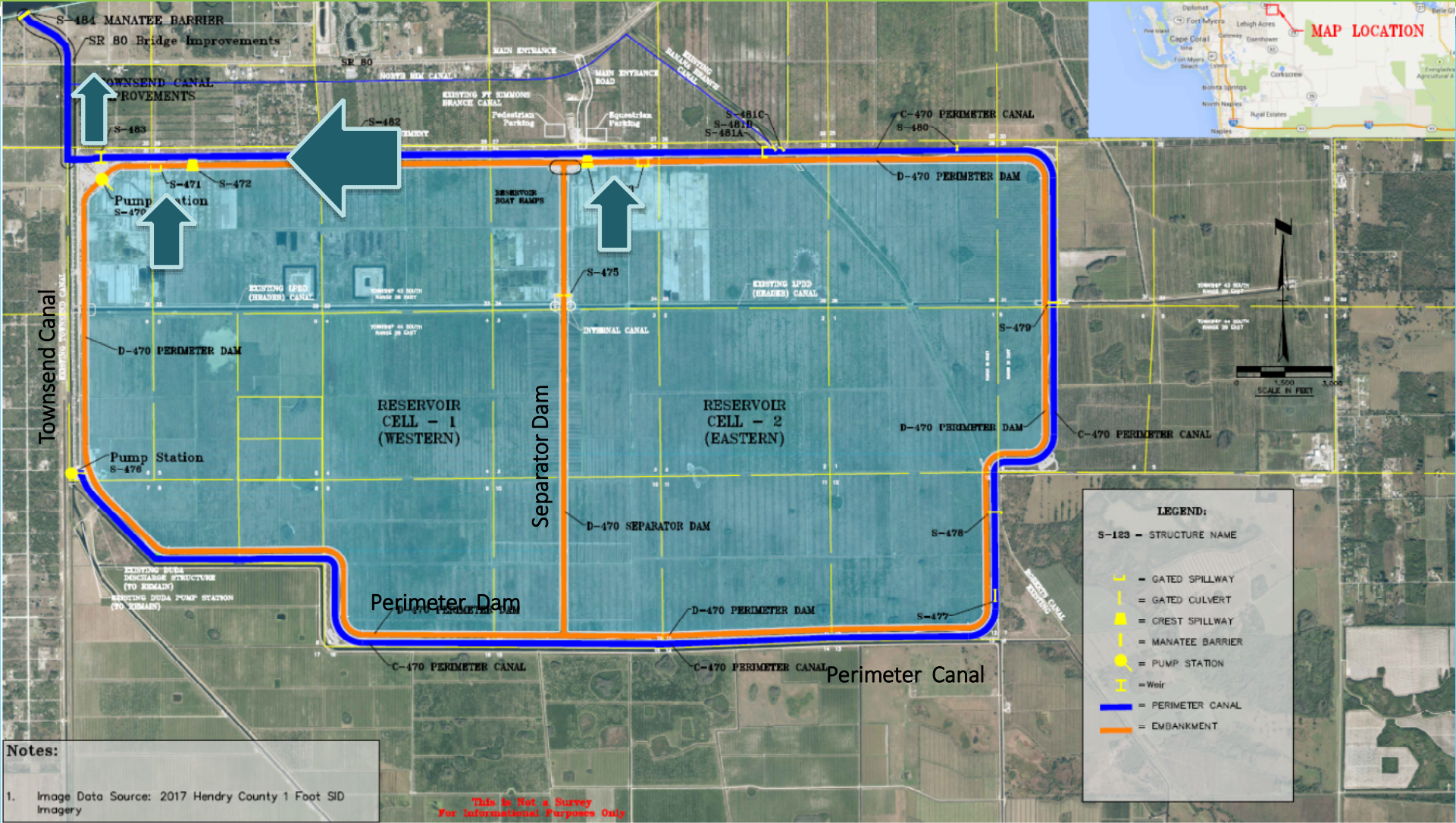
C43 Reservoir Operations



C43 Reservoir Inflow – via S470



C43 Reservoir Discharge (normal)



General Operational Notes

- **Fill during wet season**
- **Discharge during dry season**
- **Project Operations Plan Under Development**
- **MFL C43 currently between 400 – 450 cfs**
- **Inflow Capacity = 1500 cfs**
- **Normal discharge to meet MFL = 450 cfs**
- **>2500 cfs Emergency Discharge Capacity**

An aerial photograph of a wide river or canal flowing through a lush, green landscape. The river is dark blue and reflects the sky. On the left bank, there is a large, dense island of trees. On the right bank, there are several houses, a swimming pool, and a large open field. The sky is blue with scattered white clouds. The text "Study Constraints" is overlaid in the center of the image in a large, white, sans-serif font.

Study Constraints

Study Constraints

- Cannot affect the congressionally approved C-43 Reservoir project purposes, infrastructure, construction schedule, or operation.
- Project lands have not been specifically identified for the Study. Technologies will be evaluated independent of land availability
- The Study will focus on reviewed and accepted technologies included in the Florida Department of Environmental Protection (DEP) Library for Water Issues
- The C-43 Reservoir and the selected treatment component(s) are not intended to achieve compliance with the Caloosahatchee River and Estuary Total Maximum Daily Loads (TMDLs)

An aerial photograph of a wide river flowing through a lush, green landscape. The river is dark and reflects the sky. On the left bank, there is a large, dense island of trees. On the right bank, there are several houses, a swimming pool, and a large open field. The sky is blue with scattered white clouds. A semi-transparent green rectangular box is overlaid on the center of the image, containing the text "Focusing on the Study" in white.

Focusing on the Study

An aerial photograph of a wide river or canal flowing through a lush, green landscape. The river is dark and reflects the sky. On the left bank, there is a large, dense island of mangrove forest. On the right bank, there are several small buildings, a swimming pool, and more trees. In the background, the river continues to flow through a flat, green area under a blue sky with scattered clouds. A semi-transparent green box with white text is overlaid on the center of the image.

