Proposal of Statement of Work:

Sediment distribution and characterization of a subsample of stormwater ponds on Sanibel Island

Budget requested: $4,998.80

Research Proposal submitted to:

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Submitted on 12/01/2016 by:
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A. **Introduction**

Sanibel Island encompasses about 80 ponds nested into urban developments (some other ponds seem natural and nested within natural areas). Some of the ponds appear to be of natural origin, some seem to have been artificially enlarged from their original size and, finally, some have obviously been dug out.

Looking at the satelite imagery and from *in situ* visual inspection, some ponds clearly show obvious signs of eutrophication. This is a generalized trend in especially southwest Florida and this is of great concern as the vast majority of these ponds are connected via surface and possibly via underground conection to Florida waters, some of which are considered outstanding Florida Water (DEP Section 403.061).

These ponds become eutrophied mainly because of the inapropriate land use and inadequate implementation of buffer zones within their surroundings leading to high external nutrients loading via rainfall driven runoffs. Often, eutrophied waters lead to – in the best scenario- rooted macrophyte (emerged and submerged), unrooted floating or submersed macrophytes or – worse- microalgae of planktonic and benthic origins.

These micro- and macrophytes are often left cycled through the ponds or are cycled through quicker subsequent to the use of algae- and herbicides which generate nutrients rich sediment accumulation subsequently leaching nutrients back into the system and thus generating more plants and algae growth (i.e. nutrients internal loading). Thus, even when the external loading in nutrients is prevented, and even with a low water residence time, ponds remain eutrophic because of the high nutrients cycling in the sediment.

Unfortunately, many ponds found on Sanibel Island are eutrophied and exhibit some or all of the associated aforementioned systematic symptoms of eutrophication. The City of Sanibel has thus approached our limnology team to diagnose 6 ponds, 5 of which are ranked amongst the worst (i.e. with a condition drawing “concerns”) and one of which has good water quality (Table 1).

Table 1. Some of the water characteristics of the 6 ponds set forward to be studied. Note that all ponds are eutrophic and that the one with the best condition (Periwinkle Pines_SW) still is mid eutrophic. DO is supersaturated in the Dunes Lake 5 and in Sanctuary lake and it is likely linked to phytoplankton photosynthesis. The high pH in these ponds reflects this. Ponds do not seem to be impaired for ammonia and most of the total nitrogen is driven by particulates. This is not true for phosphorus as soluble reactive phosphorus encompasses for a large fraction of TP. With the exception of Tradewinds South Lake_Tahiti (freshwater pond), all ponds have brackish water.

Pond name	Station Lat	Station Long	IN	SRP	Chla	TN	TP	NH4	Nox	Salinity	CDOM	DO	DO	Turb	pH	TN / TP	Nut. limit	TSI	Trophic State	Surface area
	degrees	degrees	mg/l	mg/l	µg/l	mg/l	mg/l	mg/l	mg/l	ppt	mg/l	%	mg/l	NTU	au			au		acres
Chateau Sur Mer	26.4526	-82.1393	0.0455	0.076	21.55	2.07	0.083	0.0415	0.004	1.05	158	61	4.7	13.75	8.15	24.9	both	65	Eu+	2.15
Dunes Lake 5	26.4529	-82.0422	0.061	0.0855	53.5	2.805	0.147	0.051	0.01	2.15	163.5	107.5	9.15	12.5	8.75	19.1	both	76	Hyper	18.3

Periwinkle Pines_SW	26.4391	-82.0703	0.0375	0.04	7.8	1.54	0.0605	0.032	0.0055	0.6	197.5	54	4.35	5	8.05	25.5	both	55	Eu	0.53
Sanctuary Lake 7	26.4913	-82.1709	0.0445	0.3905	36.9	2.12	0.5515	0.0405	0.004	0.75	207	171.5	12.1	9.7	9.36	3.8	N	69	Eu+	1.38
Sanibel Island Golf Course	26.4408	-82.0523	0.086	0.066	72.6	3.6	0.093	0.076	0.01	1.3	140.3	NA	7	NA	NA	38.7	P	72	Hyper	2.0
Tradewinds South Lake_Tahiti	26.4532	-82.1411	0.0695	0.1295	135.2	3.875	0.192	0.0445	0.025	0.45	138.5	71	5.65	11.7	8.2	20.2	both	86	Hyper+	0.28

