9th Biennial Conference on Stormwater Research and Watershed Management

Occurrence of *Cryptosporidium*, *Giardia*, and Metals in Florida Stormwater Ponds and Assessment as Alternative Water Supplies for Irrigation

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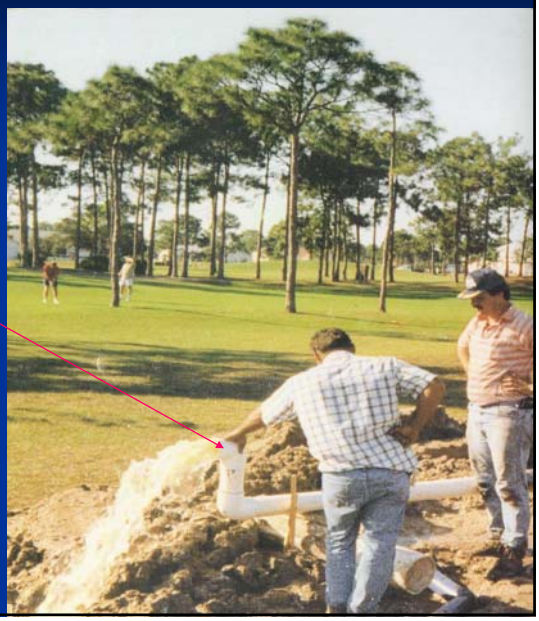
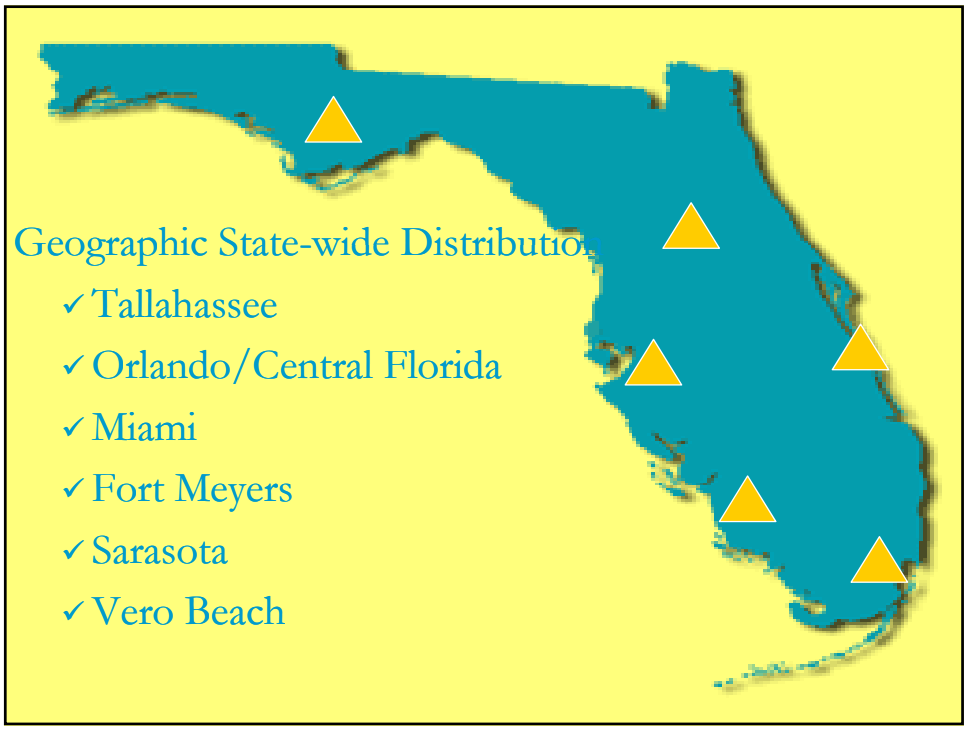
Objective

- Determine the suitability of stormwater pond water as an alternative water supply for public access irrigation.
  - 29 samples from 22 stormwater ponds
  - Data compared to existing Florida rules, guidelines and reclaimed water quality currently used for public access irrigation

Sampling Sites

- 3 ponds used for irrigation
  - 1 pumped directly from pond
  - 2 horizontal wells
  - Some ponds sampled twice
- 9 different land uses