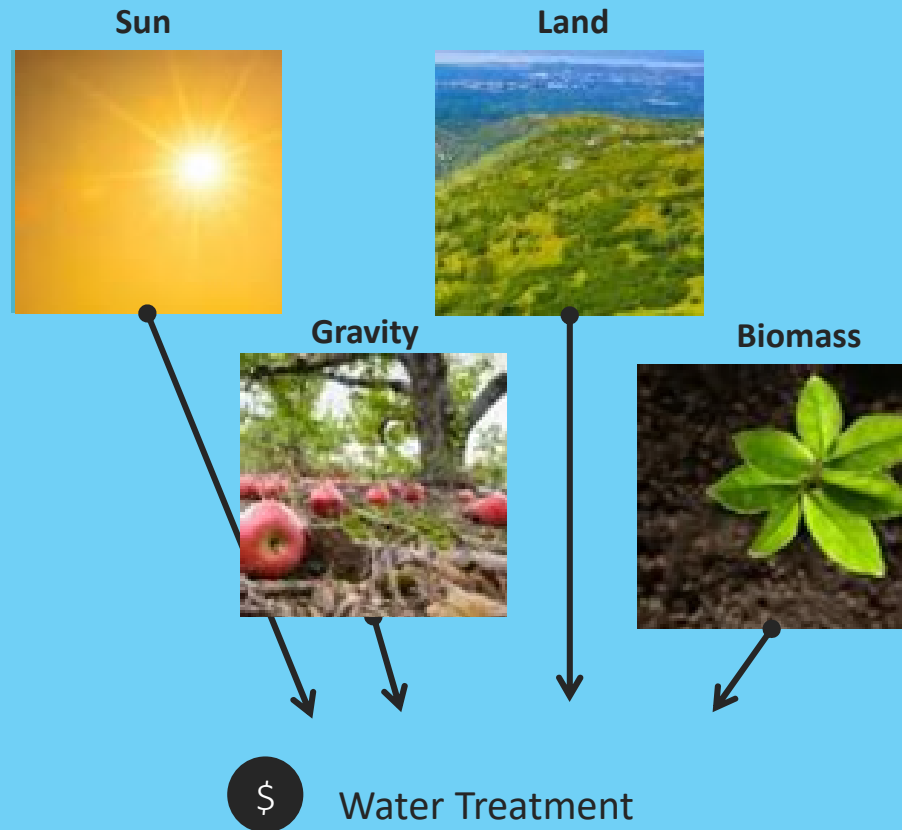
Biological, Chemical, and Physical

Treatment Focus on Nutrients

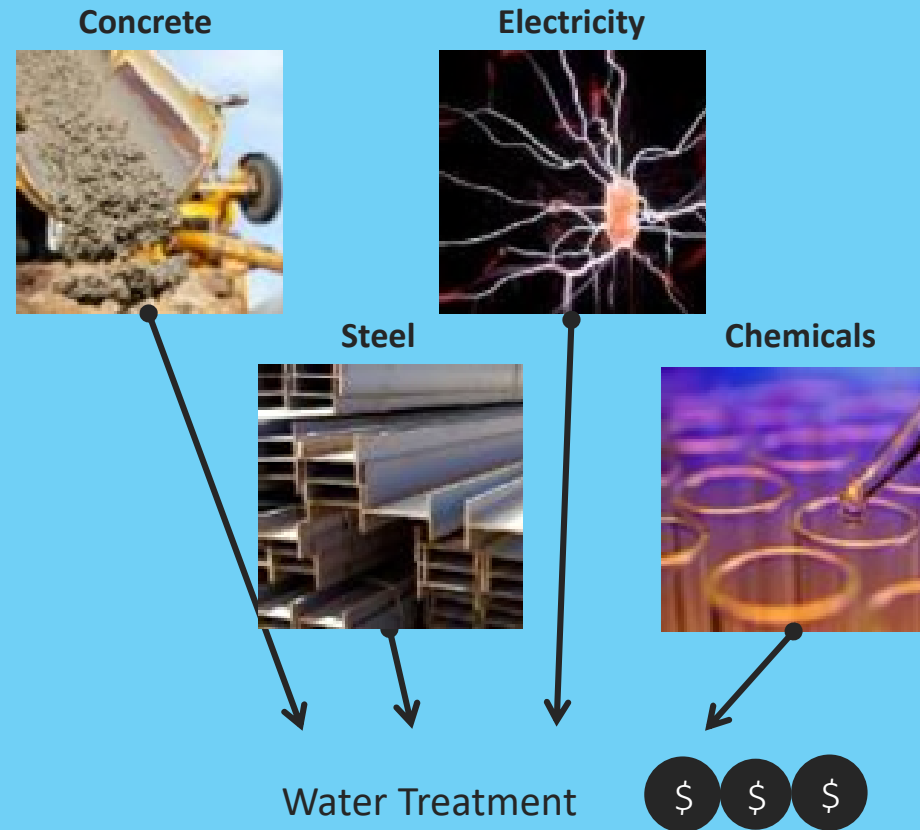
- Nitrogen
 - Dissolved Organic Nitrogen
 - Dissolved Bio-available Organic Nitrogen
 - Dissolved Inorganic Nitrogen (Ammonia, Nitrate, Nitrite)
 - Total Nitrogen
- Phosphorus
 - Particulate Phosphorus
 - Soluble Reactive Phosphorus
 - Total Phosphorus
- Suspended Solids (Algae, Particulates)

