Use of Wetlands for Stormwater and Wastewater Treatment




Speakers
Jim Bays/ CH2M HILL
Larry Schwartz/ SFWMD
Chris Keller/Wetland Solutions Inc.

Florida Chamber's

2014 Environmental Permitting Short Course

Marco Island Florida

July 24-25 2014

Topic Briefings

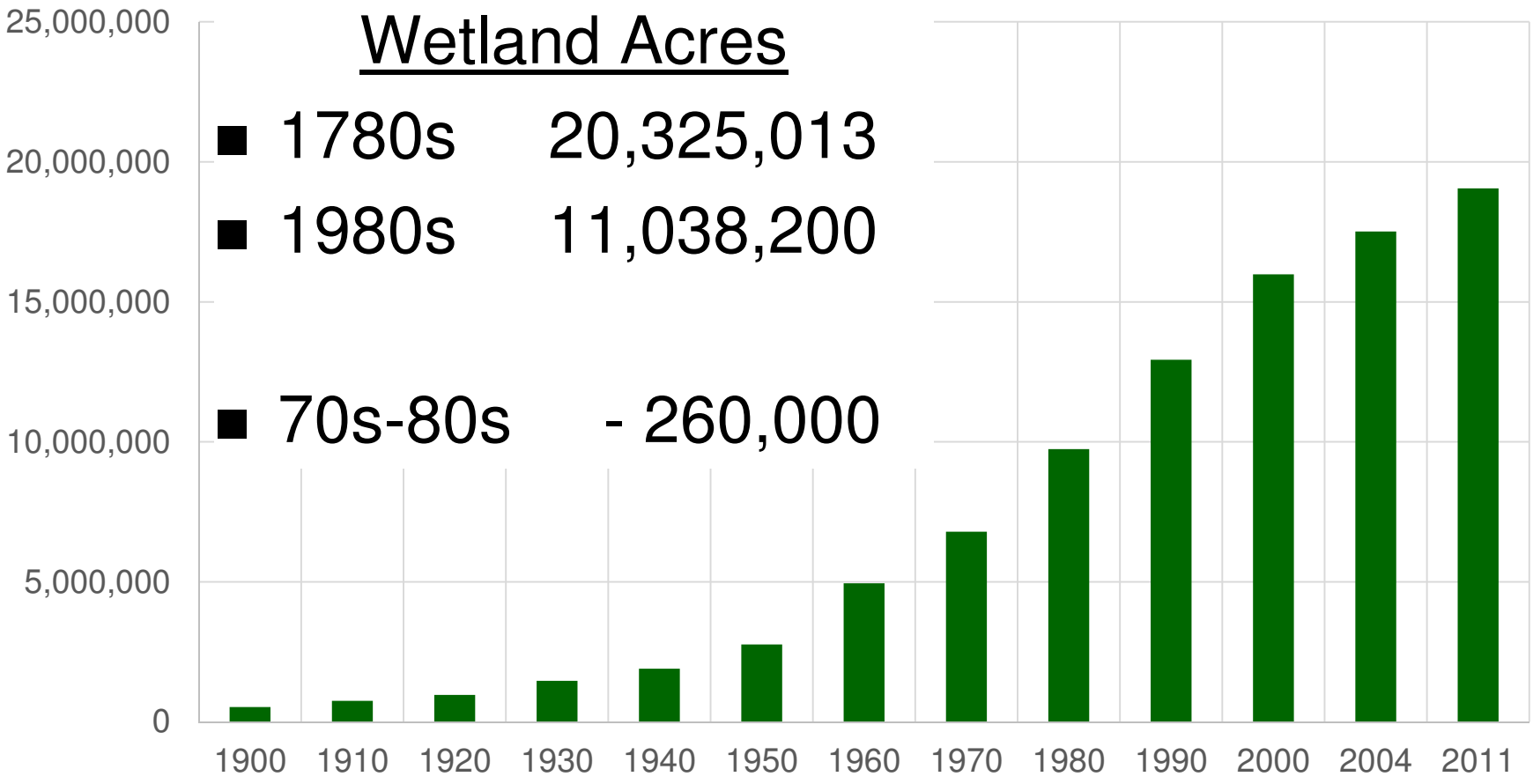
- ✓ Treatment Wetlands
  - ✓ Jim Bays/CH2MHILL
- ✓ Stormwater Wetlands
  - ✓ Chris Keller/Wetland Solutions Inc.
- ✓ Wetland Application Rule and Everglades Science Plan Overview
  - ✓ Larry Schwartz/SFWMD
- ✓ Q&A

Copies of presentations on Conference Web Site

Treatment Wetlands

- Design Overview
  - Ecological Basis
  - Sizing
  - Hydrology and Hydraulics
  - Planting Design
  - Public Use
  - Operation and Maintenance
- Selected Case Histories and New Applications

Florida 46% Historic Wetland Loss in Response to Population Growth



http://www.epa.gov/owow/wetlands/vital/epa_media/usa.gif

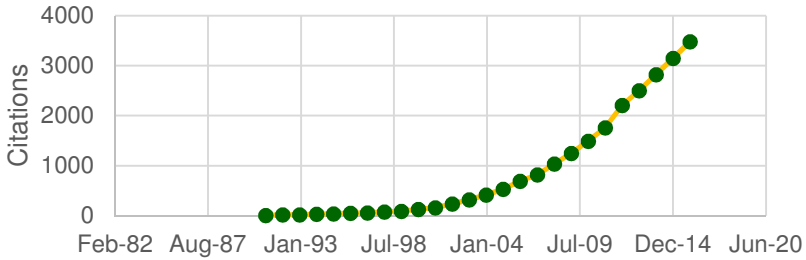
Legislation Counters Wetland Losses Using Effluent and Stormwater As Wetland Water Source

- Experimental Exemption for Wastewater Recycling 1979
- Warren Henderson Act 1984 (ERP)
- Wetlands Application Rule 1986
- Everglades Forever Act 1994
- Reuse Rule 1989 (last update 2007)
  - 10 systems, 33.4 mgd, 5440 acres (FDEP 2014)

http://www.dep.state.fl.us/water/wastewater/dom/wetmap.htm

Wetlands for Water Treatment: Florida Origins and History

- 1970s
  - Center for Wetlands (**Odum**)
  - Houghton L MI (Kadlec)
- 1980s
  - Arcata Marsh CA
  - **1984 – Henderson Act**
  - **1986 – Wetlands Application Rule**
  - 1987 – Lakeland, Orlando
- 1990s
  - EPA: TW Data Base
  - SFWMD: **EFA**, ENRP
  - SJRWMD: L Apopka Flow-way
  - SWFWMD: Rushton research
- 2000s –Implementation



Definitions

Wetland:

- An ecosystem characterized by extended periods of ***saturation***, resulting in ***hydric soils*** and dominated by ***vegetation*** adapted to such conditions

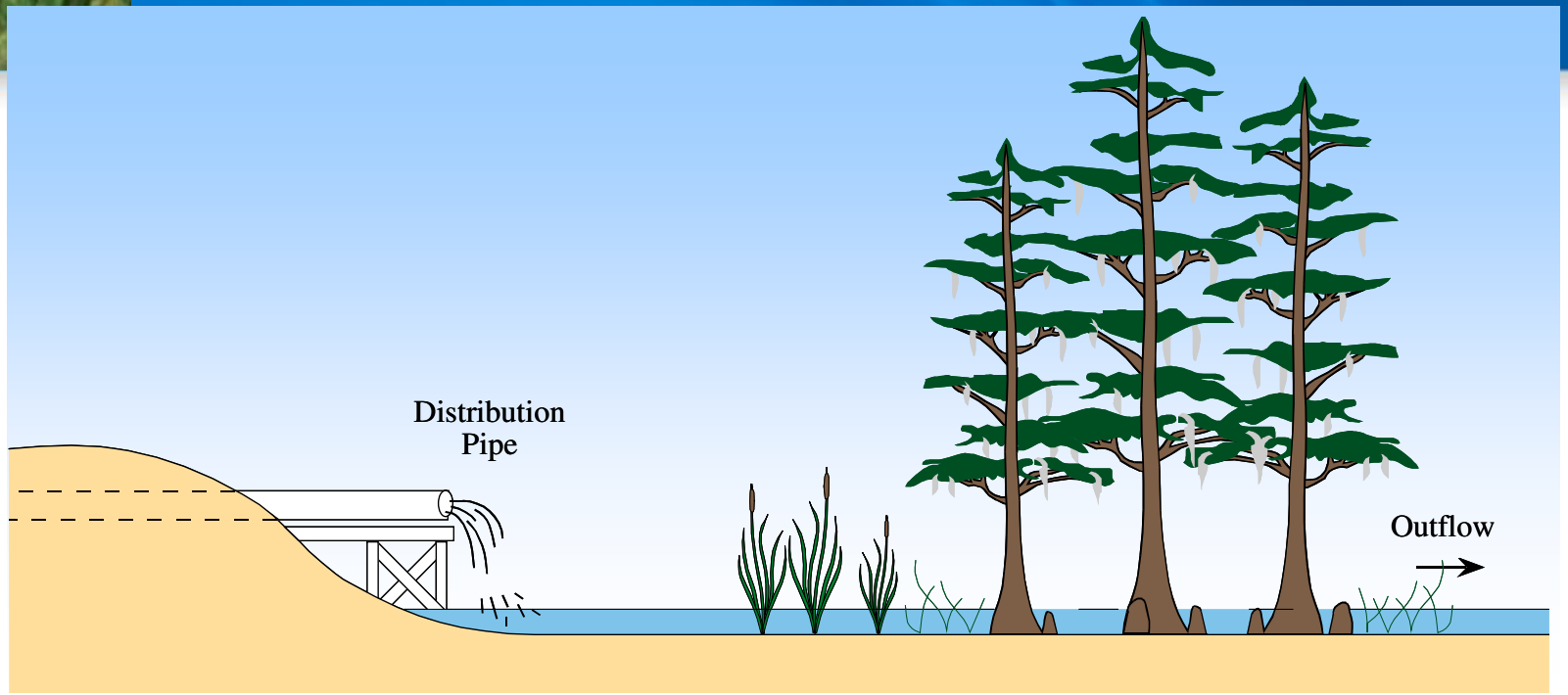
Constructed wetland:

