



## > Characterizing Lake Sediment Variability for Cost-effective TMDL Implementation

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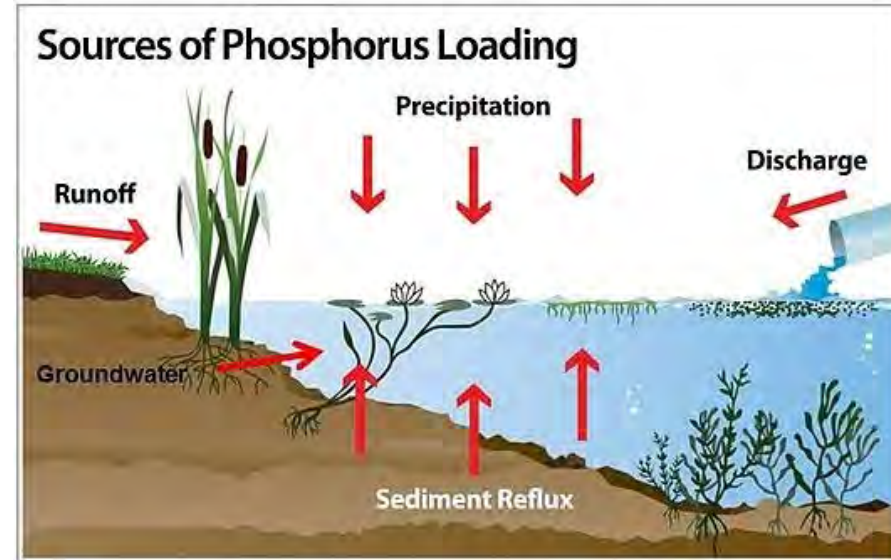


# > Outline

1. The Creature from the Black Lagoon
2. Project Background
3. Nutrient Removal Study
4. Data as a Tool
5. Applications

# > The Creature from the Black Lagoon

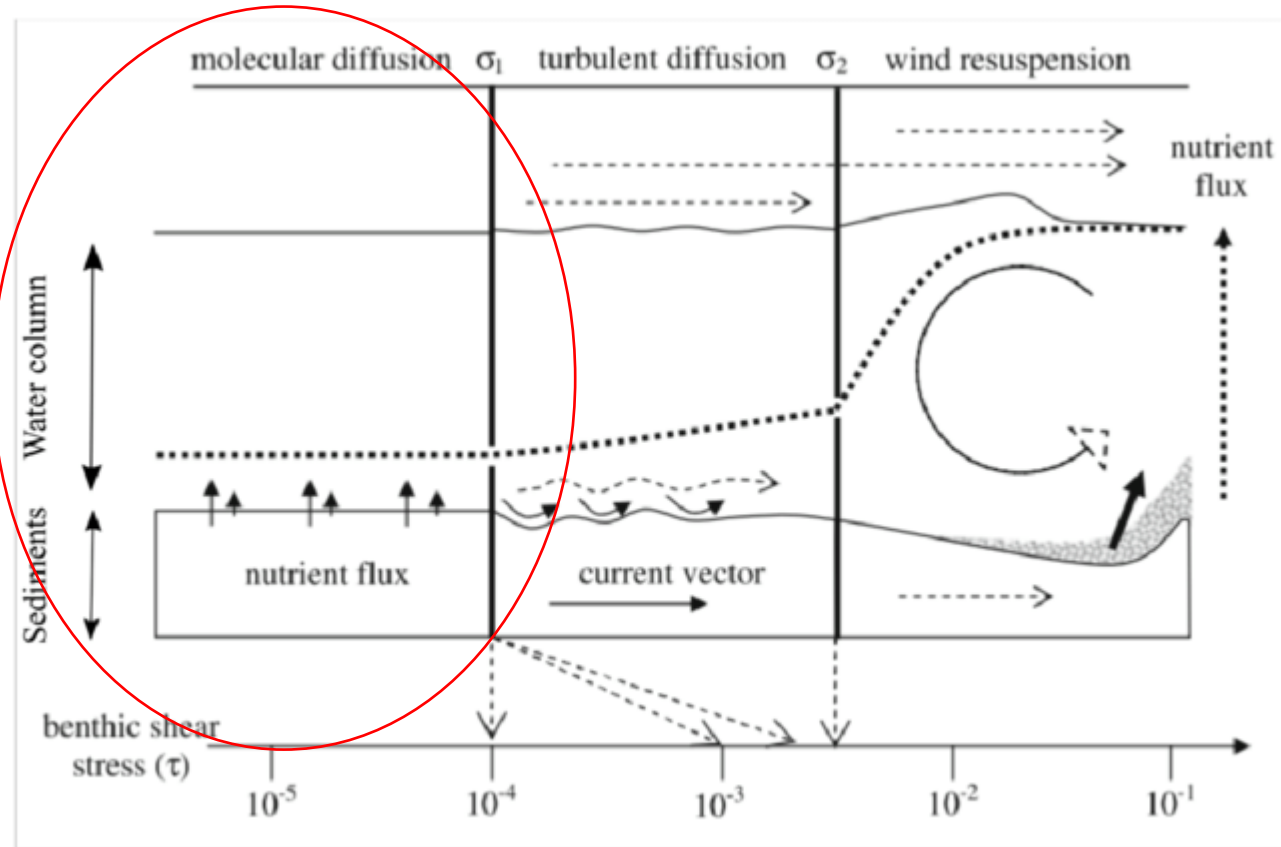
## OR Internal Nutrient Loads in Sediments



