Protect Sanctuary Waters: Finish the Wastewater Job Shallow Wells

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Water Quality Protection Program
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Goal: Eliminate Discharges of Pollutants remaining in AWT Treated Wastewater to Outstanding Florida Waters

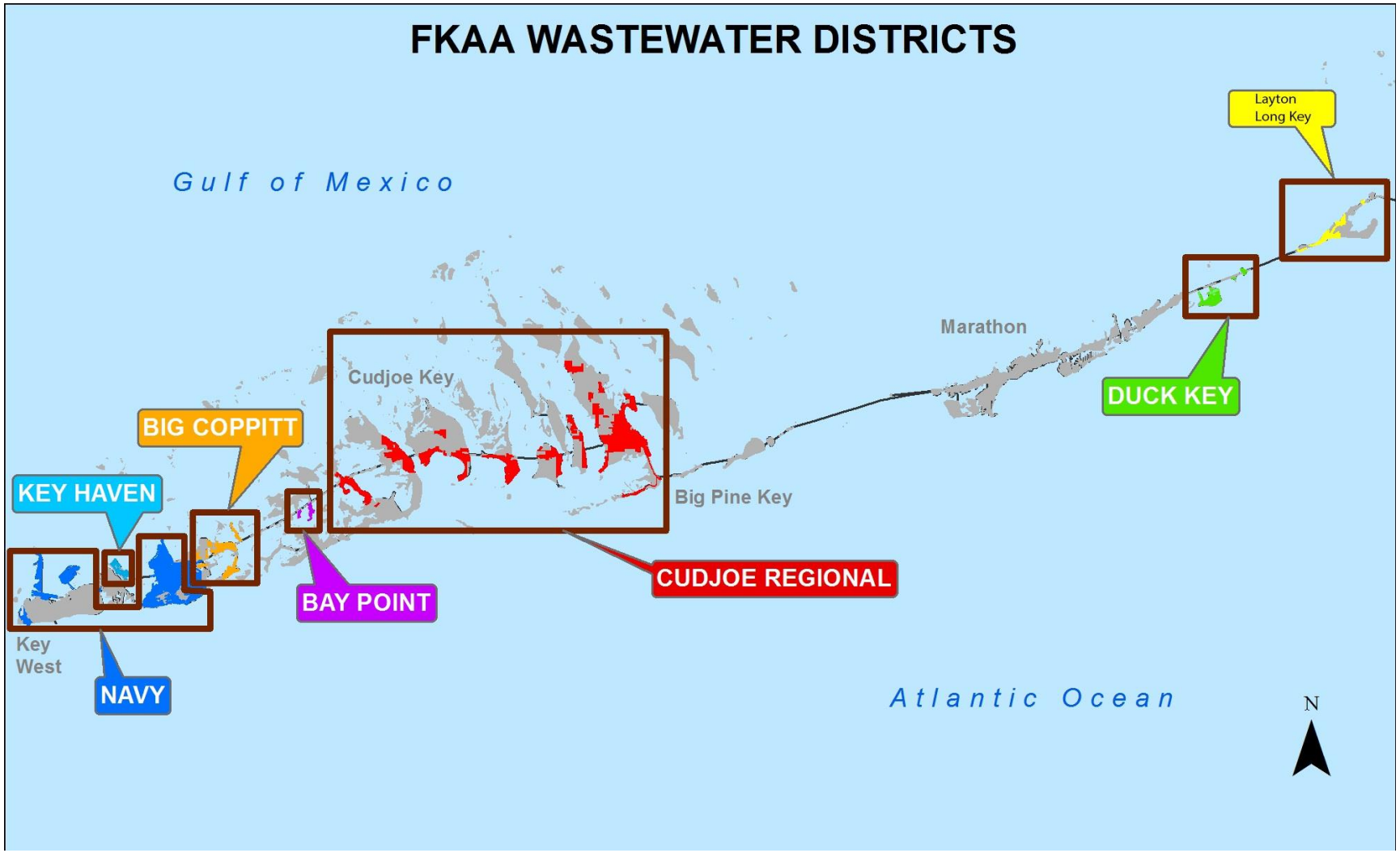
DID YOU KNOW?