- a ***manmade*** system designed to replicate the physical and ecological components of a natural wetland ecosystem

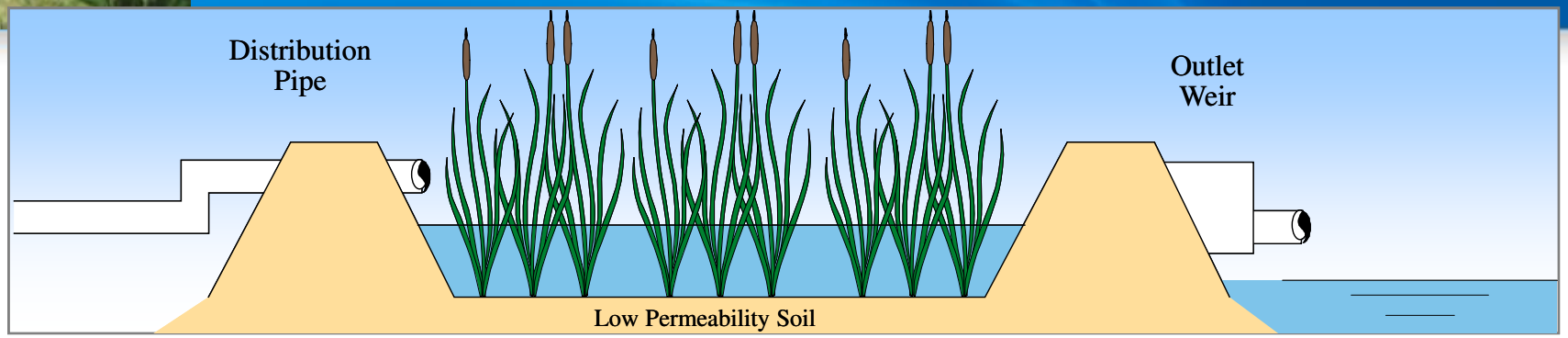
Treatment wetland:

- a ***natural or constructed*** wetland system engineered to ***reduce contaminants*** from water