Source: SOLITUDE, 2021

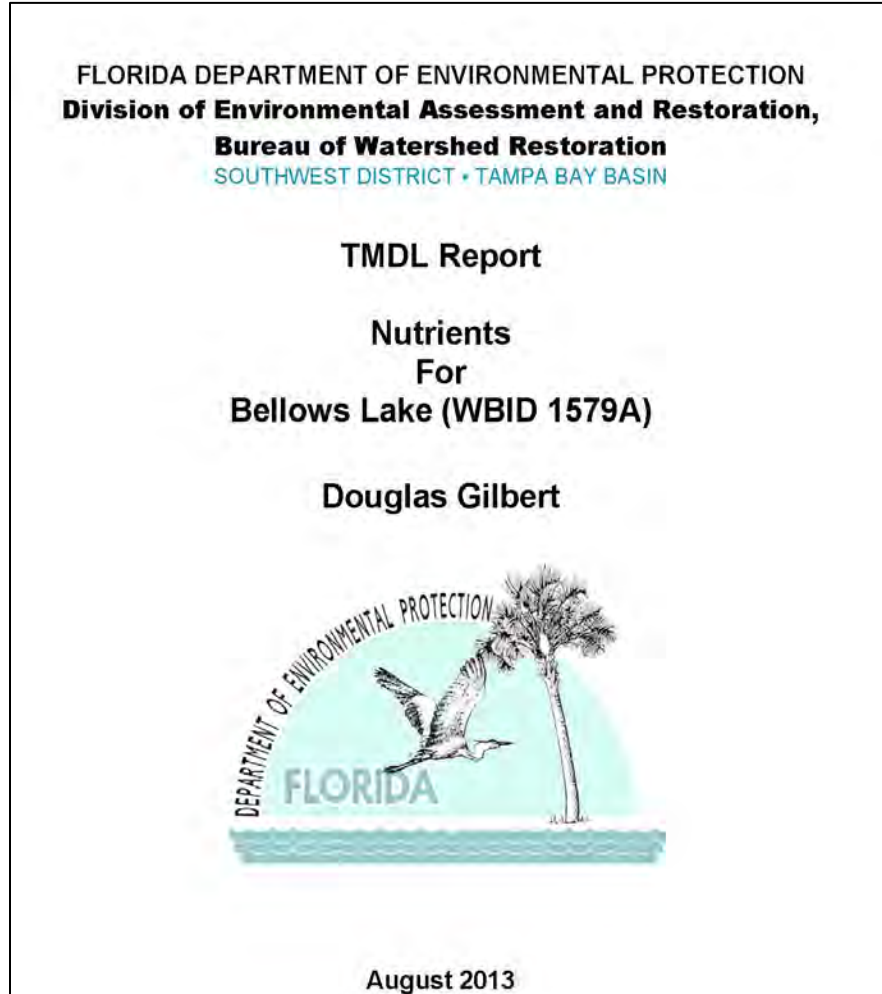
# > The Creature from the Black Lagoon

## OR Internal Nutrient Loads in Sediments



Source: Blottière, 2015

# > Project Background



**Table 6.1. TMDL Components for Nutrients and BOD<sub>5</sub> in East Lake (WBID 1579A)**

Parameter	WLA Wastewater	WLA NPDES Stormwater (% reduction)	LA (% reduction)	MOS
Total Nitrogen	N/A	30.5	30.5	Implicit
Total Phosphorus	N/A	33.3	33.3	Implicit
BOD <sub>5</sub>	N/A	63.3	63.3	Implicit