Natural and Conventional Treatment

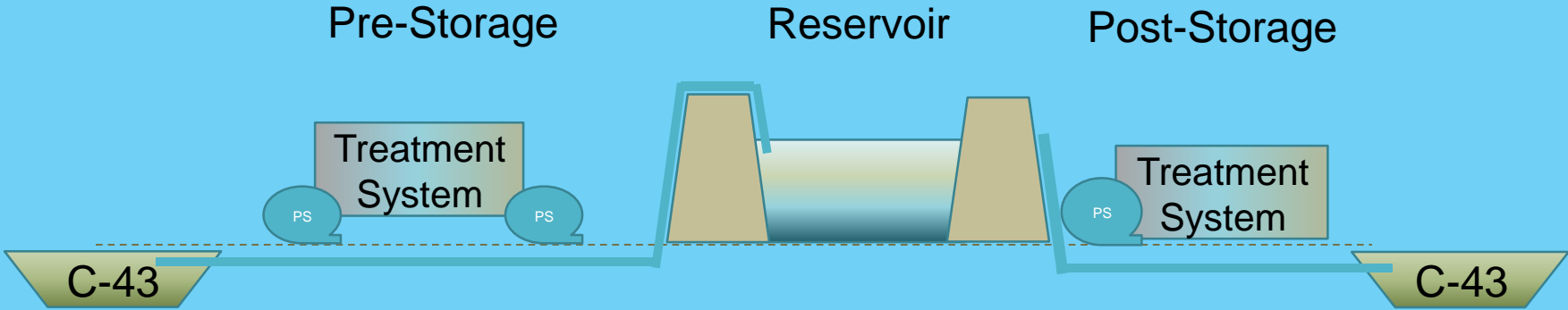
Natural Treatment Systems



Engineered (Conventional) Systems



Treatment Placement: Conceptual Configurations



Stand Alone or in Combination:

	Pre-Storage		Reservoir			Post-Storage	
Physical	Sand Filtration	Membrane Seperation	Aeration	Oxygenation	Recirculation	Sand Filtration	Membrane Seperation
Chemical	Coagulation/ Flocculation	Electro- coagulation	Coagulation/ Flocculation	Nutrient Inactivation		Coagulation/ Flocculation	Electro- coagulation
Biological	Treatment Wetland		Treatment Wetland	Floating Wetland Islands		Treatment Wetland	

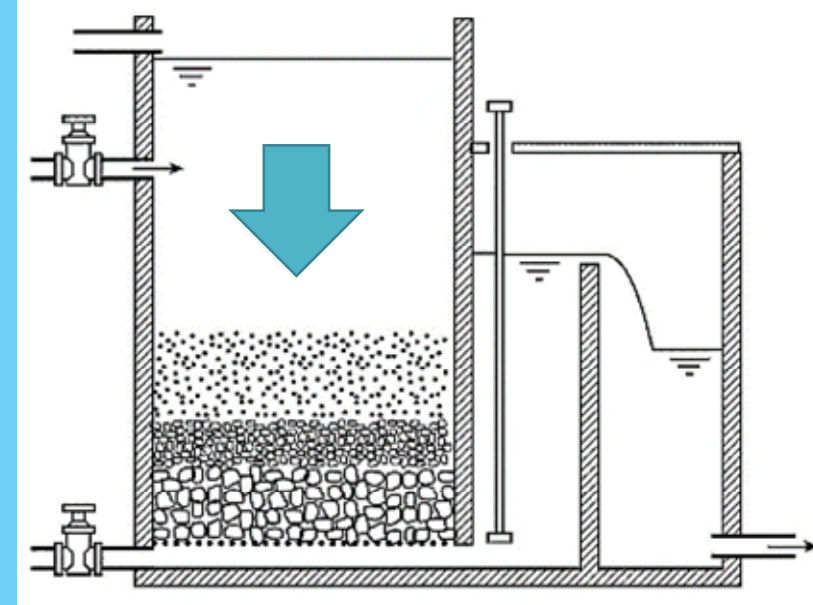
Physical Process Technology: Media Filtration

Separates Algae and Nutrients

Sand Filter



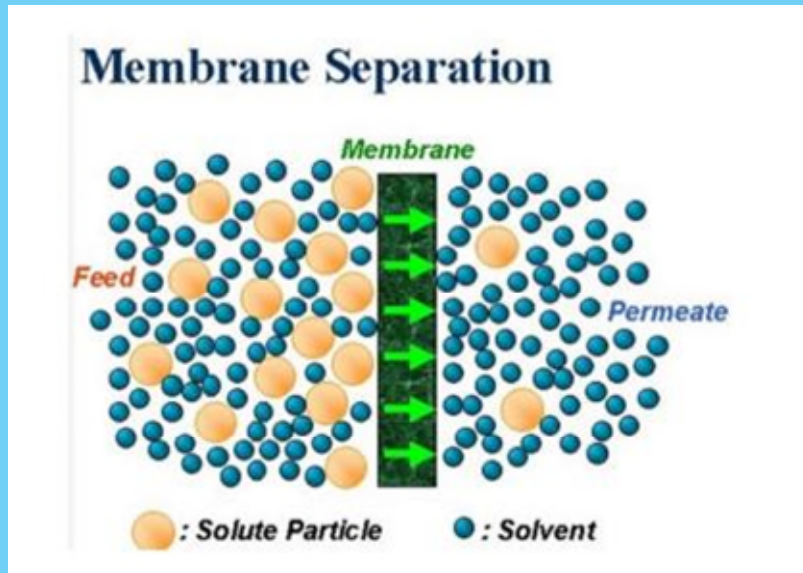
42 cfs Outfall D-002 Sand Filter, Mosaic Co, FL



Physical Process Technology: Membrane Filtration

Separates Algae and Nutrients

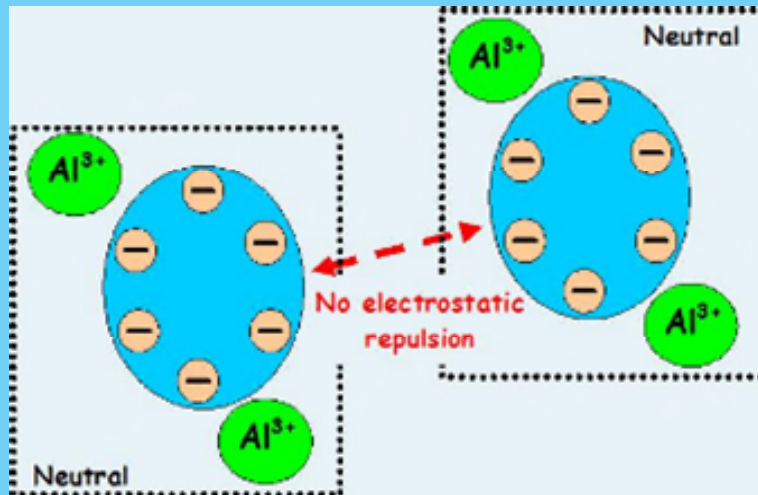
Membrane Filtration



154 cfs Twin Oaks Valley WTP, San Diego,
CA

Chemical Process Technology: Coagulation/Flocculation/Sorption/Sedimentation *Separates Algae and Removes Nutrients*

