CDM

City of Sanford Site 10 Data Evaluation

Presentation to Lake Jesup-Crane Strand-Long Branch BMAP Working Group

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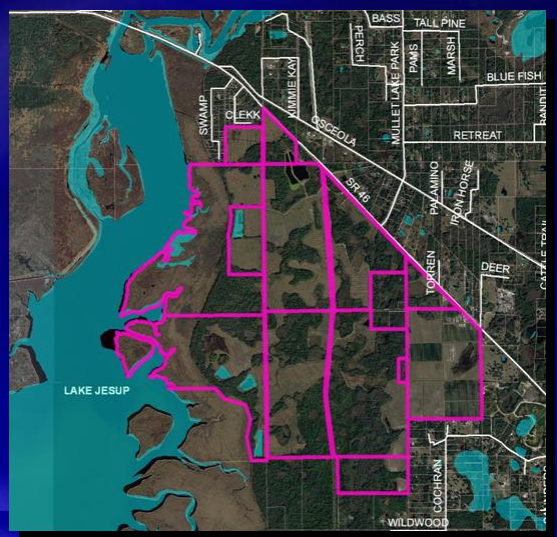
Agenda

- Site 10 Description
- Site 10 Operations
- On-Site Stormwater Management
- Loadings
  - Operations
  - Groundwater
  - Stormwater
- Summary & Conclusions

Site Description

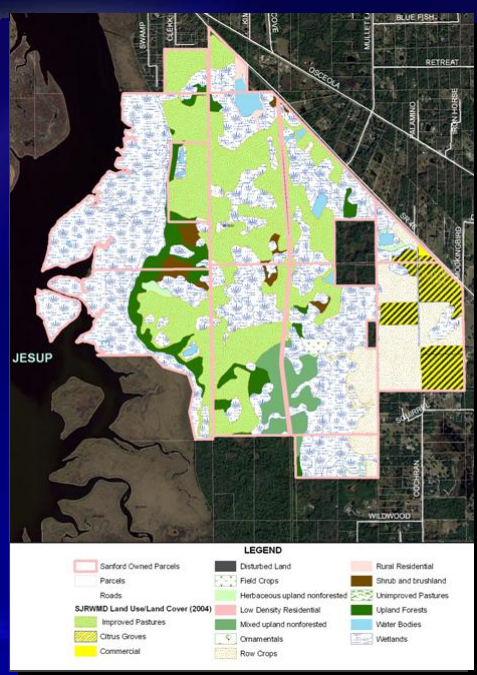
- Northeast shore of Lake Jesup
- Site 10 is comprised of ~1,868 acres
- Remaining area is marsh fringe
- Permitted capacity slow-rate public access reuse system



Site Description
(Cont.)

- Land Use - SJRWMD LULC (2004)
- Agriculture - 47%
- Wetlands - 38%

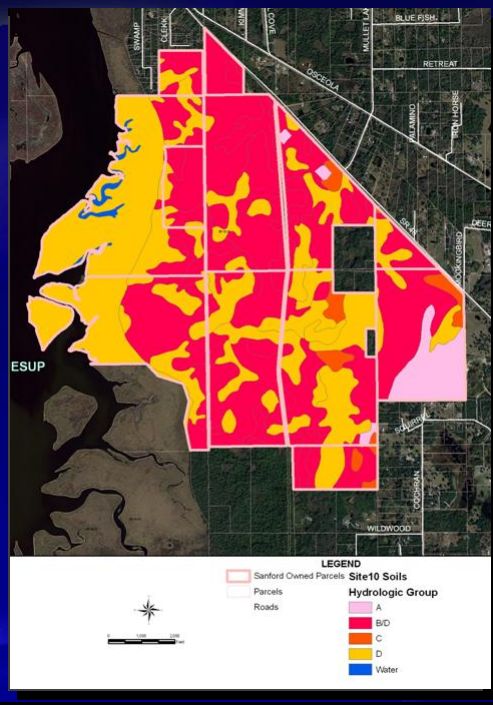
Land Use/Land Cover	Acres	Percent
Improved Pastures	568.53	**30.8%**
Citrus Groves	104.54	**5.7%**
Commercial	1.91	0.1%
Disturbed Land	0.99	0.1%
Field Crops	8.34	**0.5%**
Herbaceous upland nonforested	11.71	0.6%
Low Density Residential	2.90	0.2%
Mixed upland nonforested	73.85	4.0%
Ornamentals	0.01	0.0%
Row Crops	178.47	**9.7%**
Rural Residential	10.07	0.5%
Shrub and brushland	32.62	1.8%
Unimproved Pastures	0.03	0.0%
Upland Forests	117.66	6.4%
Water Bodies	35.68	1.9%
Wetlands	699.20	**37.9%**
Totals:	1846.51	100.0%



Site Description
(Cont.)