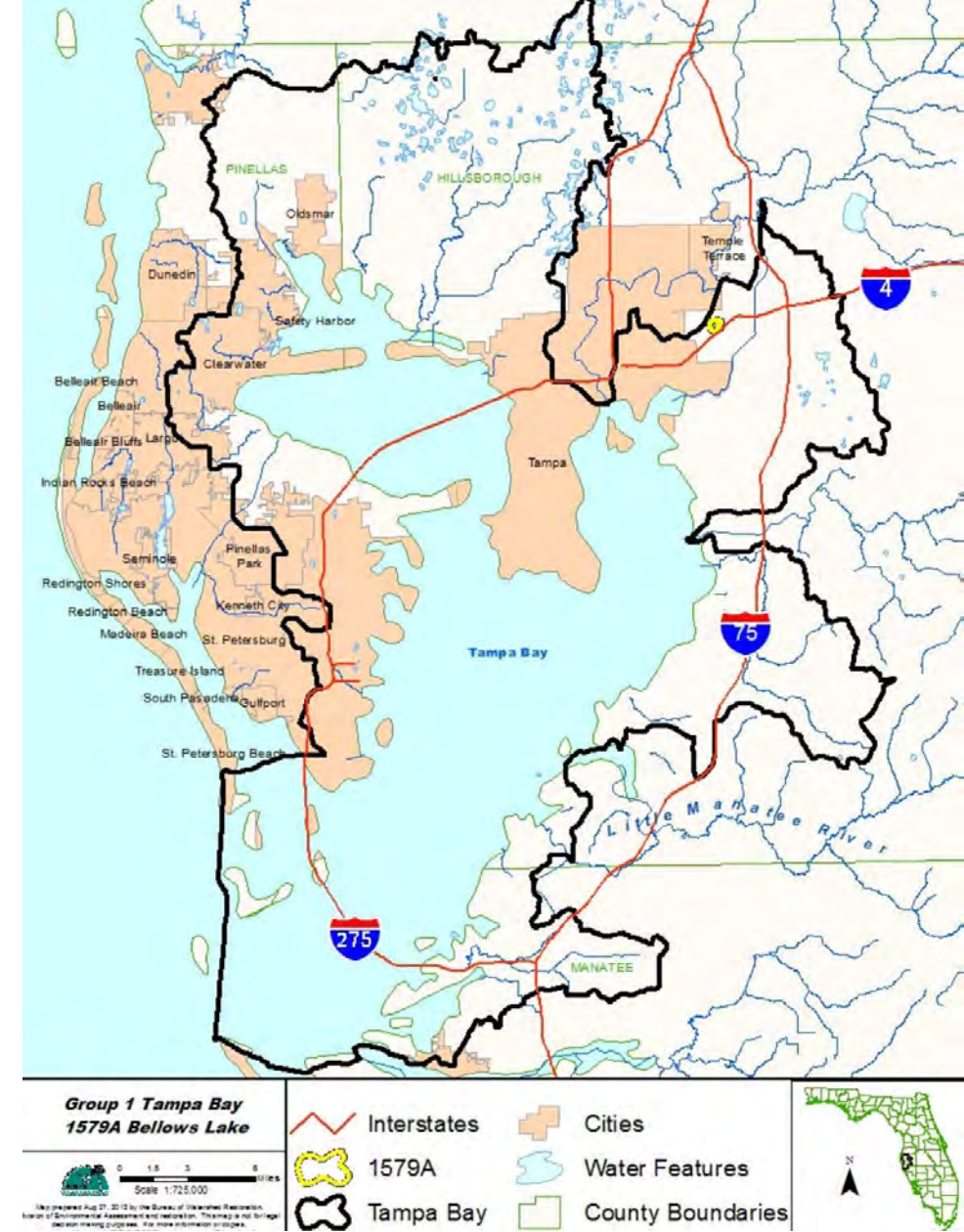
N/A – Not applicable.



# > Project Background

FLUCCs Code	Land Use	Modified WBID 1579 Acreage	Modified WBID 1579 % Acreage
1200	Residential Medium Density	10.7	1.6%
1300	Residential High Density	111.5	17.0%
1400	Commercial And Services	143.8	22.0%
1500	Industrial	130.4	19.9%
1700	Institutional	65.5	10.0%
1900	Open Land	19.4	3.0%
2100	Cropland And Pastureland	67.0	10.2%
4340	Hardwood Conifer Mixed	5.2	0.8%
5200	Lakes	4.2	0.6%
5300	Reservoirs	37.5	5.7%
6410	Freshwater Marshes	2.1	0.3%
6430	Wet Prairies	3.4	0.5%
6440	Emergent Aquatic Vegetation	1.6	0.2%
8100	Transportation	52.2	8.0%
	<b>Total</b>	<b>654.4</b>	<b>100%</b>