Chemical Coagulation, Flocculation and Sedimentation



Chemical Removal Technologies:

Wide Variety of Compounds Available

Examples (Tested by SFWMD)

1. Aragonite
2. ElectroCoagulation™
3. Phoslock®
4. STI
5. ViroPhos™
6. WP-1™
7. Ferrate
8. AquaLutions™
9. WP-1™
10. Nclear®

EXAMPLE: AquaLutions™@S-78

	TP (mg/L)	TN (mg/L)	DON (mg/L)
Inflow	0.115	1.791	1.142
Outflow	0.005	0.799	0.456
% CR	96%	55%	60%

Chimney et al. 2013



Phoslock®

STI

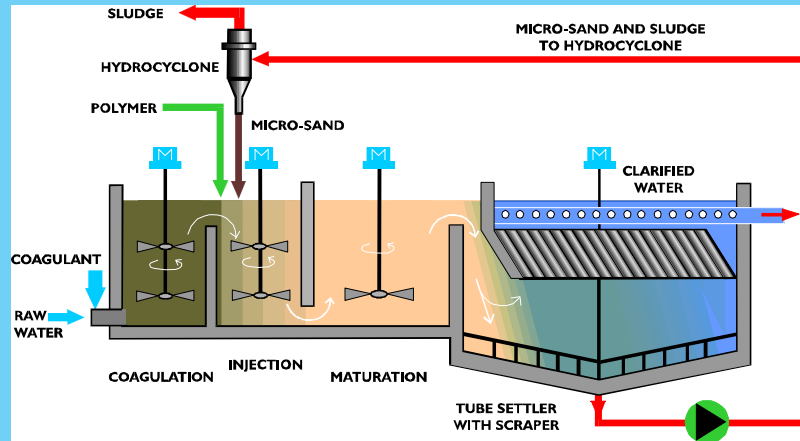
ViroPhos™

WP-1™

Chimney et al 2013

Chemical Process Technology: Coagulation/Flocculation/Sedimentation *Separates Algae and Removes Nutrients*

Chemical Coagulation and Sedimentation



116 cfs L. B. Stovall Water Treatment Plant,
Greenville, SC

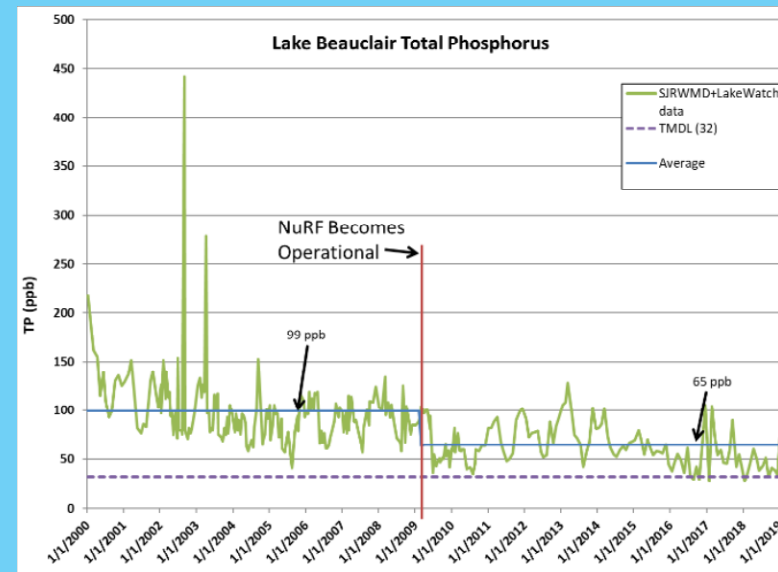
<https://www.tpomag.com/>

Chemical Process Technology: Coagulation/Flocculation/Sedimentation *Separates Algae and Removes Nutrients*

Lagoon-based Alum Treatment



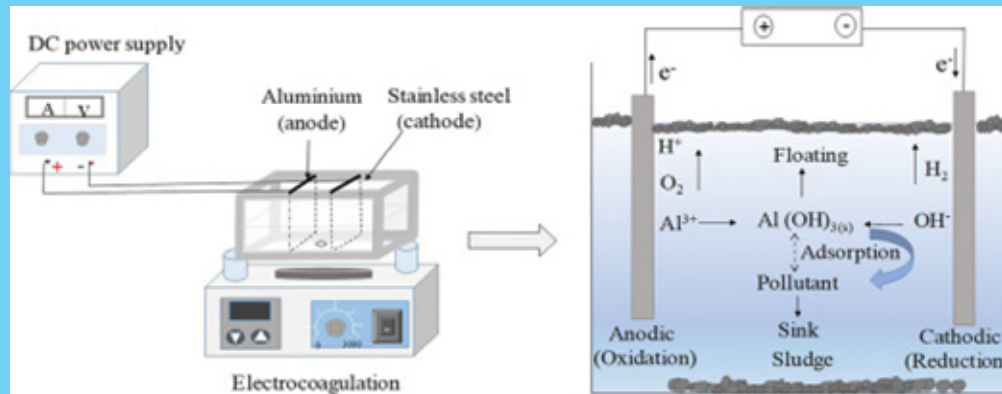
300 cfs Nutrient Reduction Facility (NuRF),
Lake County FL



<https://www.lcwa.org>

Chemical Process Technology: Coagulation/Flocculation/Sedimentation *Separates Algae and Removes Nutrients*