Discharges from shallow wells to Sanctuary waters are NOT monitored.

ROLE FOR WATER QUALITY PROTECTION PROGRAM

1. Ask DEP questions
2. Get answers
3. Design shallow well discharge monitoring program
4. Implement pilot shallow well monitoring program

How many Gallons/Day of Treated Wastewater Goes Down Shallow Wells as the primary disposal method?



Not Shown

- Marathon
- KWRU/Stock Island

How many Gallons/Day of Treated Wastewater Goes Down Shallow Wells

DEP CAN EASILY PROVIDE THE ANSWERS

Location	Max Monthly Capacity	Permitted Average Daily	2019 Three Month Actual Flow
Marathon	1.?? mgd	1.8 (??) mgd.	
Cudjoe*, **	1.18 mgd	.94 mgd	
KWRU		.998 mgd	
Bay Point	Under 100,000		
Big Coppitt			
Boca Chica			
Key Haven, etc.			
TOTAL:			

*Cudjoe Shallow Wells currently permitted for Primary Disposal

** How many gallons go down Shallow Wells when used as “back-up”?

What Does That Mean? – How Much Nitrogen and Phosphorous per year goes into Sanctuary Waters?

DEP CAN EASILY PROVIDE THE ANSWERS

Location	Total Nitrogen (Pounds) Per Year Permitted/Actual	Total Phosphorous (Pounds) Per Year Permitted/Actual
Marathon		
Cudjoe	8,584 lbs.* / ??	2,861 lbs.**/??
KWRU		
Bay Point		
Big Coppitt		
Boca Chica		
Key Haven, etc.		
TOTAL:		

*0.94 mgd (permitted AADF)
x 3 mg/l (permitted nitrogen average)
x 8.34
x 365 days=
8584.362 pounds of nitrogen per year.

**0.94 mgd (permitted AADF)
x 1 mg/l (permitted phosphorous average)
x 8.34
x 365 days=
2,861 pounds of nitrogen per year.

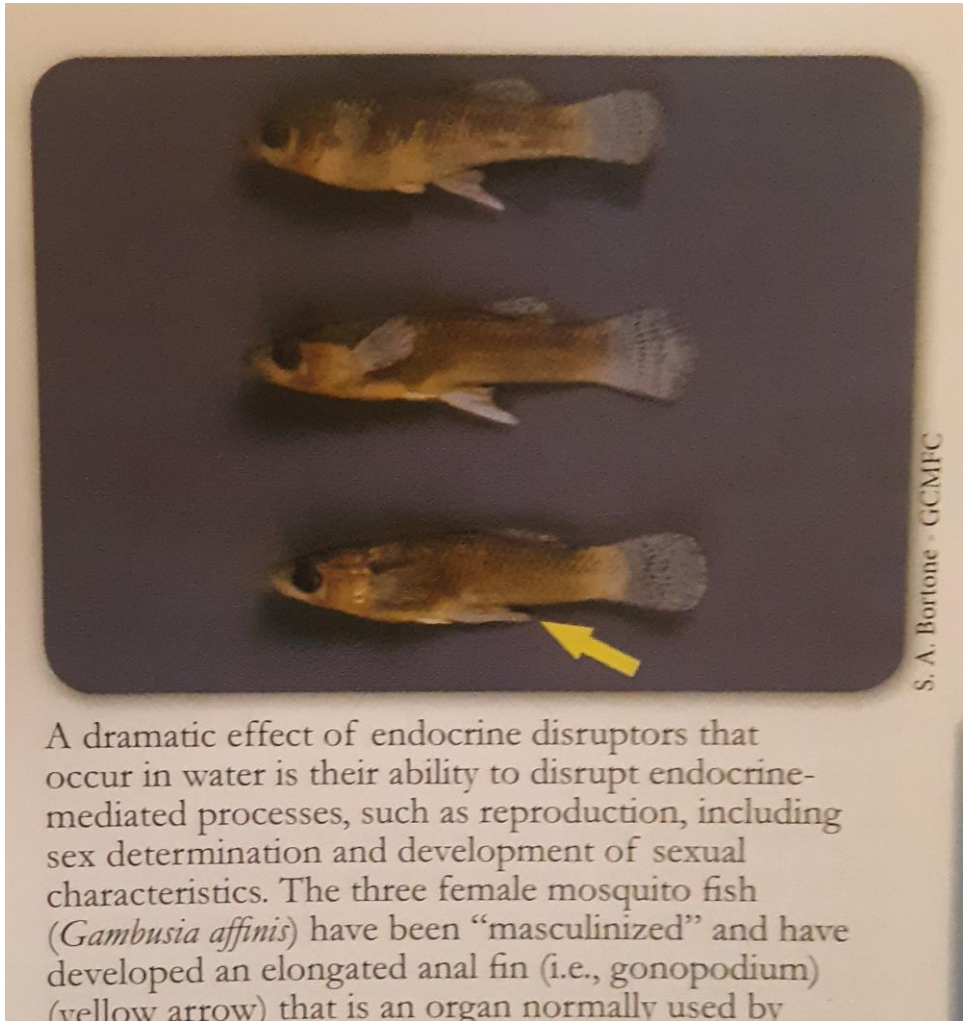
CAVEAT: Information should be provided by DEP. Advised by Prof. Engineer that this is consistent with their method of calculating.