	TN (mg/L)	TP (mg/L)	BOD
Median	2.01	0.083	5.45
Criteria	1.4	0.055	2.00



# > Project Background

## Existing Lake Conditions





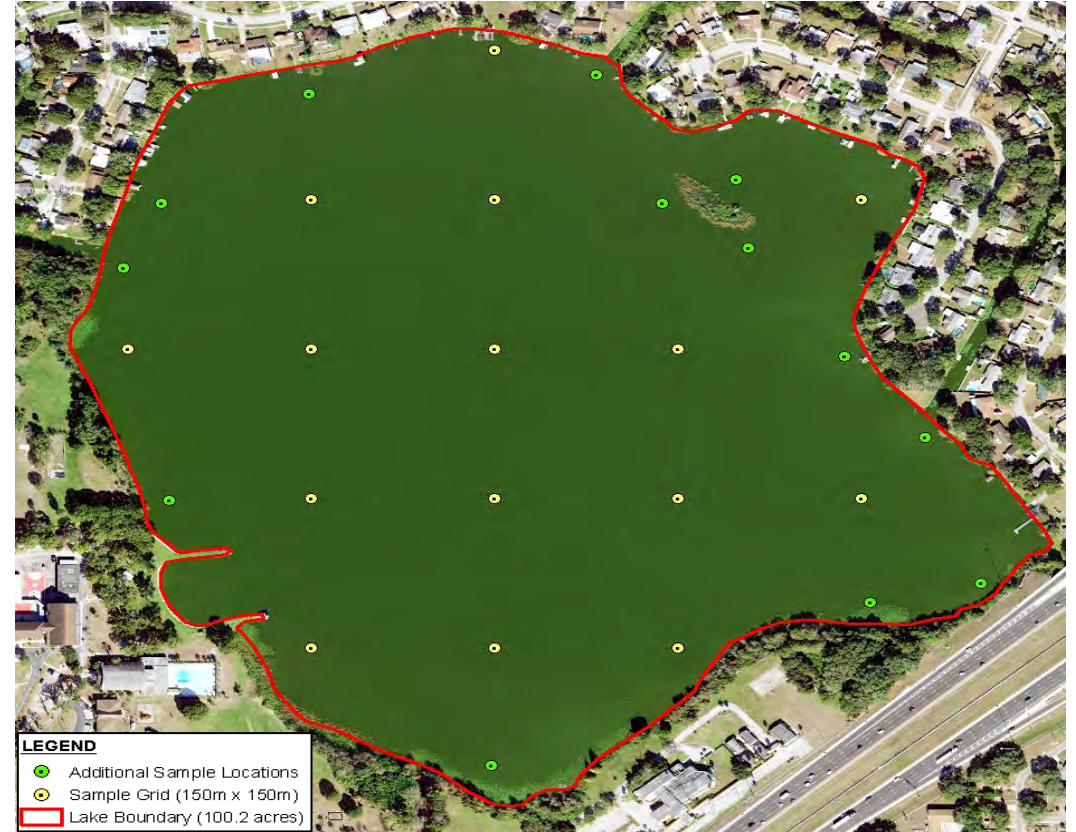
# > Project Background

## Existing Lake Conditions





# > Nutrient Removal Study



# > Nutrient Removal Study

Muck Depth

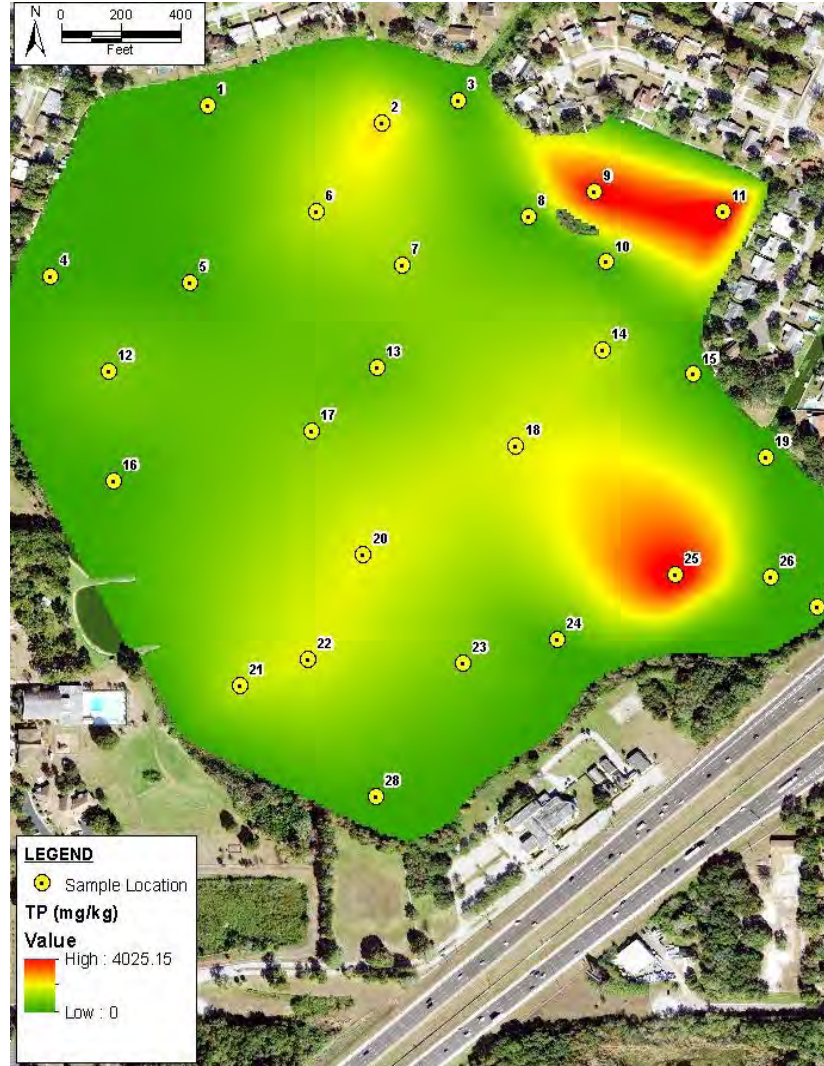


Sediment Grab Sampling