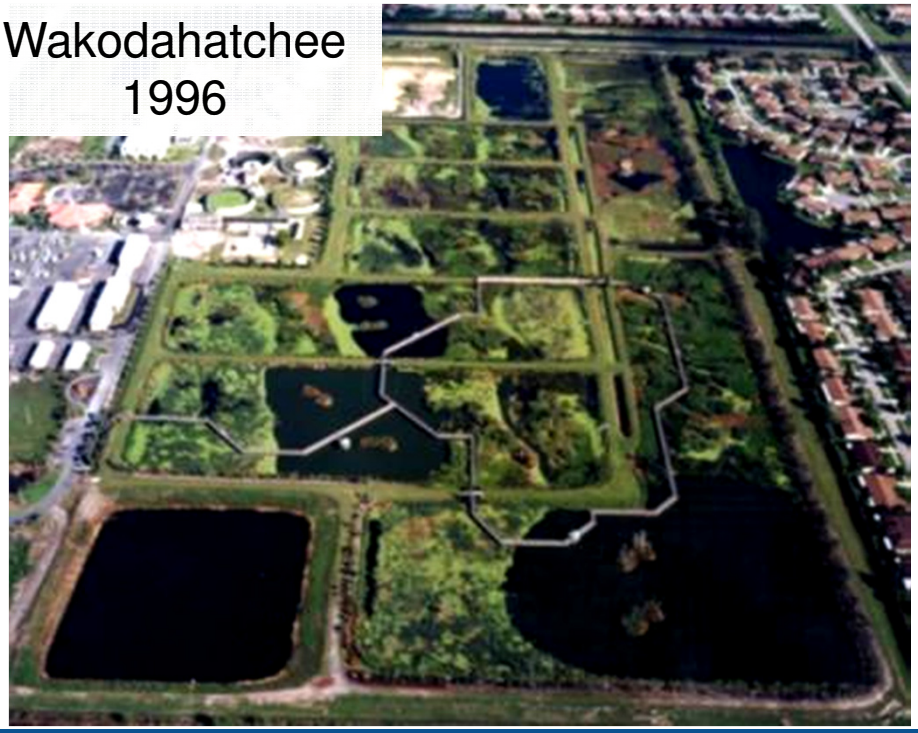
Natural Wetlands for Treatment



Surface Flow Constructed Wetlands

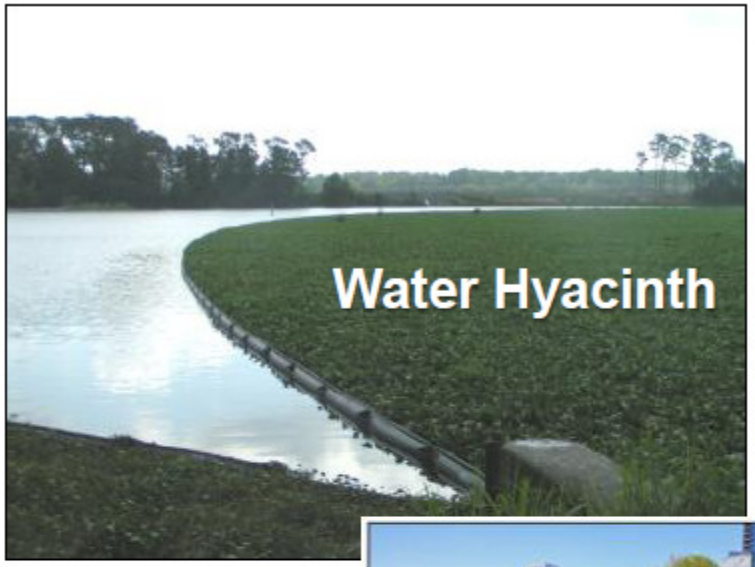


Wakodahatchee
1996



Other Natural Treatment Systems

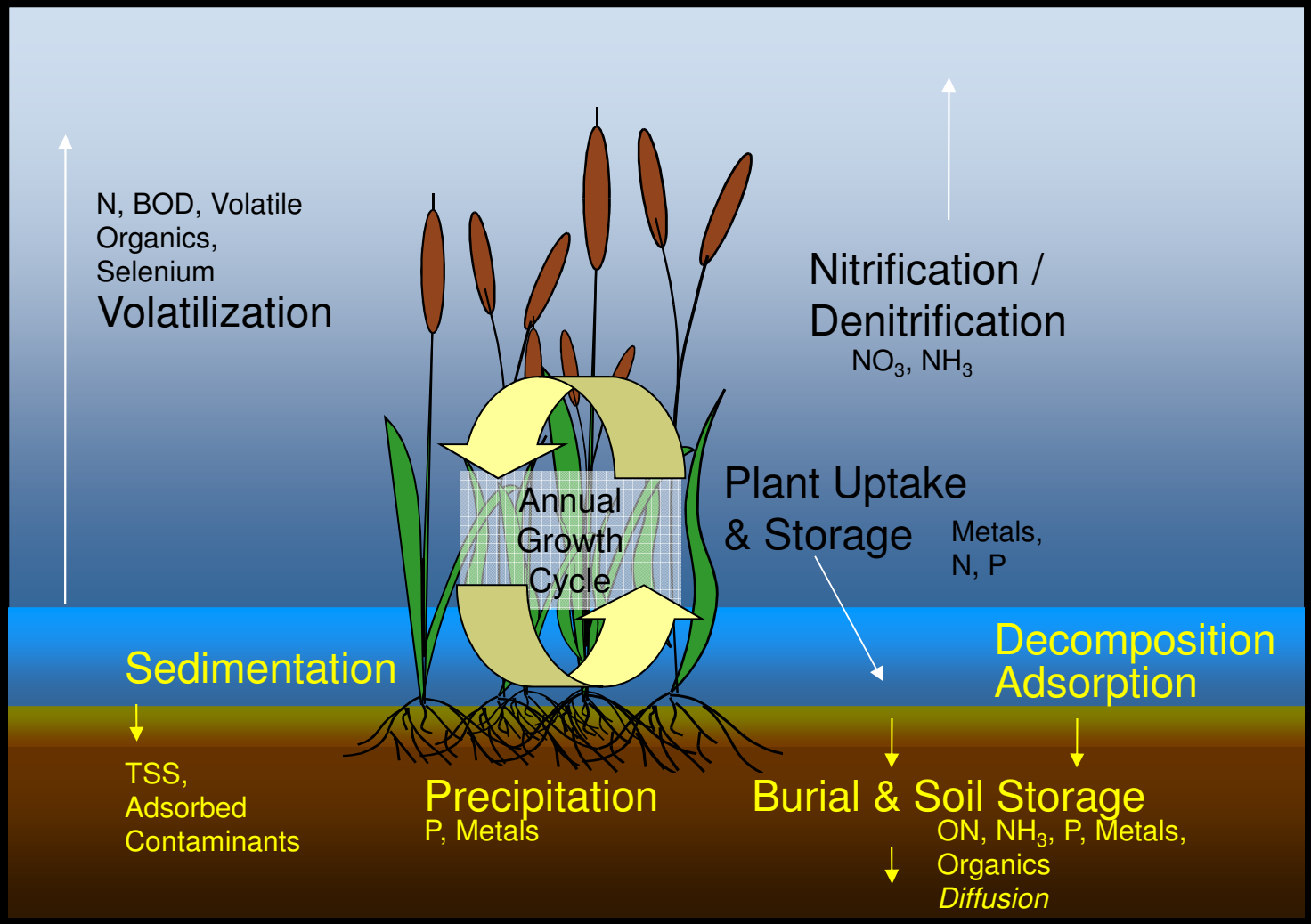
Floating Aquatic Plant Systems



Floating Wetland Islands

Periphyton/SAV

Wetlands Affect Water Quality Naturally

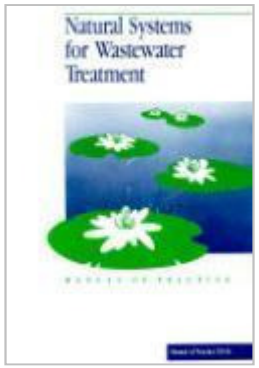


Surface Water

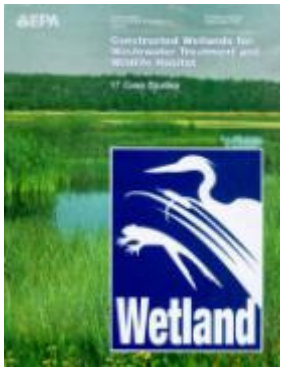
Detritus

Sediments

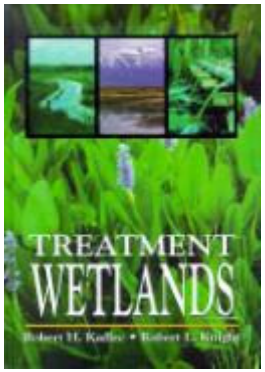
Steady Progress in Treatment Wetlands Design



1989

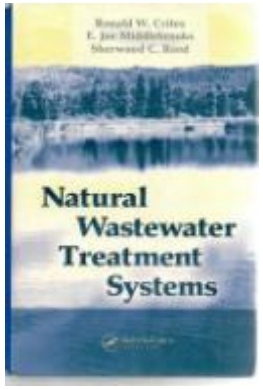


1993

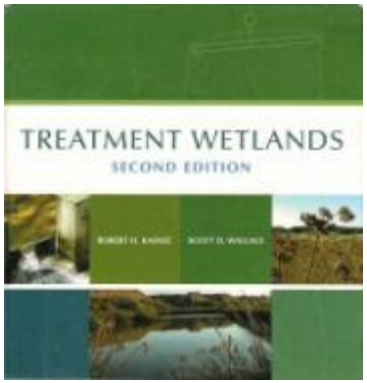


1996

2000



2006

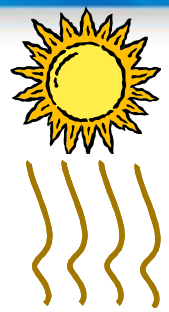


2009

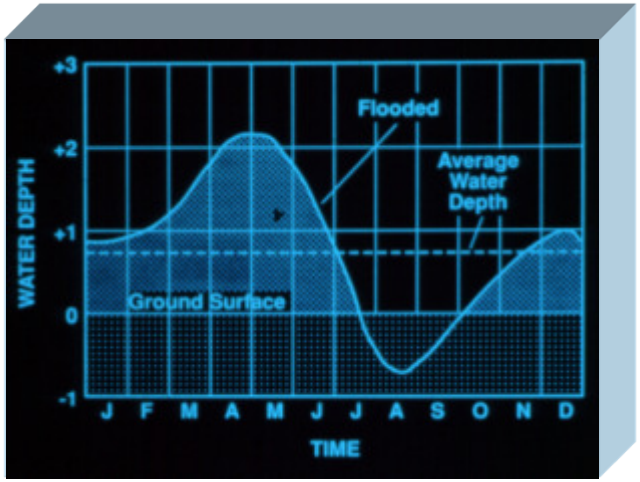
Annual South Florida Environmental Report

1990 2000 2010

A Preliminary Water Balance Is Needed to Ensure Adequate Water to Maintain Wetlands