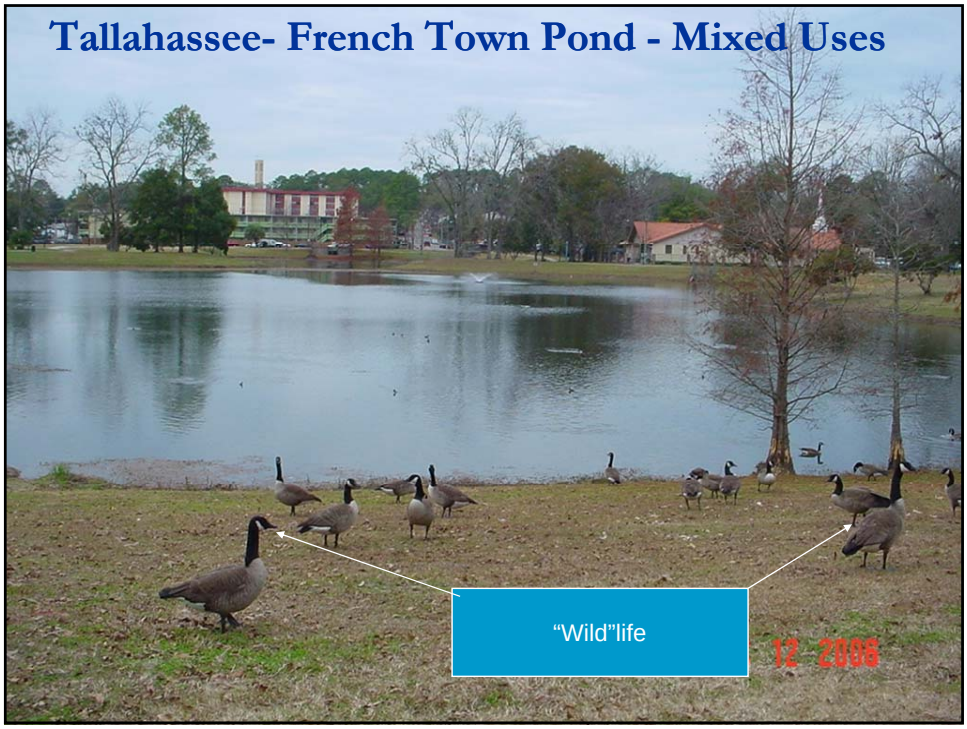




Celery Fields- Sarasota- Mixed Residential Rural

Ft. Meyers -Residential Golf Course

Tallahassee- French Town Pond - Mixed Uses



Central Florida "Lake Condel" - Residential

UCF "Stadium Pond"- Horizontal Well

Miami-Miramar Pond- Commercial

Cryptosporidium & *Giardia* are emerging pathogens of public health concern

Cryptosporidosis Reported Outbreaks

- Milwaukee 1993- crytposporidosis outbreak that caused 400,000 illnesses and at least 50 deaths.
- '89-'94, 5 reported outbreaks of *Cryptosporidiosis*, averaging 67,706 cases per year.

From New England Journal of Medicine Mackenzie, et al., July 1994
And Haas, and Rose, Quantitative Microbial Risk Assessment, 1999

Giardiasis Reported Outbreaks

- 89- '94 11 outbreaks of Giardiasis were recorded with an average of 164 cases per year
- '80-'96 84 outbreaks with 10,262 cases were reported.

Ref: Haas, and Rose, Quantitative Microbial Risk Assessment, 1999

Pathogen Background

- Waterborne protozoan pathogens
- Oocyst & cyst infectious forms
- Size- large enough for filtration-
  - *Cryptosporidium* oocyst- *4-6 μm*
  - *Giardia* cyst – *8-15 μm*
- Ubiquitous in the environment
- More than forty mammals including humans are hosts
- Cross species barriers, in particular *C. Parvum*

EPA Method 1623

- ✓ Only EPA accepted method for simultaneous detection of *Cryptosporidium* oocysts and *Giardia* cysts.
- ✓ Identifies and enumerates "potentially" viable (oo)cysts.
- ✓ FDEP recommended Minimum Detection Limit (MDL) of 1 per 100L -requires 100L or more of sample
- ✓ FDEP recommends: not less than 10 per 100L
- ✓ 28% samples in this study exceeded the MDL accepted by the FDEP
- ✓ Analyses were conducted by Orange County Utilities Central Laboratory, one of four certified labs in the U.S.