The objectives of such a study will be to:

- Determine the bathymetry of each pond using sonar technology
- Determine the muck accumulation in each pond using
    - First, sonar technology to determine where sediment accumulates
    - Second, groundtruth the findings from sonar technology via traditional sediment coring
- Determine submerged aquatic vegetation (SAV) using sonar technology and groundtruth some of the locations to validate sonar data.
- Analyze sediment and floc characteristics
    - sediment and floc thicknesses as well as sediment layers underneath these (e.g. marl, sand, limestone etc.)
    - dry weight “DW”, ash free dry weight “AFDW
    - total phosphorus (TP) and total nitrogen (TN) contents
- Bacteria community analysis using E-DNA techniques using $1,000 funding from FGCU internal grant on a selected set of ponds (funding secured)

Data from the various investigation mentioned above will be used to draw conclusions regarding how to rehabilitate the ponds and to create a typology of pond’s health based upon bacterial populations. In particular, based on the physico-chemistry of the water and sediment and the associated microbial populations, some ponds will be selected for being good candidates to alternatives to sediment or floc reduction (i.e. alternatives to dredging) via microbial treatments.

Ultimately, the rationale of the whole study would be to eventually select two or three ponds which are similar in terms of watershed uses and morphometry to the pond with good water quality to treat some of these ponds with beneficial bacteria using the commercially available products from the Cape Coral based company (www.microbelift.com). Treated ponds would then be compared the non-treated ponds and to the "control" non treated pond. This company approached our team to conduct such a controlled experiment but the idea will have to be revisited when the study described in this proposal is over as this will require funding from the company since water and sediment will have to be analyzed by another laboratory than the company providing the microbial treatment.

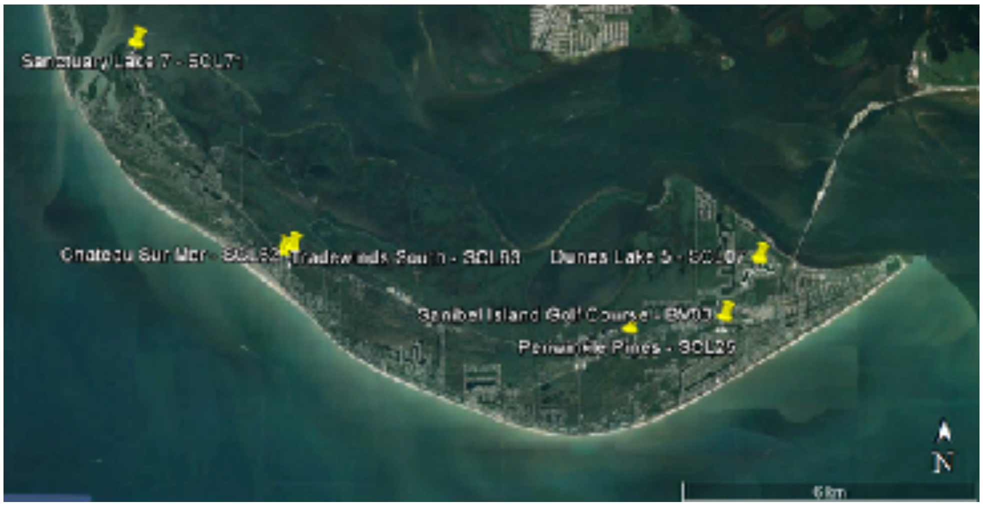

Figure 1. Satellite picture (2/17/16) of the ponds which will be studied. Refer to Table 1 for their characteristics.