Pumped or GravityInflow



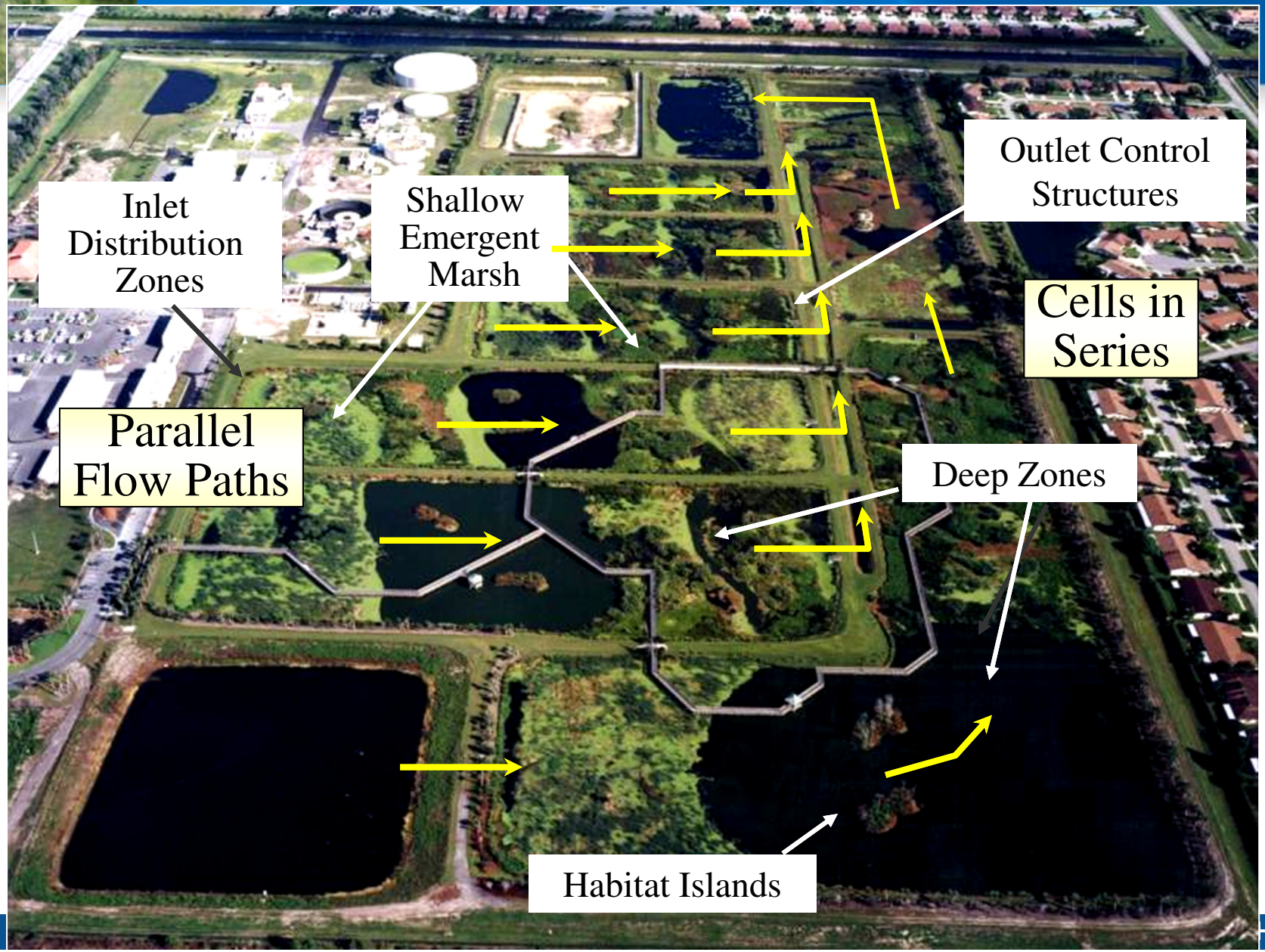
Pumped or Gravity Outflow

Infiltration

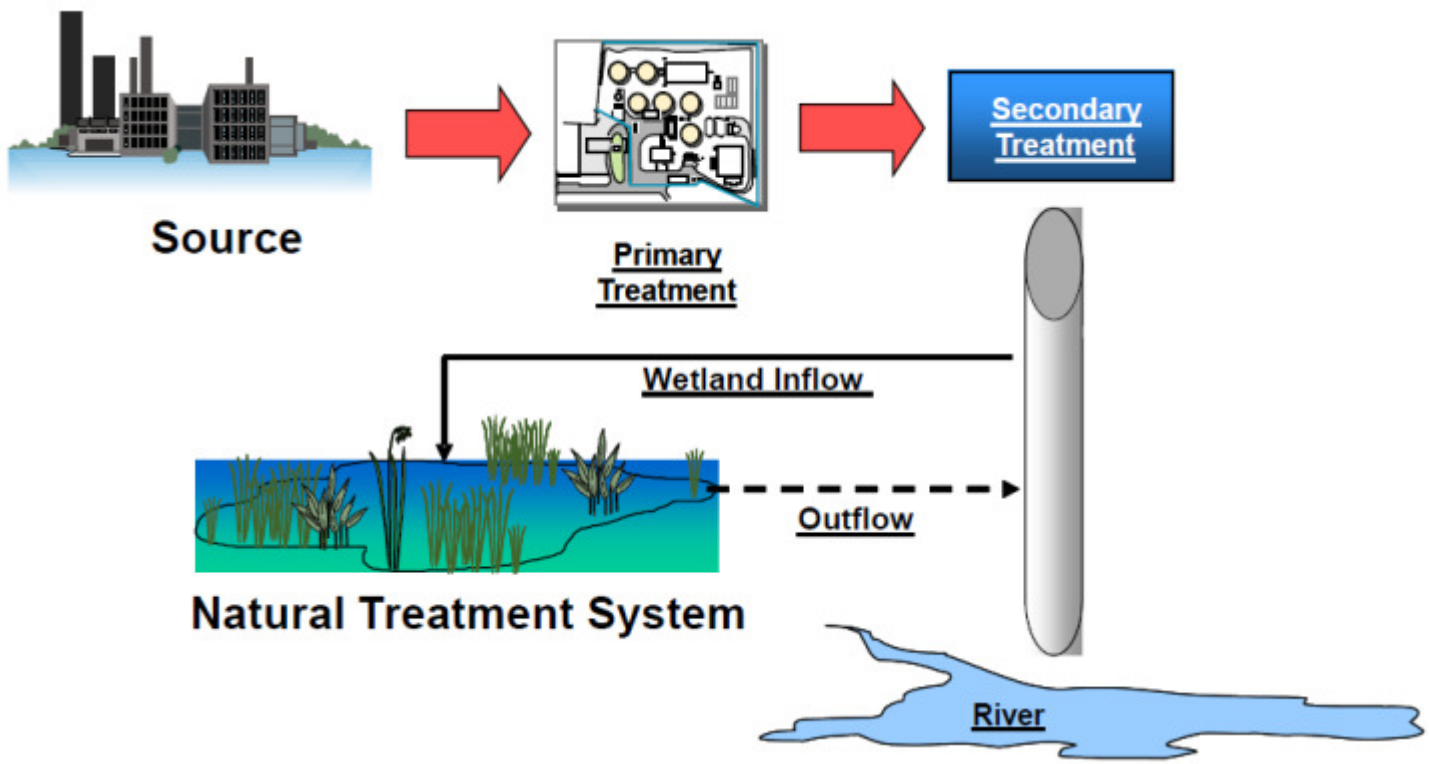
Use vegetative indicators to establish target SHWL, NP elevations

Infiltration can be a planning objective

Compartments in Treatment Wetlands Aid System Hydraulics and Performance



Effluent Treatment Wetland: Pretreatment Requirements



Surface Water/Stormwater Wetland: Pretreatment Requirements

Runoff and Load Generation → Conveyance and Pretreatment → Additional Treatment and Attenuation → Final Treatment and Attenuation

- ✓Source Controls
- ✓Public Education
- ✓Erosion Control
- ✓Roof Runoff
- ✓Florida Yards
- ✓LID

- ✓Swales
- ✓Catch Basins
- ✓Filter Inlets
- ✓Oil/water Separators

- ✓Storage Tank
- ✓SedimentUmp
- ✓Alum

- ✓Retention
- ✓Detention
- ✓Wetlands
- ✓Alum

!!

http://www.co.broward.fl.us/Stormwater/

http://www.co.broward.fl.us/Stormwater/

CH2MHILL.

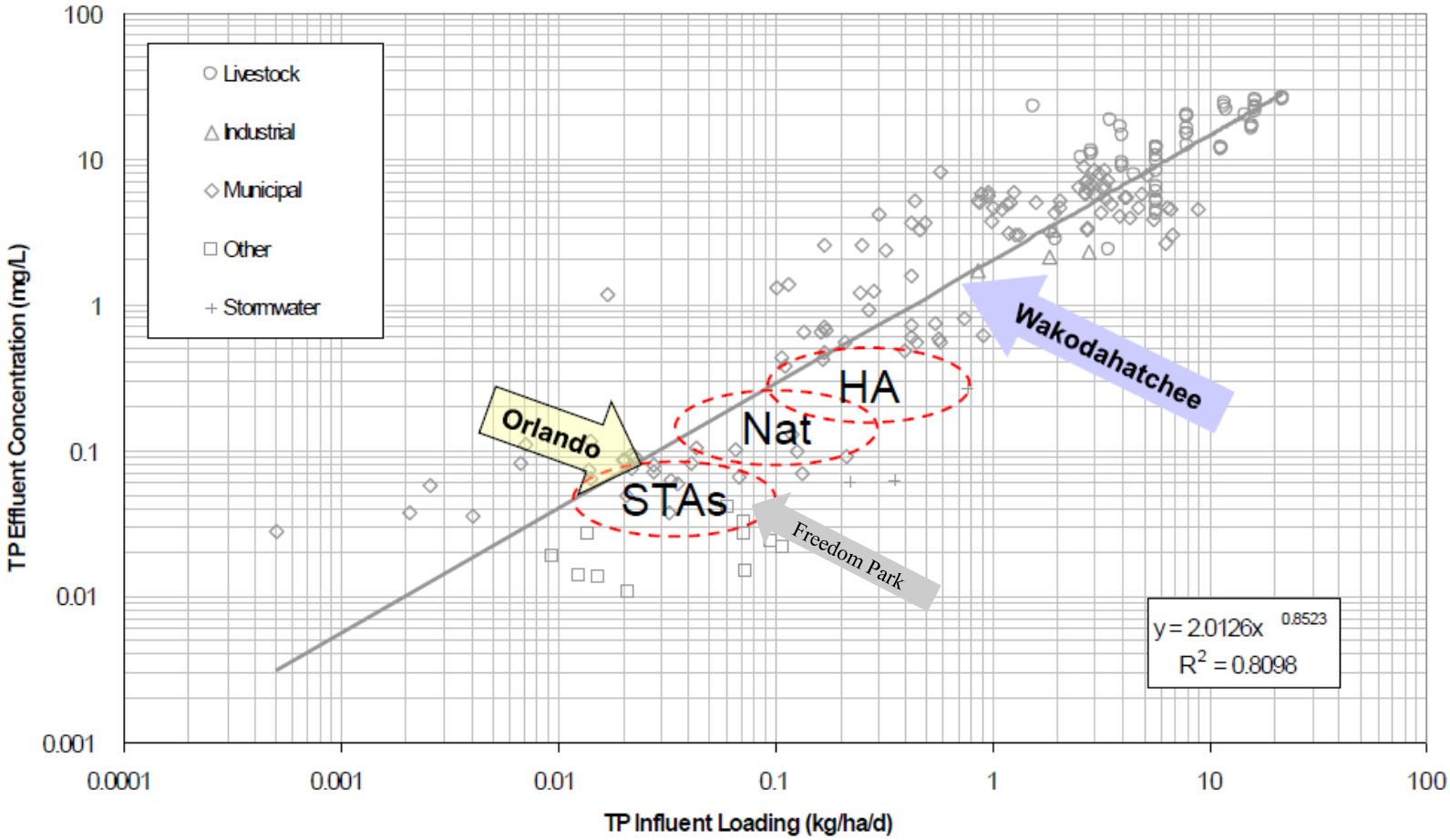
General Performance Results Set General Expectations