# > Nutrient Removal Study

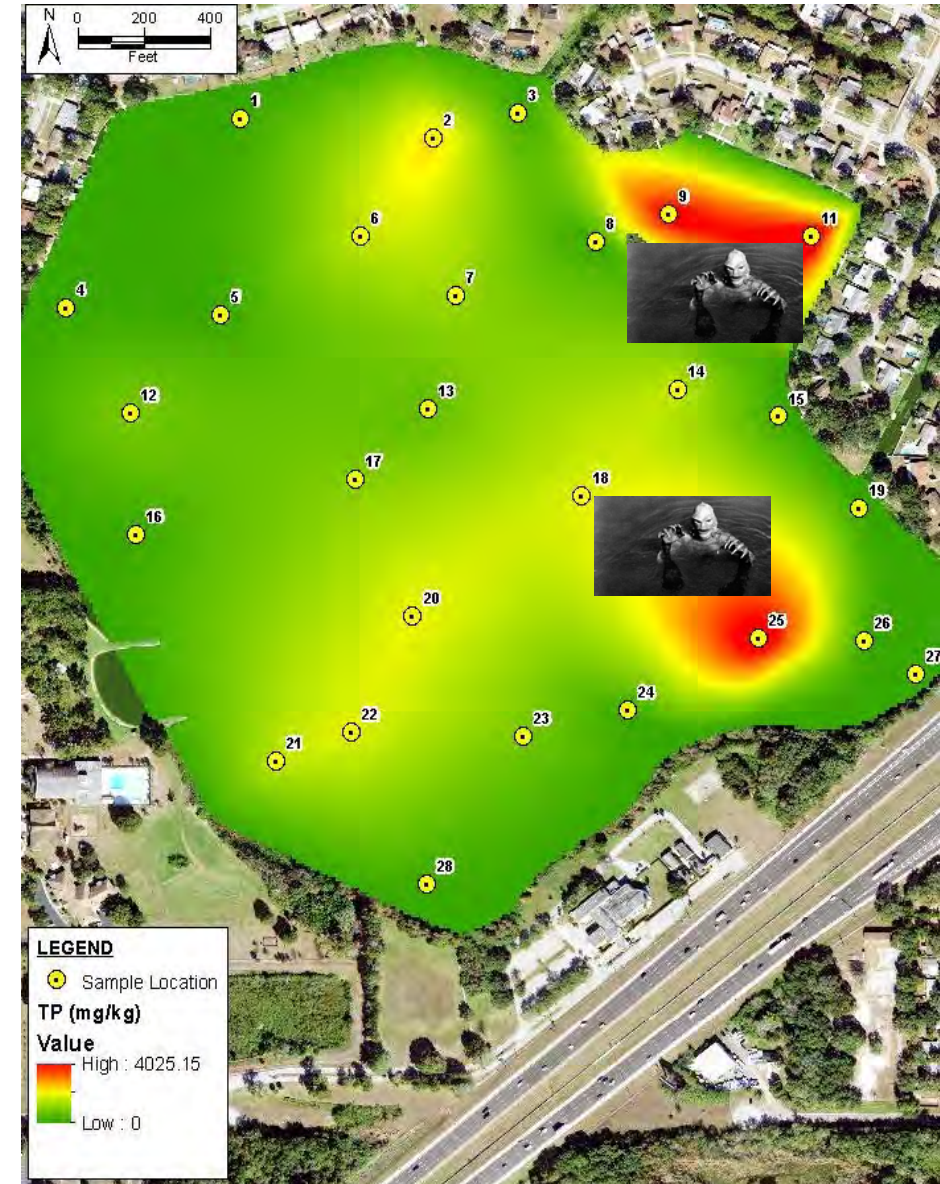




# > Nutrient Removal Study

## Lake Sediment Concentrations

- Source of P to lake? Probably, but need to look at flux
- Can we use targeted management? Seems likely (but need to look at flux)
- Where do we sample for flux? Where high TP is located (not necessarily deepest sediments)