Electro-coagulation



Powell Water Systems

Biological Process Technology

Separates Algae and Removes Nutrients

Treatment Wetlands



STA

Managed Aquatic Plant
Systems (Floating Treatment
Wetlands)



Jacobs Engineering Group

In-Reservoir Treatment

Limits Nutrient and Light Availability to Algae

Aeration/Destratification



1,100 acres, 15.5 billion gallons
C B Young Reservoir, Tampa Bay Water, FL

Nutrient Inactivation



Alum Application

In-Reservoir Treatment

Decrease Algal Population

Ultrasonication



www.LGSonic.com

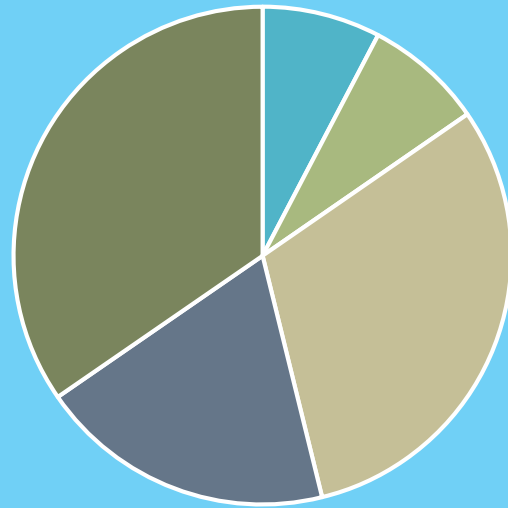
Algistat/Algicide Application



PAK 27 Application

FDEP Accepted Water Treatment Technologies

27 Physical, Chemical and Biological Treatment Methods



- Sorption
- Sedimentation
- Filtration
- Biological
- Coagulation

DEP - Technology Library

Division of Environmental Assessment and Restoration Division of Water Resource Management

Technology Library for Water Issues

The following technology proposals have been reviewed and accepted by DEP.

Division/Program: Water Category (if DWM): Keywords:

ID	Company (Website)	Primary Applicant (Email)	SecondaryRequest Applicant (Description) (Email)	Reviewer (Email)	Finalized
1900	Environment21	Mitchell Moran	Environment21 StormPro Florida Technology Library Application	James Landini	21-May-2019
1865	Bio Clean Environmental	Zachariha Kent	Kraken Filter - Stormwater BMP Application	James Landini	07-May-2019
1847	AquaShield, Inc.	Mark Miller	Aqua-Filter Stormwater	James Landini	16-Apr-2019

Highlights

[Program Description](#)

- [Search Accepted Technologies](#)
- [In-House Technology Requests](#)

Division Applications

- Water**
 - [Application Form](#)
 - [Application Instructions](#)
 - [Accepted Technologies](#)
 - [In-House Requests](#)
- Waste**
 - [Program Description](#)
 - [Application Form](#)
 - [Application Instructions](#)
 - [Accepted Technologies](#)

http://fldeplc.dep.state.fl.us/tech_portal/

Technology Evaluation *Criteria*

Selection Criteria Categories

- Performance
 - ✓ *Proven results*
 - ✓ *Florida specific data validating results of the technology*
 - ✓ *Cannot cause harm*
- Cost
- Physical Requirements
- Administrative

Technology Evaluation

Next Steps

Selection Criteria Categories

- Performance
 - ✓ *Proven results*
 - ✓ *Florida specific data validating results of the technology*
 - ✓ *Cannot cause harm*
- Cost
- Physical Requirements
- Administrative

Technology Evaluation

Next Steps

Selection Criteria Categories

- Performance
 - ✓ *Proven results*
 - ✓ *Florida specific data validating results of the technology*
 - ✓ *Cannot cause harm*
- Cost
- Physical Requirements
- Administrative