Parameter	Removal Efficiency	Limit
BOD	50 – 90%	2 – 10 mg/L
TSS	50 – 90%	2 – 10 mg/L
TN	40 – 90%	1 – 3 mg/L
TP	10 – 90%	<1 mg/L
Fecal Coliforms	80 – 99%	<100 – 1,000 col/100 mL
Metals	50 – 90%	Below Detection

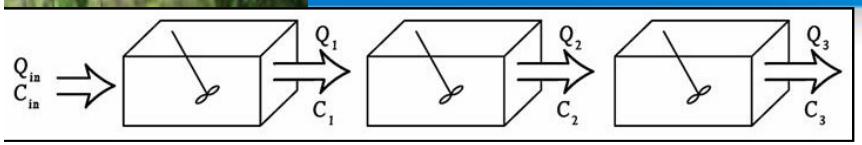
0.004 mg/L

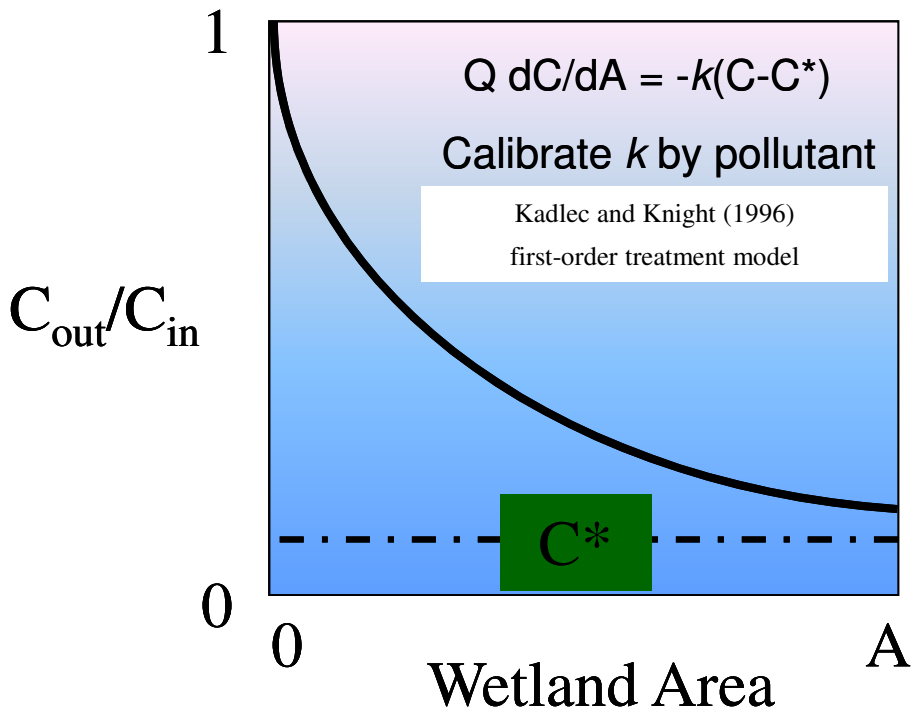
[a] Removal efficiencies and effluent concentrations are very dependent upon influent concentration and hydraulic loading rate.