But What Is The Problem? The Wastewater Is Treated To Drinking Water Standards?

Sanctuary Waters are Polluted with very low levels of nutrients

Pollutant	Drinking Water Standard	AWT Standard	Keys Surface Water Standard (Cudjoe area)
Total Nitrogen	10.00 mg/L	3.00 mg/L	0.25 mg/L
Total Phosphorous	Unlimited	1.00 mg/L	0.009 mg/L
Compounds: Pharmaceuticals, Personal Care Product	Not yet regulated	Not yet regulated	Mutagenic - None shall be present

But What Is The Problem? The Wastewater Is Treated To Drinking Water Standards.



A dramatic effect of endocrine disruptors that occur in water is their ability to disrupt endocrine-mediated processes, such as reproduction, including sex determination and development of sexual characteristics. The three female mosquito fish (*Gambusia affinis*) have been "masculinized" and have developed an elongated anal fin (i.e., gonopodium) (yellow arrow) that is an organ normally used by

EPA is beginning to study Contaminants of Emerging Concern, which are not removed by AWT methods.

- **Pharmaceuticals, including hormones**
- **Personal Care products**

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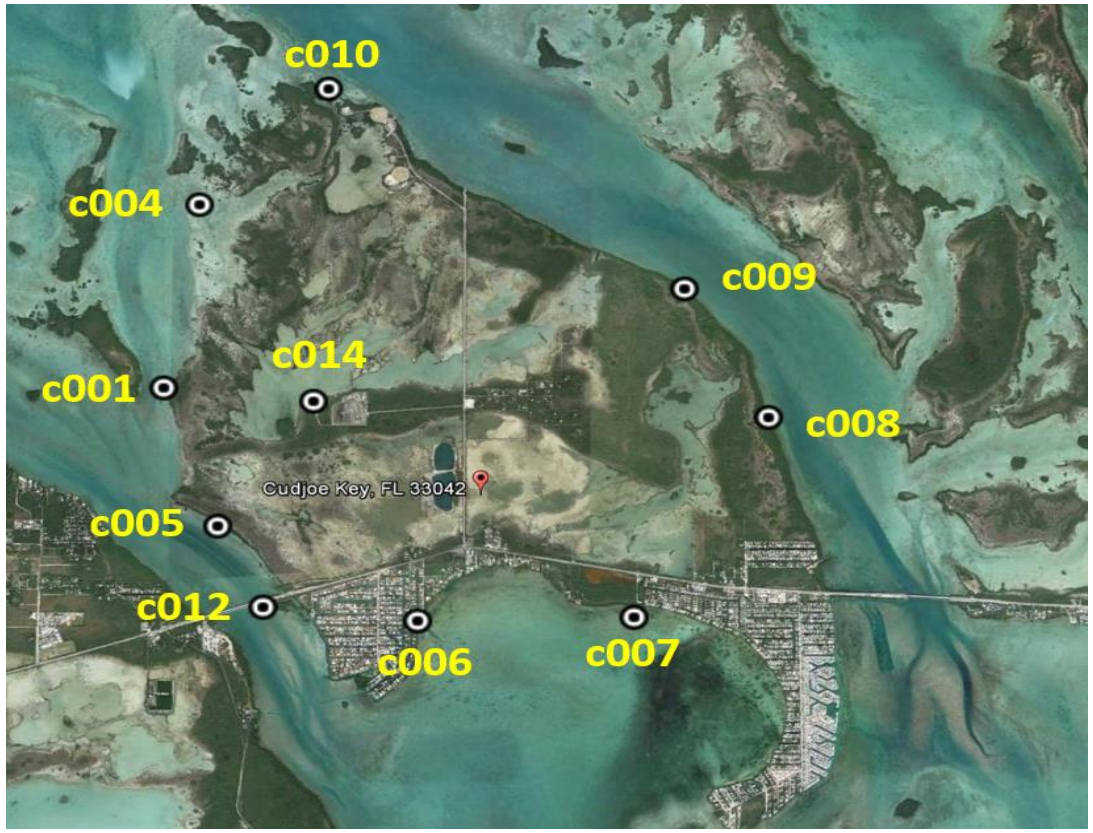
Design a Surface Water Monitoring Program for Shallow Well Injection

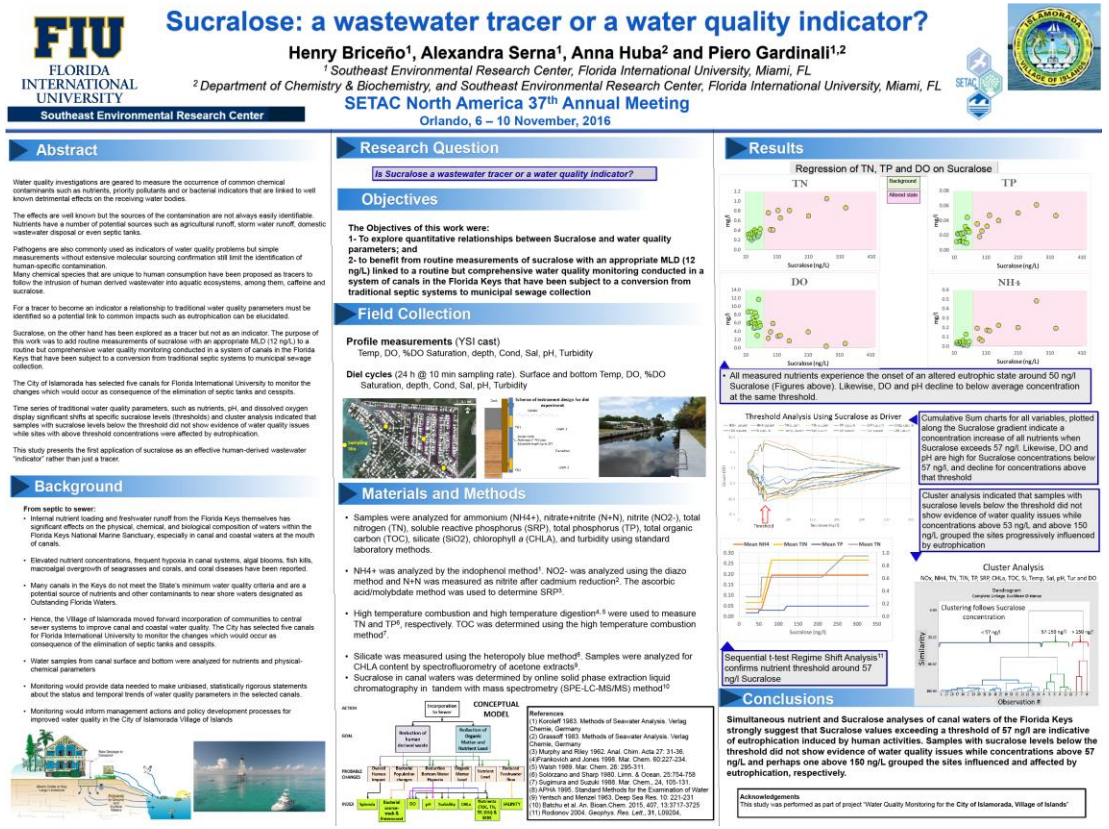
1. Select sampling locations based on geologic assessment of area surrounding the WWTP shallow wells. Identify sink holes, etc. which could indicate expedited pathways.