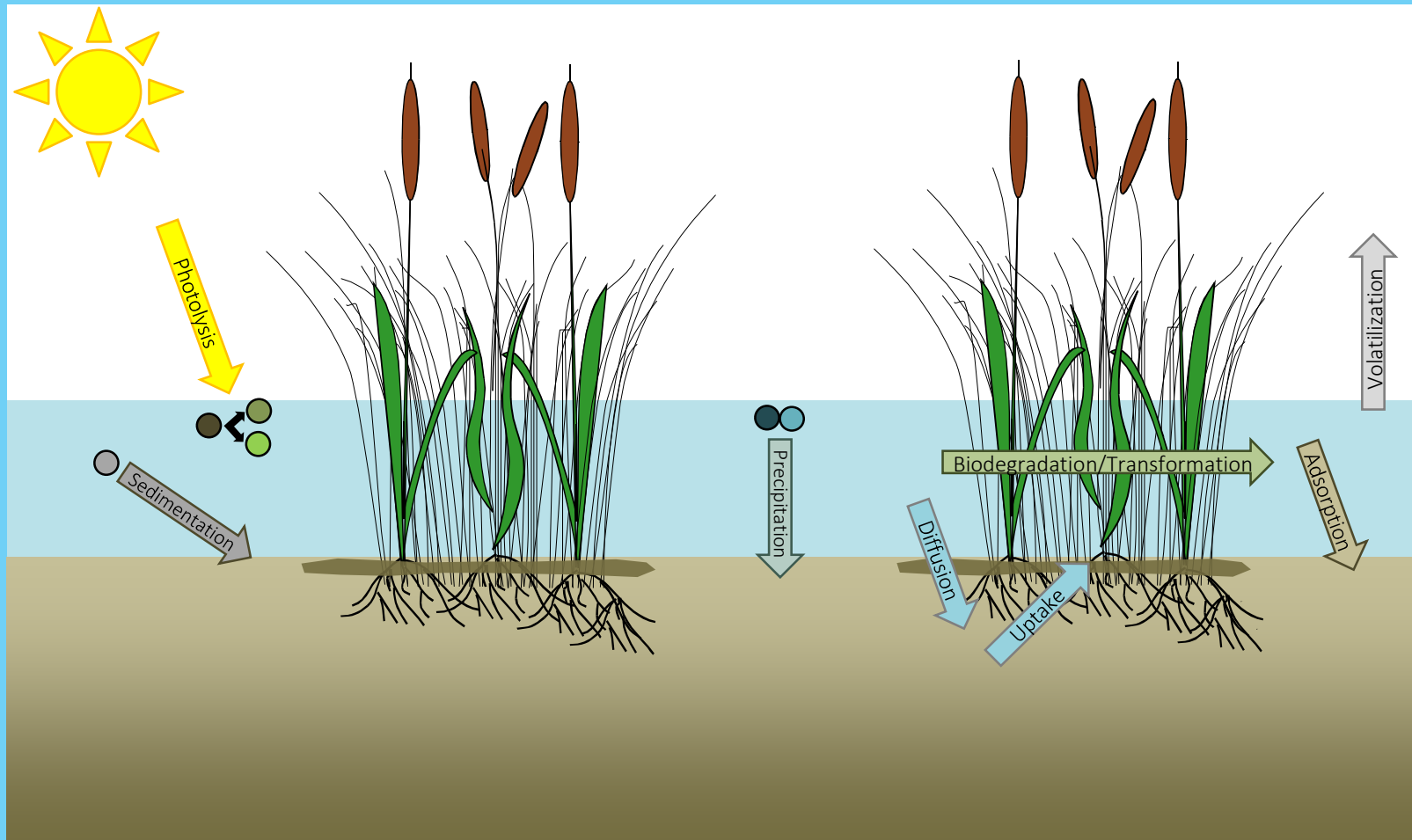
Next Steps

- Research
- Data Evaluation
- Preliminary Ranking
- Final Ranking
- Recommendations

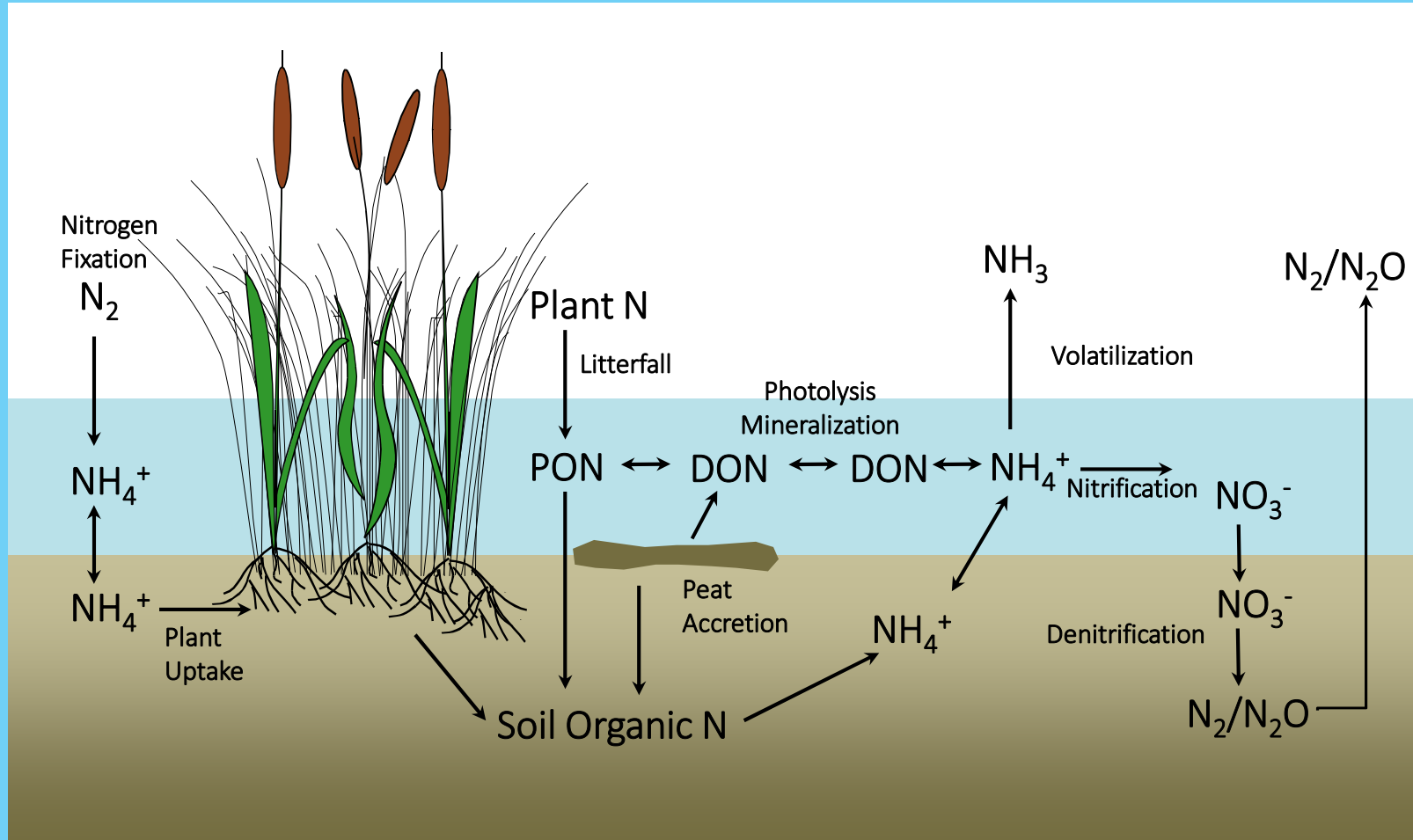
An aerial photograph of a wetland area. A large, dark body of water occupies the lower half of the frame. To the left, there is a large, dense green island. To the right, there is a shoreline with some residential structures, including a house with a white roof and a pool. The background shows a vast expanse of green wetland under a blue sky with scattered clouds.