B. Methods

Bathymetry

Prior to the bathymetry, staff gauges will have to be installed so that a stage-pond volume can be generated. Staff gauges will be inexpensive 2" by 4" posts driven into the sediment[1]. The top of each post to the surface of the water will be used as an altitude benchmark. This altitude (NGVD) will be precisely determined (generally to the near cm) with a Trimble™.

The bathymetry will consist in the uniform coverage of the entire pond surface with a boat/canoe equipped with a GPS/SONAR combo unit. The embarked Wide Area Augmentation System (WAAS) enabled GPS device will record the locations in UTM units (17R X, Y). WAAS accuracy is generally < 3m. Soundings will be made with the coupled SONAR (Z). Locations and soundings (X, Y, Z) will be logged onto the unit's memory and will be downloaded onto a PC for further data analyses (see below). The path of the boat will describe a tight square grid which warrants the production of an accurate bathymetric map.

Note that, to keep the budget low, no land surveying will be done within the emerged parts of each pond. The perimeter of the pond will be determined when the lake is full (or close to be).

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[1] It is a small footprint temporary solution to measure water level in the ponds. These posts can last several years if left undisturbed and a staff gauge ruler can be screwed onto them as an inexpensive option. Our group typically does not have the capability to install permanent staff gauges able to resist a hurricane for example. However, if piers or permanent structures are already in place in the pond, our group can install a staff gauge affixed to this permanent structure.

The data will be converted into maps using Surfer 12 (www.goldensoftwware.com) and cibiobase.com (an online computing service with special algorithms used to transform sonar data into vegetation height and bottom hardness).

Sediment

Because of the limited budget, sediment cores will be taken subsequent to the sediment survey via sonar mapping. A bottom hardness map will thus be generated using the same methodology used for the bathymetry (see above section). Note that this technique is still experimental. Coring locations will then be judiciously selected based upon the map generated.

Sediment and floc thicknesses will be performed once for each pond as it is not anticipated that the sediment characteristics will vary very significantly over the course of a year. Ponds which have a large size and/or a convoluted shape will require more sediment cores.

Once at the core sampling station, the Jon boat/canoe will be securely anchored and the sediment will be cored using a hand corer onto which is coupled a clear acrylic/polycarbonate tube. Various tube lengths (30 to 150 cm) and diameters (5-7 cm) will be used to accommodate the type of sediment encountered. Once retrieved, the clear tube containing the sediment will be uncoupled from the hand held corer. The core will then be measured to the nearest ½ cm. A (at least 10MP) picture of the core held in front of a white board will be taken with a digital camera. The core ID, water depth and total core length will be written on the board prior to taking the picture.

The core will then be extruded from bottom up so that the thickness of floc, unconsolidated sediment, consolidated sediment, and all other layers are measured, depending on the length of each core section) to the nearest mm or cm. The colors, texture of the different layers will also be recorded. Floc will be defined as the part of the sediment core that is not free standing when the core is extruded from the tube. The floc and the (free-standing) sediment core with the exception of the original lake bottom layer (generally sand, marl, clay or limestone) will be kept separately in two different and labeled Ziploc plastic bags. The samples will then be chilled at ~4ºC in a cooler.

In the laboratory, the floc and sediment volume will be determined, homogenized and split in 3 different fractions. A first fraction (~100ml) will be used for the determination of the bulk density and organic matter content. A second fraction (~200mL) will be dried at 80 ºC until constant weight, weighed, ground with a Bel-Art™ Micro-Mill grinder. The dry material can then be analyzed for various elements which will be discussed on a later date but which include: TP (total phosphorus, NELAC certified), TN (Total nitrogen) and TC (total carbon).

SAV

SAV will be mapped with Sonar in the similar fashion as for the bathymetry and the bottom hardness. SAV will be groundtruthed using some of the methods from Thomas and Everham, 2014 (SFWMD funded study on L. Trafford) which is attached to this proposal.

Water column (6 stations)

To be cost effective, all stations will match the ones provided with us and found in Table 1. This will be done at the end of the dry season when the pond is at possible worst condition (water being warm and concentrated with nutrients).