# > Nutrient Removal Study





# > Nutrient Removal Study

## Lake Sediment Flux

Sample Location	Sample ID	TP Flux (mg m <sup>-2</sup> day <sup>-1</sup> )
Aerobic		
S-2	2-1	1.20
S-5	5-1	0.96
S-9	9-1	9.81
S-17	17-1	1.17
S-20	20-1	7.66
S-25	25-1	17.67

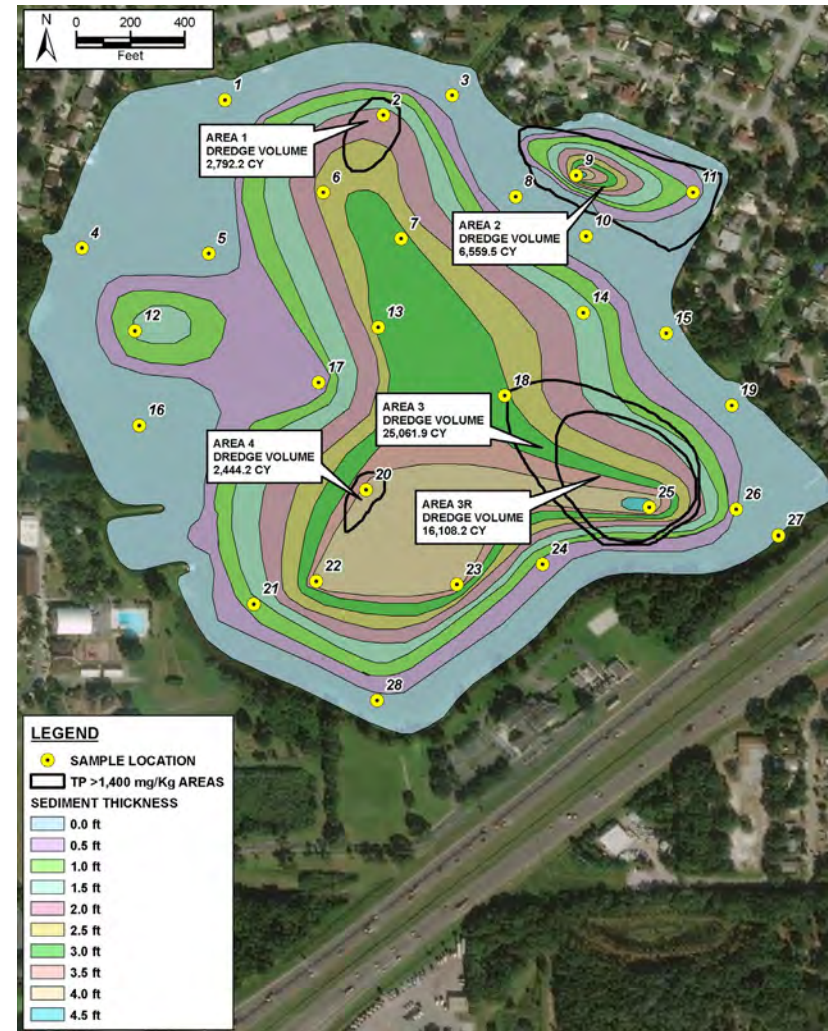
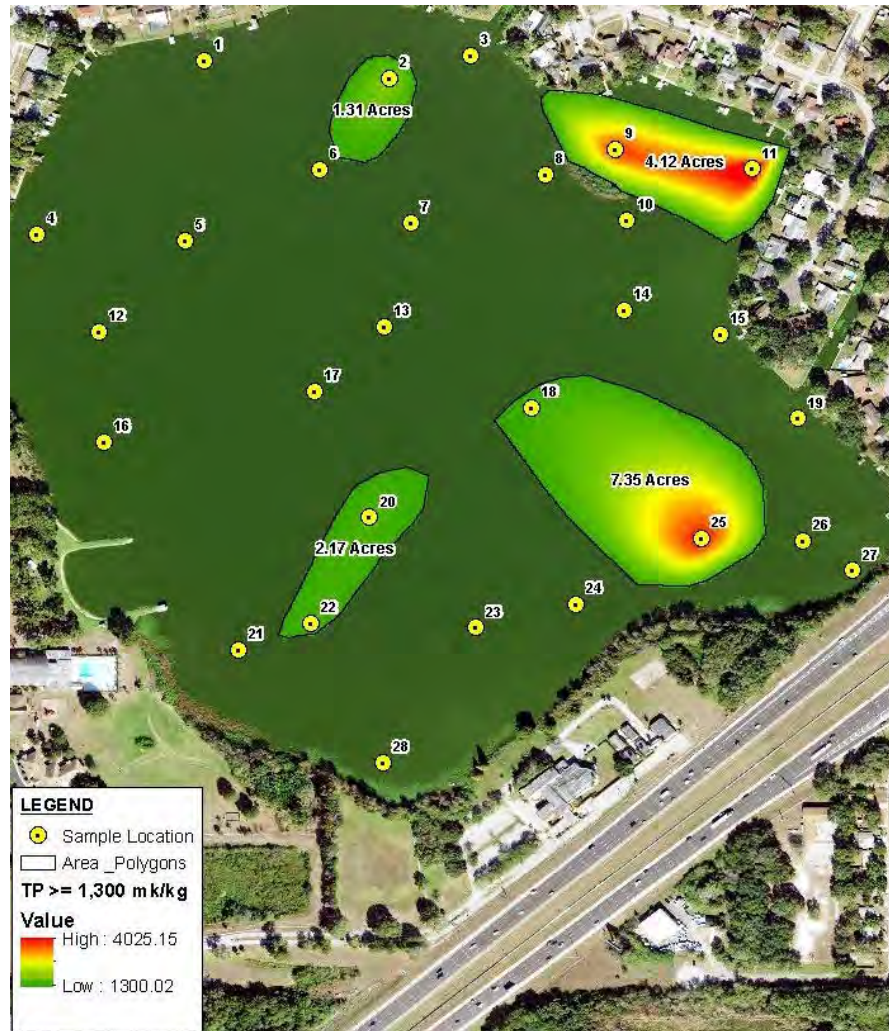