Florida's Pathogen Guidelines

- Focus on residential irrigation
- "maximum" –single inadvertent consumption of 100 mL
- Used human dose response to estimate an annual risk of infection $=10^{-4}$
- All cysts "viable"
- Viability of oocysts and cysts was not ascertained in this study of stormwater ponds and is not required by Florida standards

Florida's Pathogen Guidelines

Microbe	Units	Average	Max
Giardia	Viable Cysts/100L	1.4	5.0
Cryptosporidium	Viable Oocysts/100L	5.8	22
Enterovirus	PFU/100L	0.044	0.165

Ref: York et al., 2003. Monitoring for Protozoan Pathogens in Reclaimed Water: Florida's Requirements and Experience.

Cryptosporidium and Giardia Results

Parameter	n	% Positive	Average (#/100L)	SD (#/100L)	Max (#/100L)
Cryptosporidium	*29*	*3.5*	6.75	3.82	12.9
Giardia	*28*	*10.7*	13.5	22.1	80

- *Cryptosporidium* – One (1) measurement of 12.9 oocysts/100 L in 29 samples all other samples were below MDL
- *Giardia* – Three (3) measurements 70,76.9, & 80 cysts/ 100L in 28 samples
- Averages calculated using ½ MDL where results were below MDL.

Notes: 1. No *Crypto or Giardia* found in the horizontal well samples.
2. MDL changed because of filter clogging.

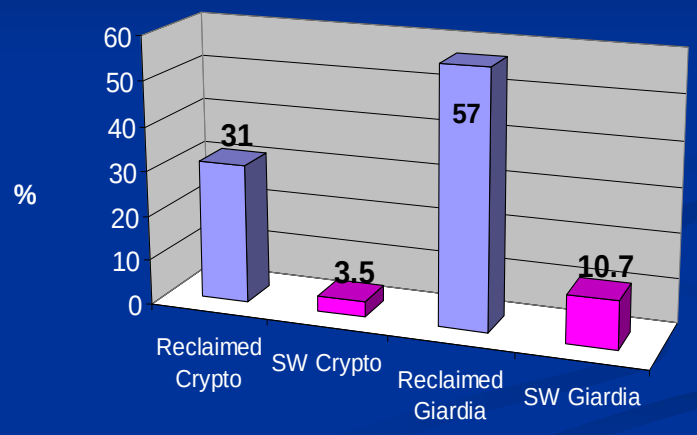
Comparison of SW Ponds and Reclaimed Water

Ref: *Slifko, T.R. 2007, Tertiary Treatment and Beyond for Pathogen Risk Reduction
** Walker Coleman, And Slifko, Removal of *Crypto and Giardia, FDEP, 2003*

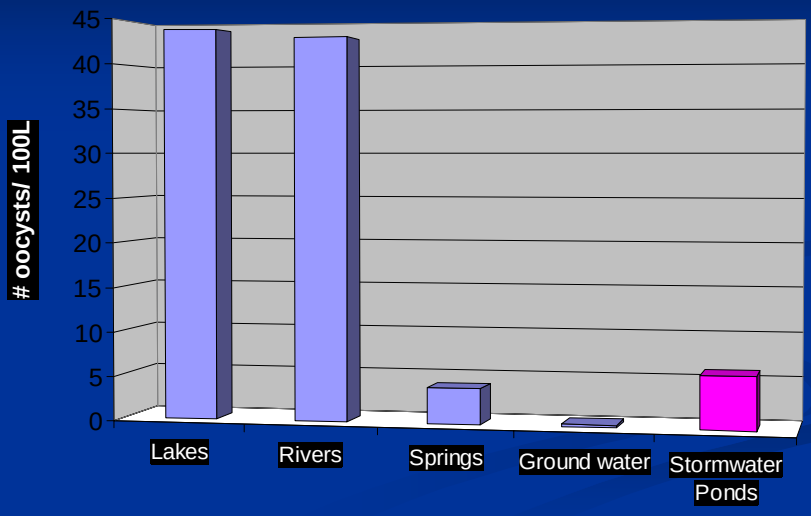
Source	n	Mean (#/100L)	Max (#/100L)
Cryptosporidium (FDEP MAX= 22/100L)			
SW Ponds	29	6.75	12.9
Reclaimed*	56	38	435
Reclaimed**	156	1.2 (75%)	352.3
Giardia (FDEP MAX= 5/100L)			
SW Ponds	28	13.5	80
Reclaimed*	56	1060	7188
Reclaimed**	156	86 (75%)	4035

Note the 2003 data (**) reported using an old & less sensitive method

% Detectable Pathogen Levels SW Ponds vs. Reclamation Facilities Study cited by the DEP, 2003