- An integrated water column sample will be collected and will be analyzed for water total phosphorus (TP), total nitrogen (TN), total chlorophyll, all the dissolved nutrients (NO_x, NH_4^+, PO_4^{3-}).
- Water clarity will be assessed with a Secchi disk and by lowering every 0.25m an irradiance 4Pi quantum type sensor (Licor™ LI193) connected to a Licor 1400 meter.
- Profiles of dissolved oxygen, temperature, pH/ORP, conductivity/salinity will be conducted with an In-Situ™ multisonde probe.
- Subsurface total alkalinity will be measured in the field with a HACH™ alkalinity kit.

Bacteria (not quoted in this proposal)

From the fresh sediment and floc collected, a subsample will be collected for bacteria analysis using E-DNA methods. This is planned to be done in all ponds at one central deep location only. Floc and sediment will likely have to be combined to save on costs.

C. Timetable of deliverables and payment schedule

Table 2. Timetable of deliverables and payment schedule.

	2016	2017						
Tasks	**Dec.**	**Jan.**	**Feb..**	**Mar.**	**Apr.**	**May.**	**Jun.**	**Jul.**
Staff gauge installation	X							
Pond bathymetry, pond hardness, submerged aquatic vegetation	X	X						
Water column characterization					X	X		
Floc and sediment coring	X	X						
Water analyses						X	X	
Sediment analyses		X	X					
Reporting (written)				Interim				Final
Payment schedule (USD)	$2,500			$1,000				$1,500

D. Budget

Table 3. Budget (note that many items below are free of charge)

POOL	City of Sanibel Island 10/16 to 07/17		%FTE	# mos.	YR 1 Request
6100	**Salaries & Benefits -Pool Account (Personnel)**				
	Serge Thomas (Pro bono)				$ -
	Total 6100 Pool				$ -
6200	**Temporary Employment- Pool Account**	pay/h	# hours		
	Undergraduate Student Assistant 2	$ 8.50	51		$ 433.50
	Fringe Benefits @ 7.65%				$ 33.16
	Graduate Student assistant time 1	$ 12.00	150		$ 1,800.00
	Fringe Benefits @ 7.65%				$ 137.70
	Total 6200 Pool				$ 2,404.36
6300	**Fringe Benefits for Personnel in 6100 Pool**				
	Serge Thomas (Pro bono)				$ -
	Total 6300 Pool				$ -
	Total Salaries				**$ 2,233.50**
	Total Fringe Benefits				**$ 170.86**
	Total Personnel Cost				**$ 2,404.36**
7300	**Other Operating Expenses Pool**	$cost	# station	# event	
	FGCU total chlorophyll	$ 7.42	6	1	$ 44.52
	Sediment TP, TN, TC, DW, AFDW	$ 48.18	22	1	$ 1,059.96
	Floc TP, TN, TC, DW, AFDW	$ 48.18	22	1	$ 1,059.96
	Miscellaneous (reference standard, instruments expendable items, posts)				$ 150.00
	Water Hyacinth Control lab analyses water TP, TN, dissolved: waived				$ -
	Bacteria already paid by FGCU via internal grant	$ 1,000.00		1	$ -
	Cibiobase.com online cloud computing @ $225/pond waived by company (Ed)	$ 1,350.00		1	$ -
	Total Operating Expenses				**$ 2,314.44**
7300T	**Travel**	$cost	# miles	# days	
	Travel to site for water sample (should be waived by FGCU)	$ 0.45	70	2	$ -
	Travel to site for sediment sampling (should be waived by FGCU)	$ 0.45	70	5	$ -
	Travel to site for bathymetry (should be waived by FGCU)	$ 0.45	70	3	$ -
	Toll	$6		30	$ 180.00
	Total travel				**$ 180.00**
7300C	**Charge back**				
	Fedex overnight shipping to laboratory				$ 100.00
	Total Direct Costs				**$ 4,998.80**
	Indirect Costs: 0% as requested by the sponsor				**$ -**
	TOTAL COSTS				**$ 4,998.80**