Loading Coordinate Graph Establishes, Confirms Performance

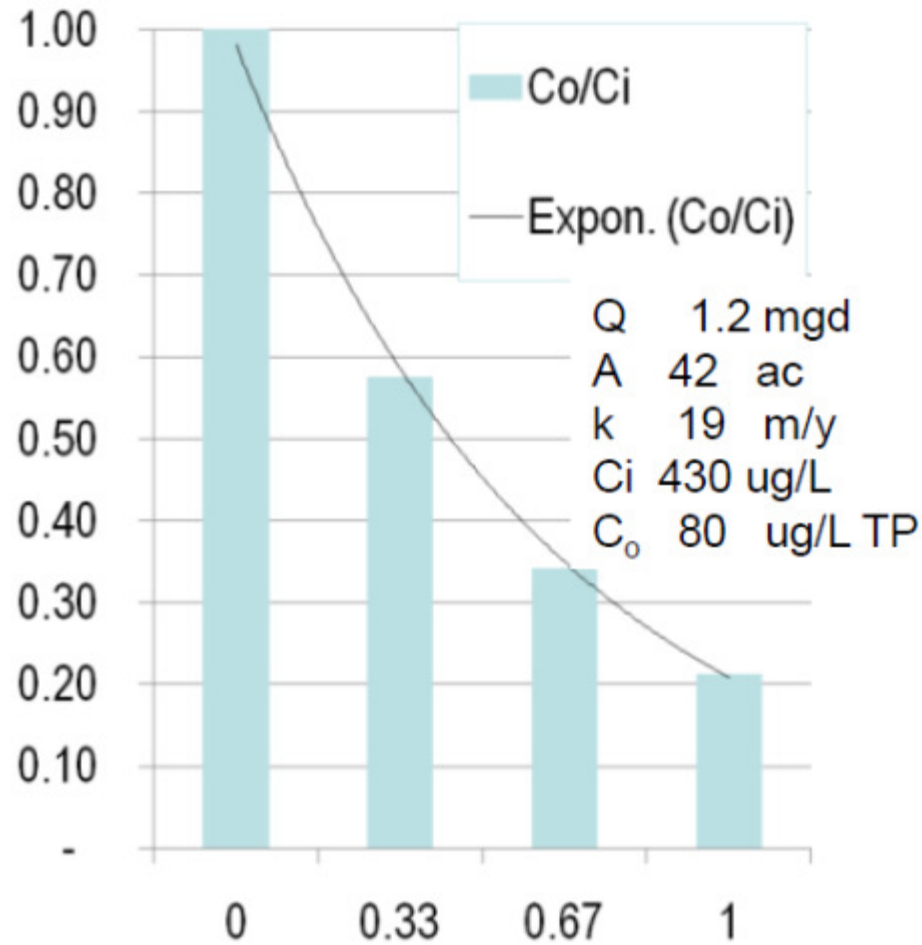


Wetland Treatment Performance Described by First-order Model





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



Example Wetland Performance

Orlando Wetlands Park FL: AWT Wetland Milestone

	In (mg/L)	Out (mg/L)
TN	2.4	0.8
TP	0.28	0.06
BOD	1.5	1.8
TSS	<1.0	<1.0

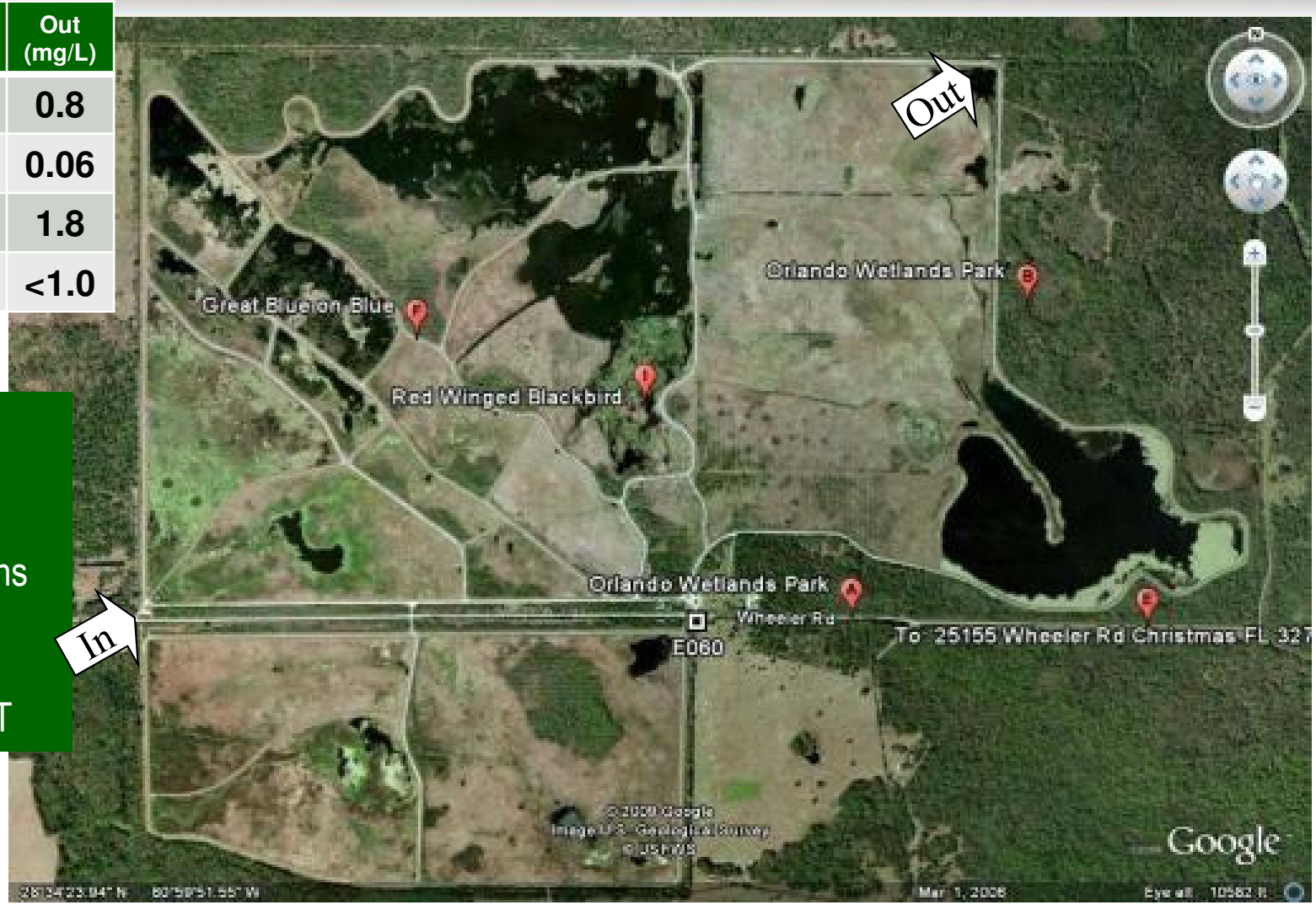
1,220 ac

12 cells

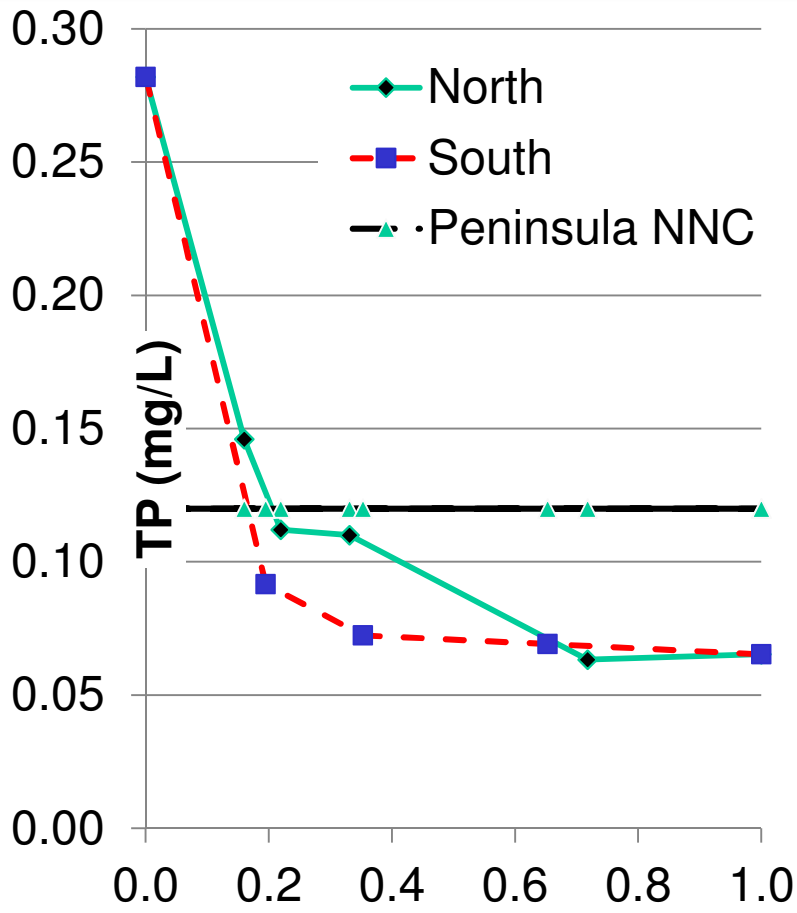
3 flow paths

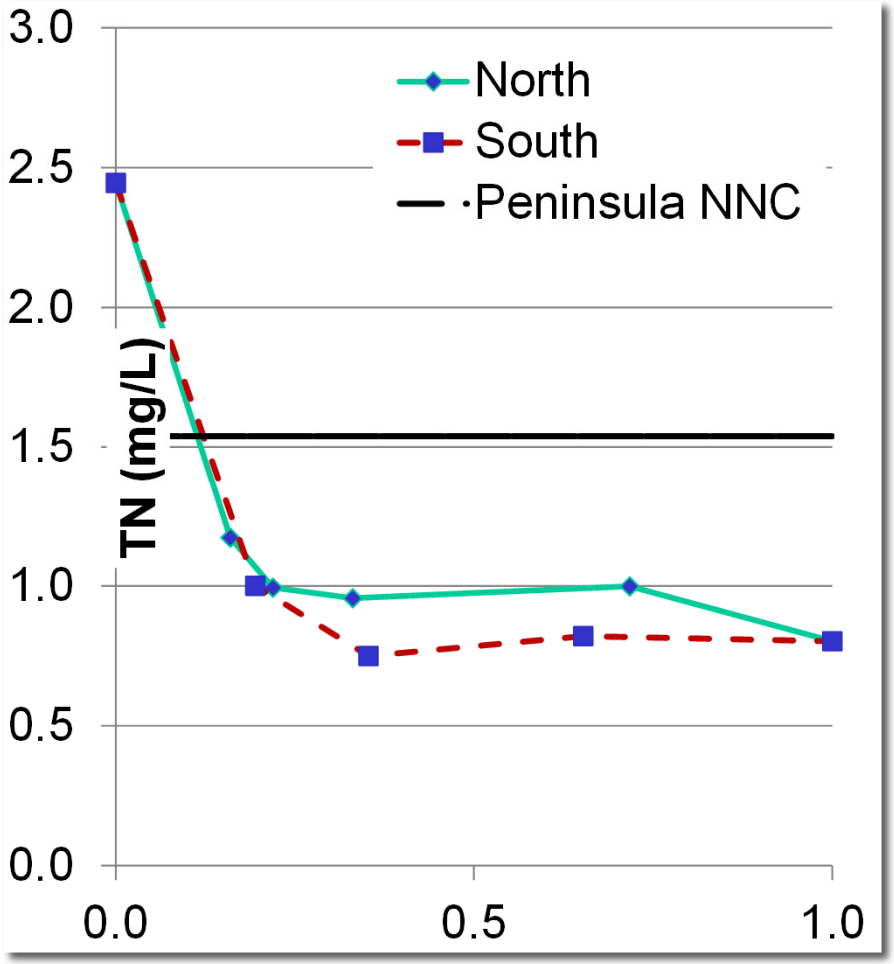
20 mgd

>30 d HRT



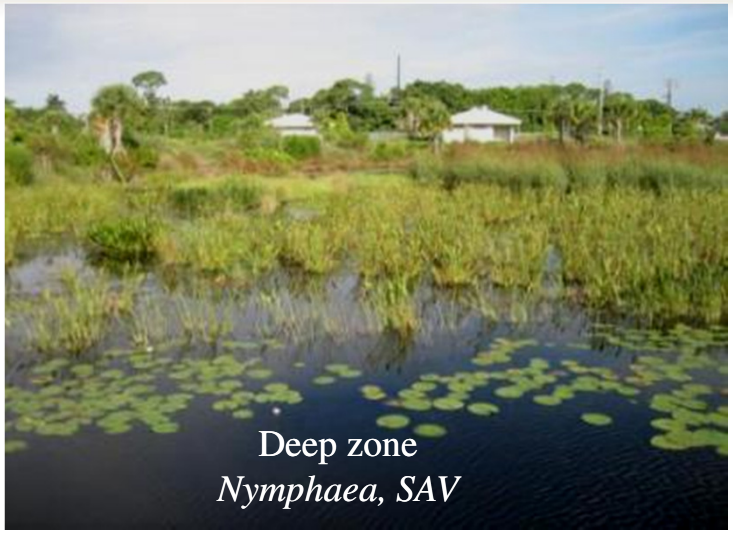
Orlando Wetlands Meet Proposed Numeric Nutrient Criteria





Source: Sees, 2005

Install and Manage Vegetation for Biomass, Diversity, Aesthetics, Flow



Treatment Wetlands Operations: Track Performance and Monitor Flow

- Water Quality
  - Monitoring
  - Constituent Loading
- Hydraulic Operation
  - Water Level and Flow Control
  - Flow Path Rotation
- Vegetation Management
  - Aesthetics and Exotics
  - Replacement for Hydraulics, Performance, Herbivory
  - Harvesting? No
- Control of Nuisance Conditions