Wetland Treatment and STAs

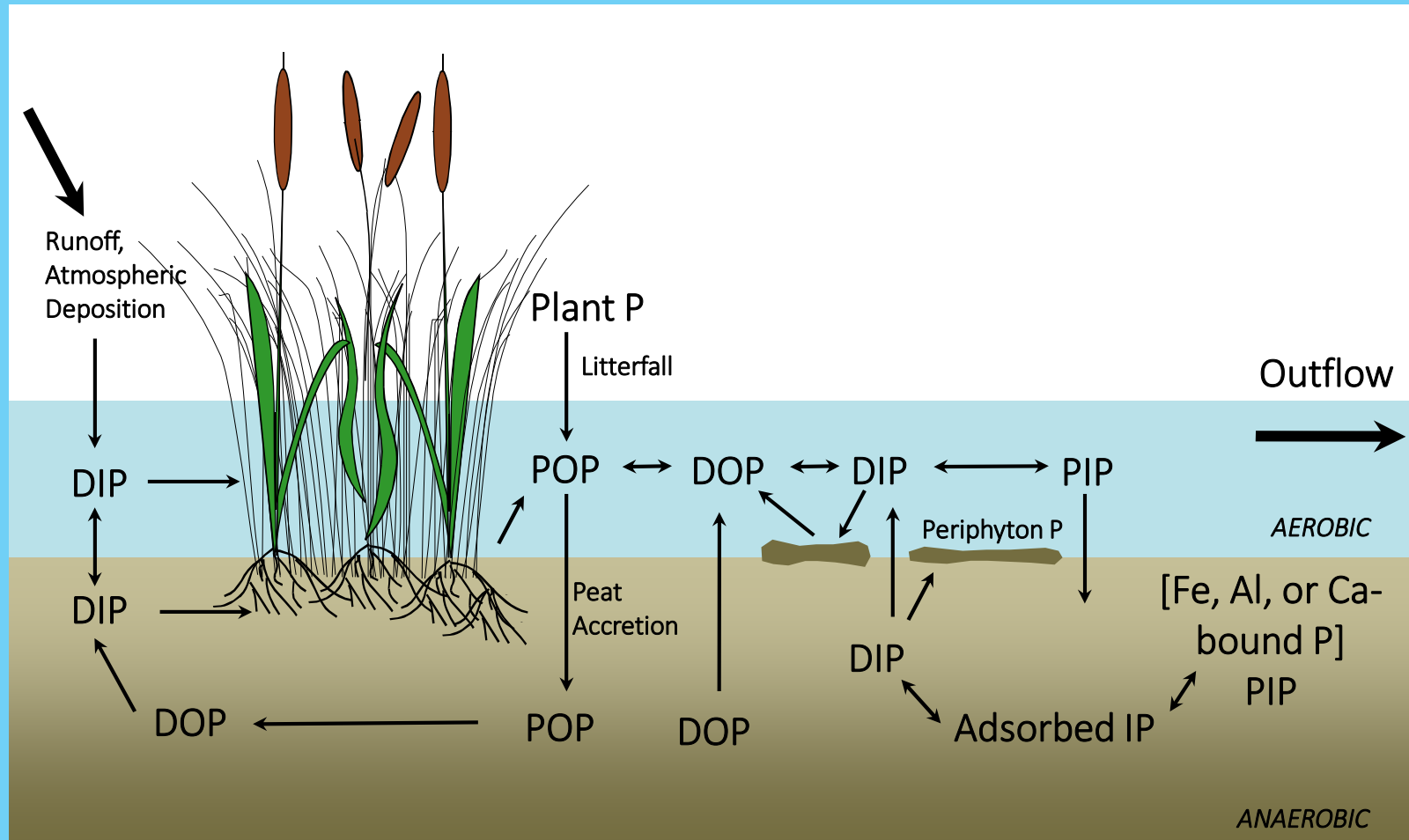
Wetland Water Quality Processes



Wetland Nitrogen Cycle



Wetland Phosphorus Cycle



Treatment Wetland Plant Communities



Floating Aquatic Vegetation (FAV)



Emergent Aquatic Vegetation (EAV)

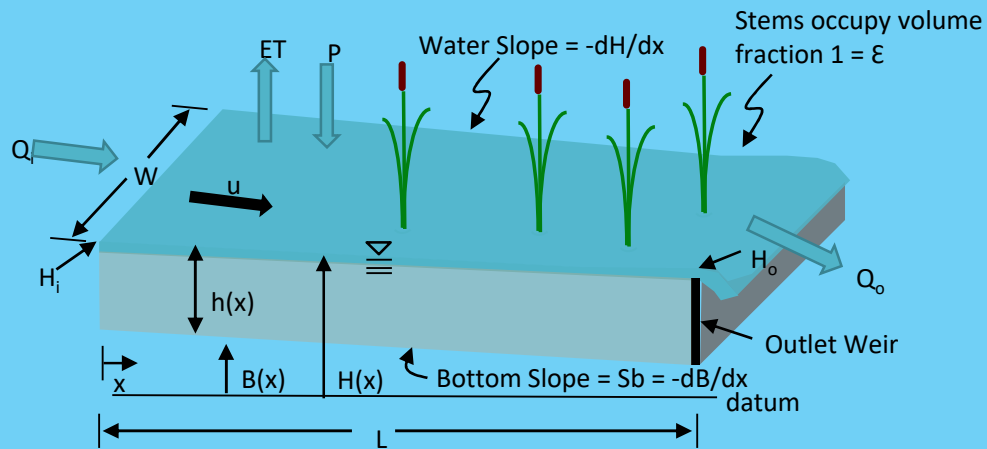
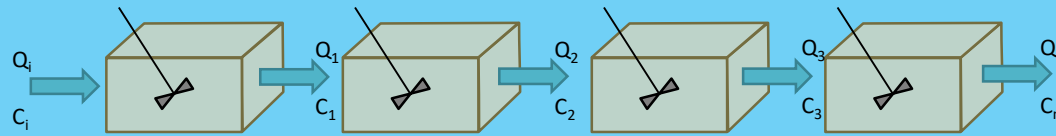


Submerged Aquatic Vegetation (SAV)