Design a Surface Water Monitoring Program for Shallow Well Injection

2. Monitor for nutrients, other pollutants of concern and salinity.

3. Monitor for Sucralose to distinguish shallow well pollution from ‘mainland wash down’ pollution.



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Sucralose: a wastewater tracer or a water quality indicator?

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Abstract

Water quality investigations are geared to measure the occurrence of common chemical contaminants such as nutrients, priority pollutants and or bacterial indicators that are linked to well known detrimental effects on the receiving water bodies.

The effects are well known but the sources of the contamination are not always easily identifiable. Nutrients have a number of potential sources such as agricultural runoff, storm water runoff, domestic wastewater disposal or even septic tanks.

Pathogens are also commonly used as indicators of water quality problems but simple measurements without extensive molecular sourcing confirmation still limit the identification of human-specific contamination.
Many chemical species that are unique to human consumption have been proposed as tracers to follow the intrusion of human derived wastewater into aquatic ecosystems, among them, caffeine and sucralose.

For a tracer to become an indicator a relationship to traditional water quality parameters must be identified so a potential link to common impacts such as eutrophication can be elucidated.

Sucralose, on the other hand has been explored as a tracer but not as an indicator. The purpose of this work was to add routine measurements of sucralose with an appropriate MLD (12 ng/L) to a routine but comprehensive water quality monitoring conducted in a system of canals in the Florida Keys that have been subject to a conversion from traditional septic systems to municipal sewage collection.

The City of Islamorada has selected five canals for Florida International University to monitor the changes which would occur as consequence of the elimination of septic tanks and cesspits.

Time series of traditional water quality parameters, such as nutrients, pH, and dissolved oxygen display significant shifts at specific sucralose levels (thresholds) and cluster analysis indicated that samples with sucralose levels below the threshold did not show evidence of water quality issues while sites with above threshold concentrations were affected by eutrophication.

This study presents the first application of sucralose as an effective human-derived wastewater “indicator” rather than just a tracer.

Background

From septic to sewer:

- Internal nutrient loading and freshwater runoff from the Florida Keys themselves has significant effects on the physical, chemical, and biological composition of waters within the Florida Keys National Marine Sanctuary, especially in canal and coastal waters at the mouth of canals.
- Elevated nutrient concentrations, frequent hypoxia in canal systems, algal blooms, fish kills, macroalgal overgrowth of seagrasses and corals, and coral diseases have been reported.
- Many canals in the Keys do not meet the State’s minimum water quality criteria and are a potential source of nutrients and other contaminants to near shore waters designated as Outstanding Florida Waters.
- Hence, the Village of Islamorada moved forward incorporation of communities to central sewer systems to improve canal and coastal water quality. The City has selected five canals for Florida International University to monitor the changes which would occur as consequence of the elimination of septic tanks and cesspits.
- Water samples from canal surface and bottom were analyzed for nutrients and physical-chemical parameters
- Monitoring would provide data needed to make unbiased, statistically rigorous statements about the status and temporal trends of water quality parameters in the selected canals.
- Monitoring would inform management actions and policy development processes for improved water quality in the City of Islamorada Village of Islands

Research Question

Is Sucralose a wastewater tracer or a water quality indicator?