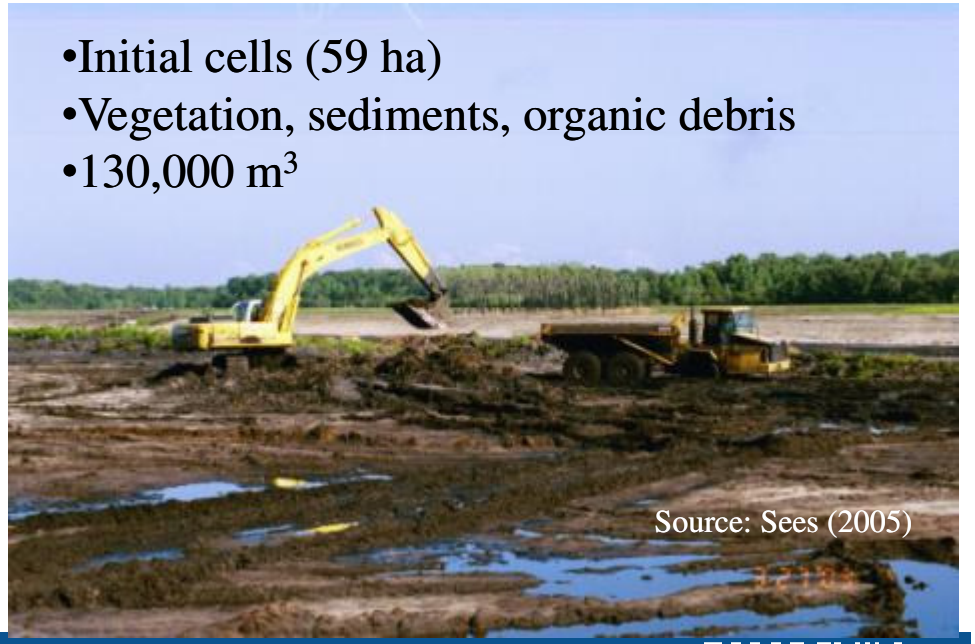
Sediment Removal FAQ

An Uncommon Practice

- Decades of Storage
- Slow Accretion Rate
  - 0.1 – 0.5 in/yr
  - Near inlet
  - Build in storage in deep zones
  - Water level adjustment
- Stormwater Considerations
  - 5 – 10 year cycle: clean out forebay/inlet deep zone

Orlando Wetlands (2002-03)

- Disposed on-site
- 160,000 bulrush installed
- Areal efficiency increased from 0.34 to 0.74.

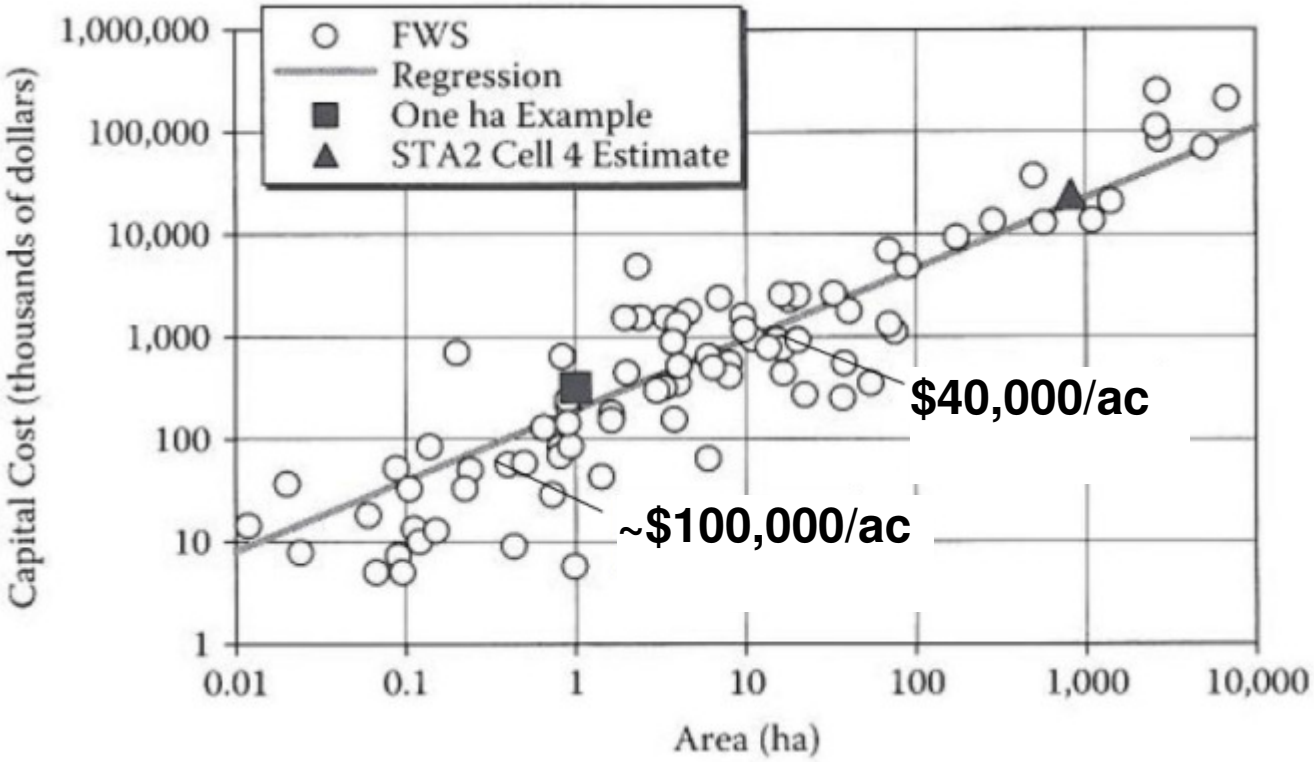


Public Recreational Use Can Exceed Expectations

Wakodahatchee
"Created Waters"
Delray Beach, FL

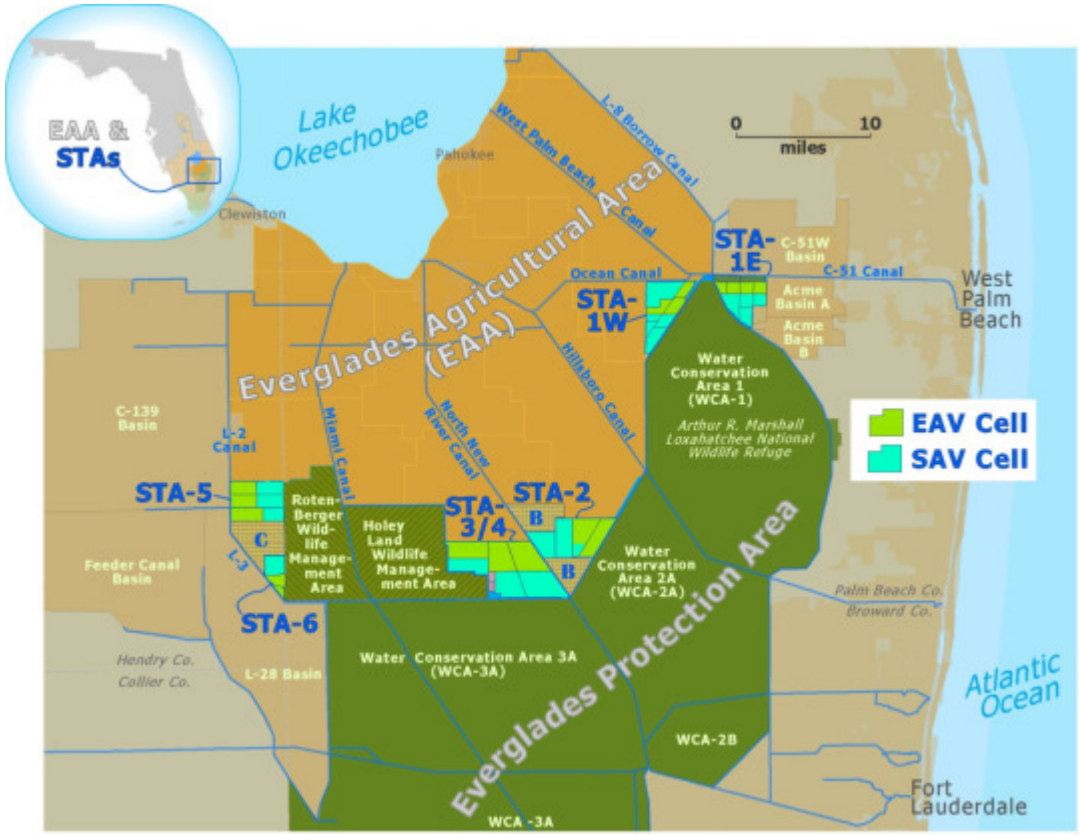
- Parking lot expanded from 10 to 50 in first year; still low.
- Available records indicate visitors increased from 165 in 1997 to conservatively *125,000* per year.
- Dec, Jan, Feb: 600 people per day.
- Birders, photographers, fitness walkers, and multi-generational groups.
- Featured in local and national media.
- Google "Wakodahatchee":
  - 50 in 2004
  - 510 in 2013

Capital Cost Considerations



Source: Kadlec & Wallace (2009)

Everglades Construction Project: World's Largest Treatment Wetlands



- 57,000 ac STA area
- 1,727 MT TP retained since 1994
- 74% TP Reduction
- FWM 37 ppb TP outflow
- 1994 ECP = $913 MM
  - $714 MM state
  - $199 MM Federal