Periphyton

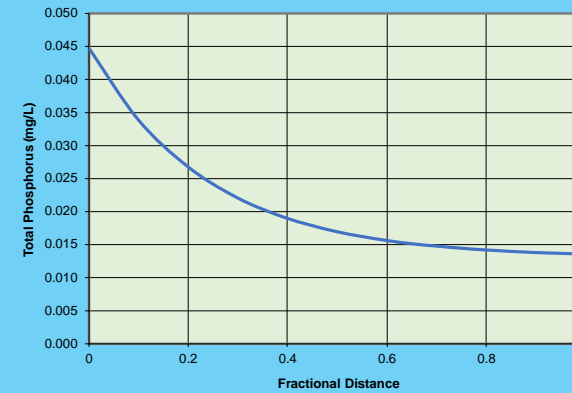
Treatment Wetlands are Engineered Systems



P-k-C* Model
(Kadlec and Wallace 2009)

$$\left(\frac{C_2 - C^*}{C_1 - C^*} \right) = \left(1 + \frac{k}{Pq} \right)^{-P}$$

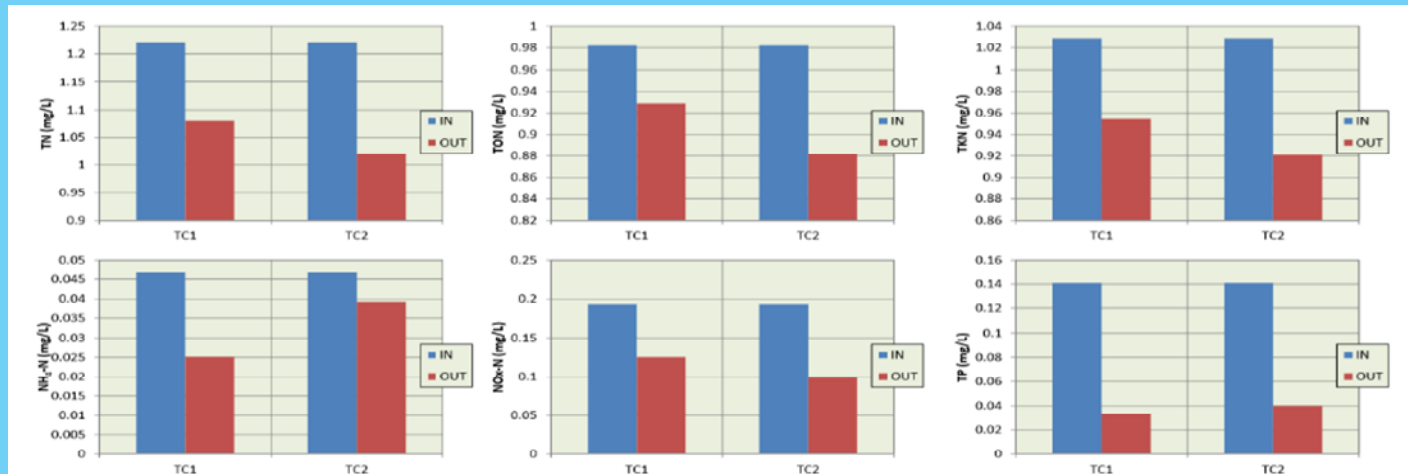
C_1 = inflow concentration (mg/L)
 C_2 = outflow concentration (mg/L)
 C^* = background concentration (mg/L)
 k = 1st order rate coefficient (m/yr)
 P = apparent number of tanks-in-series
 q = hydraulic loading rate (m/yr)



C-43 West Storage Reservoir Test Cell Water Quality (2007)

Concentration Reductions

- ❖ TN 14%
- ❖ TP 74%



C-43 WQTTP Mesocosm Study (2019)



Final Project Report *Deliverable 8.3*

C-43 Water Quality Treatment and Testing Project (C43-WQTTP) – Phase 1

Prepared for
South Florida Water Management District



Date
July 9, 2019

Prepared by
J-Tech in association with Wetland Solutions, Inc.



C-43 WQTTP Mesocosm Study (2019)

Objectives: test wetland based strategies to demonstrate removal of nitrogen, especially DON, from the C-43 Canal

- ❖ What vegetation community will provide best treatment performance for TN and DON?
- ❖ What contribution will on-site soils have on nitrogen uptake and release?
- ❖ What hydraulic loading rate (HLR) will result in the most efficient nitrogen removal rate?

C-43 WQTTP Mesocosm Study (2019)

Preliminary Results:

- ❖ TN: 23% concentration reduction and 33% mass reduction
- ❖ DON: comprised 68% of source water TN
- ❖ DON reduction better in wet season (14%) than dry season (4%)
- ❖ Some DON converted to BDON and removed
- ❖ DIN removal greater than 90%
- ❖ TN removal similar between plant communities
- ❖ TP removal greater than 75% (SAV better than EMV)

NTS and the C-43 Feasibility Study

Objectives:

- ❖ Summarize past C-43 studies
- ❖ Evaluate water quality benefits of regional projects
 - ✓ Lee County
 - ✓ Sanibel
 - ✓ Lehigh Acres
- ❖ Develop conceptual plans and cost estimates

An aerial photograph of a wide river flowing through a lush, green landscape. The river is dark and reflects the sky. On the left bank, there are dense trees and some small structures. On the right bank, there are more trees, a few houses, and a swimming pool. In the background, the river continues to flow, and the land is covered in dense vegetation. The sky is blue with some clouds.

Next Steps



<https://www.sfwmd.gov/content/c-43-west-basin-storage-reservoir-water-quality-feasibility-study-working-group>

Future Public Meetings

Date	Time	Location
January 10, 2020	2pm-4pm	Hendry County Extension Office, 1085 Pratt Blvd, LaBelle, FL 33976
March 25, 2020	6pm-8pm	SW Florida Community Foundation Collaboratory, 2031 Jackson Street, Suite 100, Fort Myers, FL 33901
July 16, 2020	2pm-4pm	SW Florida Community Foundation Collaboratory, 2031 Jackson Street, Suite 100, Fort Myers, FL 33901



Engaging the Feasibility Study Working Group