Objectives

The Objectives of this work were:
1- To explore quantitative relationships between Sucralose and water quality parameters; and
2- to benefit from routine measurements of sucralose with an appropriate MLD (12 ng/L) linked to a routine but comprehensive water quality monitoring conducted in a system of canals in the Florida Keys that have been subject to a conversion from traditional septic systems to municipal sewage collection

Field Collection

Profile measurements (YSI cast)
Temp, DO, %DO Saturation, depth, Cond, Sal, pH, Turbidity

Diel cycles (24 h @ 10 min sampling rate). Surface and bottom Temp, DO, %DO Saturation, depth, Cond, Sal, pH, Turbidity

Materials and Methods

- Samples were analyzed for ammonium (NH4+), nitrate+nitrite (N+N), nitrite (NO2-), total nitrogen (TN), soluble reactive phosphorus (SRP), total phosphorus (TP), total organic carbon (TOC), silicate (SiO2), chlorophyll a (CHLA), and turbidity using standard laboratory methods.
- NH4+ was analyzed by the indophenol method[1]. NO2- was analyzed using the diazo method and N+N was measured as nitrite after cadmium reduction[2]. The ascorbic acid/molybdate method was used to determine SRP[3].
- High temperature combustion and high temperature digestion[4, 5] were used to measure TN and TP[6], respectively. TOC was determined using the high temperature combustion method[7].
- Silicate was measured using the heteropoly blue method[8]. Samples were analyzed for CHLA content by spectrofluorometry of acetone extracts[9].
- Sucralose in canal waters was determined by online solid phase extraction liquid chromatography in tandem with mass spectrometry (SPE-LC-MS/MS) method[10]

CONCEPTUAL MODEL

References
(1) Koroleff 1983. Methods of Seawater Analysis. Verlag Chemie, Germany
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(10) Batchu et al. An. Bioan.Chem. 2015, 407, 13:3717-3725
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Results

Regression of TN, TP and DO on Sucralose

- All measured nutrients experience the onset of an altered eutrophic state around 50 ng/l Sucralose (Figures above). Likewise, DO and pH decline to below average concentration at the same threshold.

Threshold Analysis Using Sucralose as Driver

Cumulative Sum charts for all variables, plotted along the Sucralose gradient indicate a concentration increase of all nutrients when Sucralose exceeds 57 ng/l. Likewise, DO and pH are high for Sucralose concentrations below 57 ng/l, and decline for concentrations above that threshold

Cluster analysis indicated that samples with sucralose levels below the threshold did not show evidence of water quality issues while concentrations above 53 ng/L and above 150 ng/L grouped the sites progressively influenced by eutrophication

Cluster Analysis

Sequential t-test Regime Shift Analysis[11] confirms nutrient threshold around 57 ng/l Sucralose

Conclusions

Simultaneous nutrient and Sucralose analyses of canal waters of the Florida Keys strongly suggest that Sucralose values exceeding a threshold of 57 ng/l are indicative of eutrophication induced by human activities. Samples with sucralose levels below the threshold did not show evidence of water quality issues while concentrations above 57 ng/L and perhaps one above 150 ng/L grouped the sites influenced and affected by eutrophication, respectively.

Acknowledgements
This study was performed as part of project “Water Quality Monitoring for the City of Islamorada, Village of Islands”

Pilot Test a Monitoring Program for Shallow Well Injection

Marathon??

New canal monitoring and nearshore monitoring efforts should identify and collect water quality data in vicinity of shallow well injection.

Show DEP It can and Should be Done by all Operators of Shallow Wells used for Wastewater Disposal to protect Sanctuary Waters.

DEP has the regulatory authority to require monitoring under its rules.

In addition, an NPDES permit with monitoring might be required in the future, pending the outcome of *County of Maui v. Hawai'I Wildlife Fund [heard Nov 6 by US Supreme Court].* (In Maui, dye tracer study proved shallow well injection of WWTP was polluting nearby ocean area; Maui claimed no NPDES permit required because discharge was "indirect" because pollutants do not flow directly into ocean but go through groundwater. ""At bottom, this case is about preventing the county from doing indirectly that which it cannot do directly," the Ninth Circuit ruled, and required NPDES permit. Maui appealed.)