Comparison of Mean Cryptosporidium Levels in Florida SW Ponds vs. Surface Waters Used as Drinking Water Sources In North America



Reuse Rules

F.A.C. Chapter 62-610

Public Access Areas (reclaimed water)

- TSS < 5mg/L
- BOD <20mg/L

EPA's Reuse Guidelines:

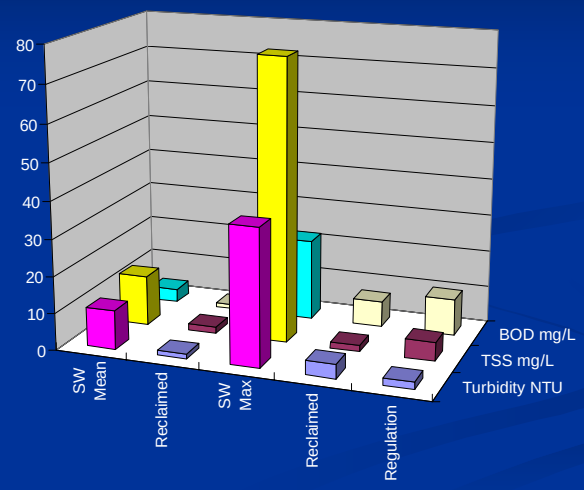
Agricultural Reuse (spray irrigation): Edible crops

- BOD< 10 mg/L
- Turbidity < 2NTU
- TSS in lieu of Turbidity < 5 mg/L

Stormwater (SW) Ponds TSS, Turbidity & BOD Compared to Reclaimed Water & Florida's Reuse Rules

Parameter	Mean		SD		Max		
	SW	Reclaimed	SW	Reclaimed	SW	Reclaimed	Florida's Reuse Rules
Turbidity NTU	10.5	1.33	10.9	0.9	37	3.8	2
TSS mg/L	13.5	1.68	15.6	1.43	76	1.68	5
BOD mg/L	3.6	1.05	3.9	1.72	21.9	7	10

Results of Stormwater Pond TSS, Turbidity & BOD Compared to Reclaimed Water & Florida's Standards for Public Access Areas



Heavy Metals and Potential Reasons for Concern

- Heavy metals may bioaccumulate in soils and are toxic to plants and animals
- May limit suitability of the use of waters high in metals for irrigation
  - ✓ Reclaimed water with relatively low levels of metals present has been deemed in two long term studies, (1 & 3yrs) in California & Australia, to be safe for irrigation of crops.

Source: USEPA

Results Metal Analyses (n = 29)

Metal	Cu (µg/L)	Pb (µg/L)	Zn (µg/L)	Cr (µg/L)	Cd (µg/L)	Hg (µg/L)
Mean	5.1	2.1	37.9	6.2	1.1	0.1
Standard Deviation	1.8	1.8	32.3	3.1	0.4	0.1
Maximum	8.0	7.0	113.0	15.0	3.0	0.4
USEPA Primary Drinking Water Standard	1300	15	N/A	100	5	2
USEPA Secondary Drinking Water Standard	N/A	N/A	5000	N/A	N/A	N/A

Summary - 29 samples

- ***Cryptosporidium*** was detected as above minimum detection limits for 3.5 % of the samples
- ***Giardia*** was detected as above minimum detection limits for 10.7% of the samples
- ***Cryptosporidium:*** average = 6.75 oocysts/100L
  max =12.9 oocysts /100L
- ***Giardia:*** average = 13.5 cysts/100L
- max = 80 cysts/100L
- **Metals** values in all cases were less than primary and secondary drinking water standards
- **BOD** average was 3.6 mg/L
- **TSS** average was 13.5 mg/L and **turbidity** average was 10.6 NTU.

Conclusions

- ***Cryptosporidium* & *Giardia*** were higher in 3.5% & 10.7% of the samples relative to Florida's reclaimed water guidelines
- Storm water quality compares favorably in terms of Crypto & Giardia to reclaimed water.
- TSS and turbidity were both higher than Florida's reclaimed water regulations
- Metals were below the primary and secondary drinking water regulated values
- BOD levels were below Florida's reuse regulations for reclaimed water.
- The horizontal well values did not exceed any of the guidelines and regulations

Future Work -Filtration

- Passage through soils has proven effective at removing *Cryptosporidium* oocysts and *Giardia* cysts.
- Filters in St. Petersburg removed~ 99%
- Results may be similar for soil filtration

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Questions and Comments
THANKS