WY 2013

- 1,060,000 ac-ft treated
- 84% TP Reduction
- FWM TP outflow 21 ppb
- 166 MT

Sources: SFER 2014

Freedom Park, Naples: Stormwater Treatment, Restoration, Recreation Treatment Wetlands Sustain Native Diversity

- 50-ac: since 2009
- 200 Million Gallons of SW Flow into Naples Bay Treated per Year
- Nitrogen Reduced By **39%** to 0.8 mg/L (background)
- Phosphorus Reduced By **82%** to 30 ppb (nr. backgr.)
- Metal Concentrations Reduced to Background Levels
- Critical Component of County's Stormwater Improvement Plan

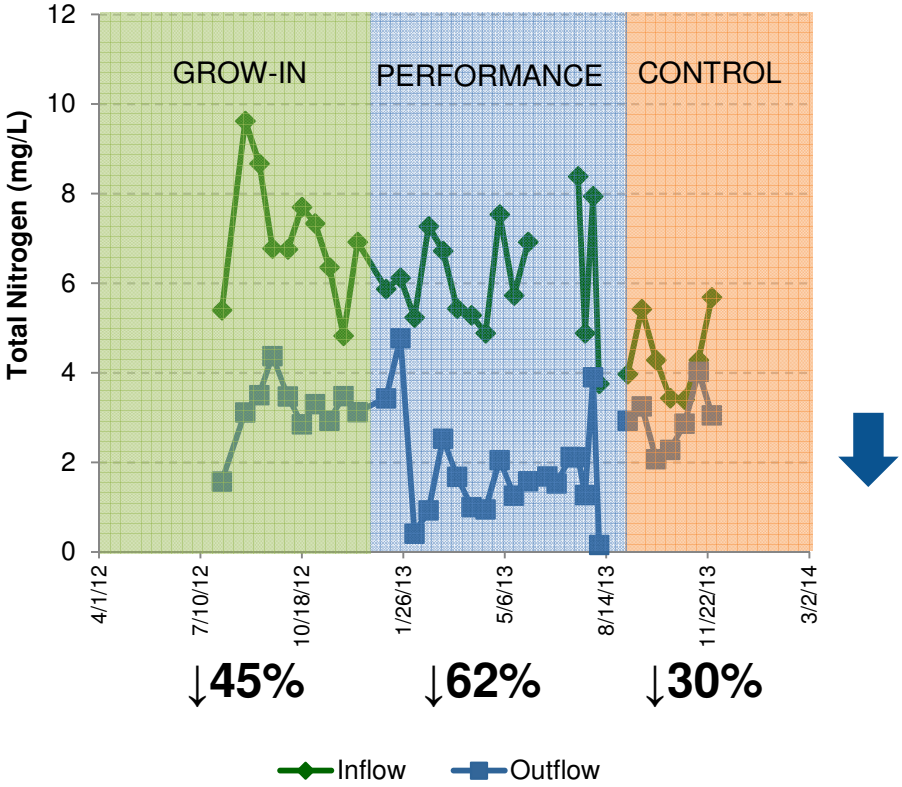
Collier County

CH2MHILL.

Floating Wetland Islands: A Strategy for Nitrogen Reduction in Reclaimed Water

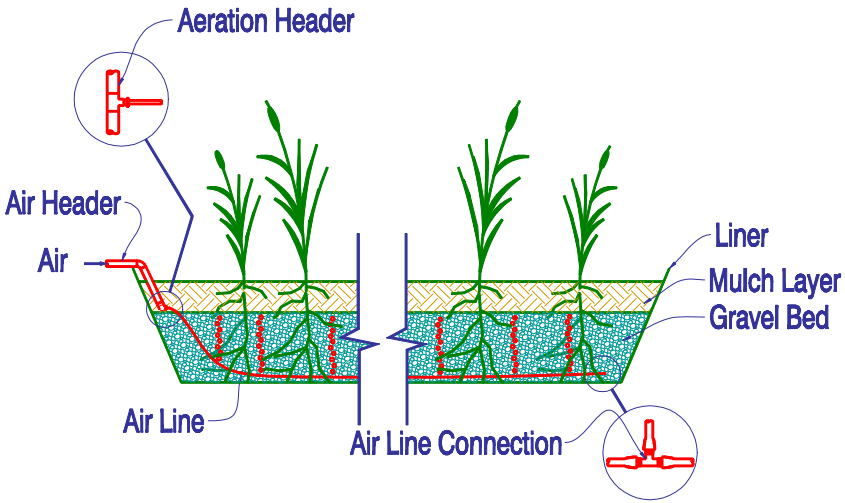
FWIs: After 1.5 years

Presence of Islands Improved TN Reduction



Enhanced Wetlands ("Intensification") and System Integration Can Help Meet TMDLs

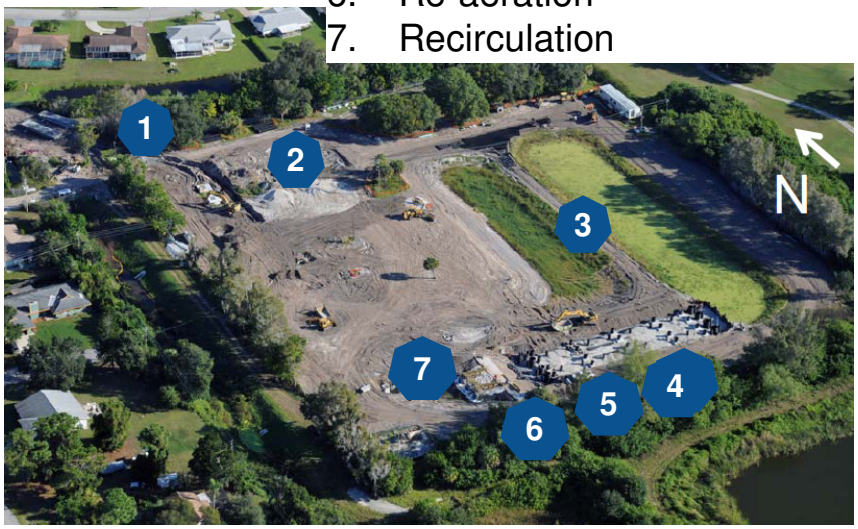
Forced Bed Aeration



Integrated Media Filtration

Alligator Creek Treatment Train:

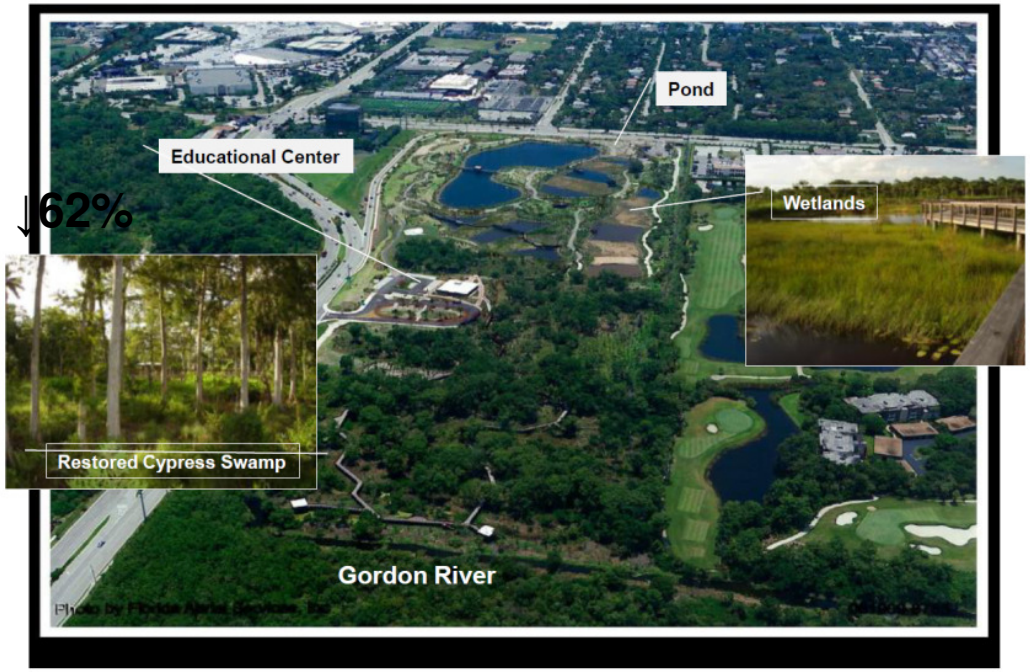
1. Flow diversion (pump)
2. Forebay settling
3. Wetland treatment (2 cells)
4. Downflow gravel filtration
5. Upflow media adsorption
6. Re-aeration
7. Recirculation



Wanielista & Flint 2012

Wetlands for Water Treatment: Perspective

- Versatile
  - Mass removal, concentration
  - New applications
- Passive, low energy, low O&M, stores nutrients
- Well-understood, good record
- Conserves land, creates habitat



Freedom Park, Naples FL

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