# > Nutrient Removal Study



# > Data as a Tool

Management Option	TP Load Removal (kg/yr)	% of Required Load Reduction	Estimated Dredge Volume (CY)	Estimated Cost (\$)	\$/kg TP	TP Load Removal (lbs/yr)	\$/lb TP
Dredge Area 1 only	1.42	0.30	2,792.2	\$223,376	\$157,022	3.14	\$71,244
Dredge Area 2 only	56.54	11.96	6,559.5	\$524,760	\$9,282	124.61	\$4,211
Dredge Area 3 only	159.19	33.67	25,061.9	\$2,004,952	\$12,595	350.86	\$5,714
<b>Dredge Area 3R only</b>	<b>97.60</b>	<b>20.64</b>	<b>16,108.2</b>	<b>\$1,288,656</b>	<b>\$13,203</b>	<b>215.11</b>	<b>\$5,991</b>
Dredge Area 4 only	4.53	0.96	2,444.2	\$195,536	\$43,179	9.98	\$19,591
Dredge Area 2 and 3	215.73	45.62	31,621.4	\$2,529,712	\$11,726	475.46	\$5,321
Dredge all Areas 1-4	221.68	46.88	36,857.8	\$2,948,624	\$13,301	488.58	\$6,035
Dredge expanded Areas 1-4 + expanded perimeters	287.29	60.76	64307.47	\$5,144,597	\$17,907	798.52	\$6,443

*Which objective is most important: % required load reduction, cost, or load removal?*

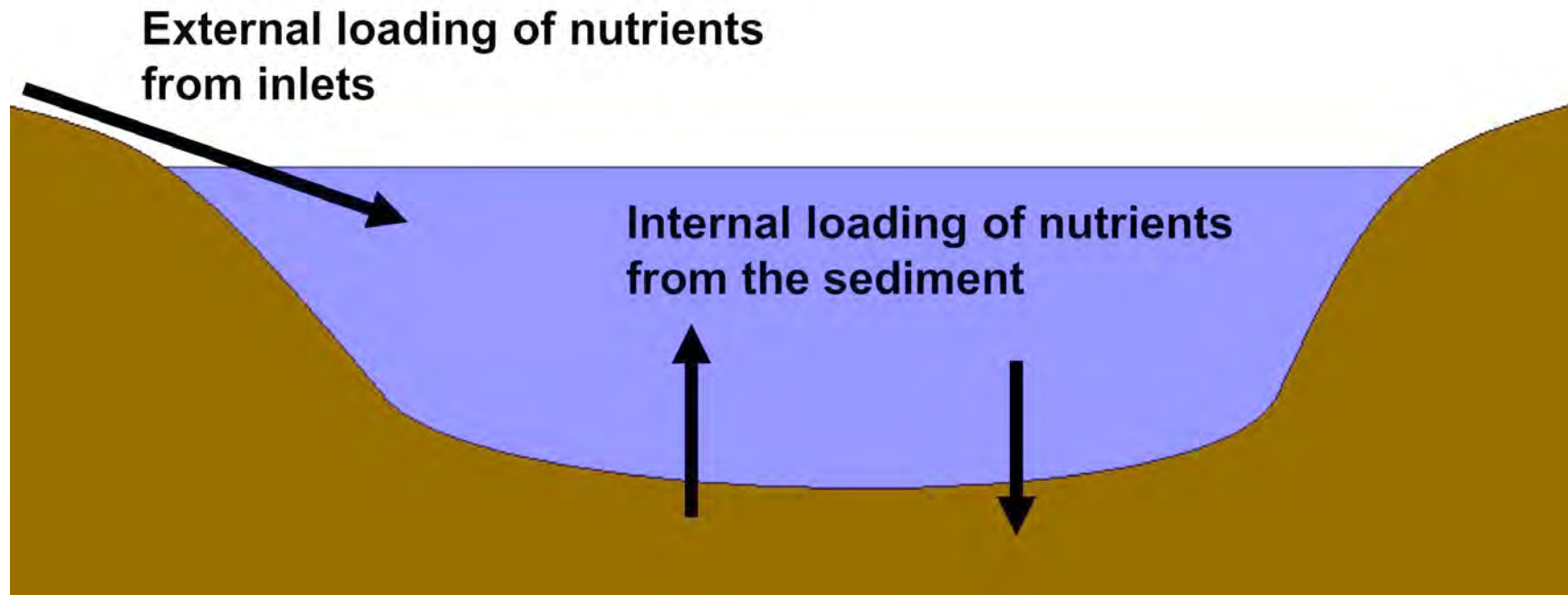


# > Data as a Tool

Site Location	East Lake	Standards				S-2	S-9	S-11	S-18	S-20	S-25
Analyte	Method	Units	Residential	Commercial	Groundwater Leachability	Result	Result	Result	Result	Result	Result
ARSENIC	EPA 6010	mg/kg	2.1	12	N/A	7	7.9	10	46	17	8
BARIUM	EPA 6010	mg/kg	120	130000	1600	22	19	27	54	47	43
CADMIUM	EPA 6010	mg/kg	82	1700	7.5	1.5	1.5	1.8	2	2.2	2.1
CHROMIUM	EPA 6010	mg/kg	210	470	38	29	28	35	23	26	42
LEAD	EPA 6010	mg/kg	400	1400	N/A	77	75	89	140	260	120
MERCURY	EPA 7471	mg/kg	3	17	2.1	0.24	0.31	0.3	0.29	0.34	0.45
SELENIUM	EPA 6010	mg/kg	440	11000	5.2	14	16	20	8.3	11	14
SILVER	EPA 6010	mg/kg	410	8200	17	2.8	3.1	4.1	1.7	2.1	2.8

# > Data as a Tool

## Use in Nutrient Budgets



*Accounts for about 1/3 of the unknown load*



# > Applications



## Cost Savings Engineering

Targeted dredging



## TMDLs

Credit allocation

-

Internal load contribution

-

BMAP development

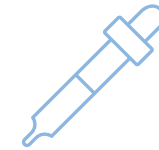


## Other Fluxes

Metals

-

Contaminants



## Evaluate Treatments

e.g. Phoslock

-

Aluminum, calcium, or clay amendments

-

Application rates

-

Efficacy

# > Questions?

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