- Site 10 is dominated by B/D and D soils

Hydrologic Group	Acres	%
A	93.3	5.1%
B/D	1149.1	**62.2%**
C	54.7	3.0%
D	549.4	**29.8%**
Totals:	1846.5	100.0%



Site 10 Operations

- City currently holds a Domestic Wastewater Facility NPDES Permit
- Permitted capacity slow-rate public access reuse system
- Can discharge up to 2.84 MGD AADF to Site 10
- Additional 37 MG of reclaimed water storage at two holding ponds

Site 10 Operations *(Cont.)*

- 620 acres of hay fields are irrigated by seepage swales
  - Permitted to receive up to 1.94 MGD
- 270 acres of citrus groves are irrigated by a micro-jet irrigation system
  - Permitted to receive up to 0.9 MGD

Site 10 Operations *(Cont.)*

- During wet-weather, City is permitted to discharge up to 1.0 MGD AADF to the St. Johns River
- Discharge point is near the Interstate 4 bridge where it crosses Lake Monroe
- Permit also identifies Site 10 as an area where land spreading of residuals may occur

Site 10 Operations *(Cont.)*

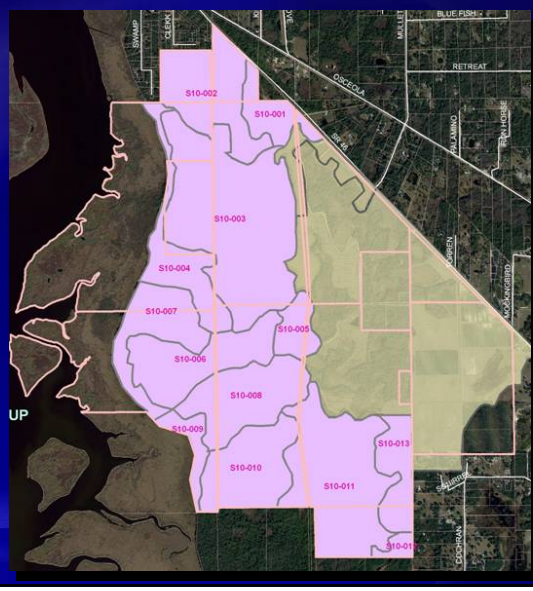
- Residual Application Points
- 7 to 10 loads of residuals are hauled to Site 10 every week
- Biosolids are spread within 24 hours of land application
- Weight of sludge ranges between 13 to 15 tons per load

Site 10 Stormwater Management

- *Irrigation and Stormwater Plan at Site 10* plans (CPH 1990)
- Swales, culverts and wet detention ponds serve the hay fields and citrus groves
- Ponds are served by overflow structures and bleed-down devices to allow discharge into adjacent wetland and forested areas

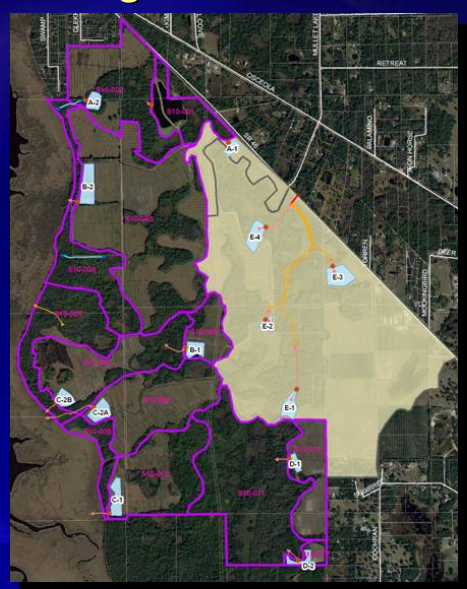
Site 10 Stormwater Management *(Cont.)*

- Contributing Area
  - *Mullet Lake Park Road Outfall Study* (Inwood, 2004)
  - Portion of Site 10 discharges towards Mullet Lake, which is outside of the Lake Jesup watershed
  - Resulting Site 10 area tributary to the Lake Jesup Watershed is 1,252 acres



Site 10 Stormwater Management *(Cont.)*

- Contributing Area
  - Delineated into 13 subbasins
  - 3 subbasins have potential to discharge directly to Lake Jesup
  - Holding ponds are equipped with an emergency discharge structure on the west side (overflow elevation is set at 19.5 ft-NGVD)



Loadings – Site 10 Operations

- Reclaimed Water and Biosolids Application
- TN & TP Loadings
- Actual & Theoretical Data
  - Discharge Monitoring Reports (DMRs)
  - Permitted flow rates
  - Personal communication with City (Biosolid loading rates)
  - Correspondence between City and FDEP

Loadings – Site 10 Operations *(Cont.)*

Field Nitrogen Loading due to Biosolids and Reclaimed Water Application

Field No.[1]	Field Acreage[2]	Field Acreage In Watershed	2003 Measured N Loading (lb/ac)	2004 Measured N Loading (lb/ac)	2005 Measured N Loading (lb/ac)	Average TN Loading Rate (lb/ac/yr)	TN Loading in Watershed (lb/yr)
F1	32.2	32.1	162.3	91.8	92.5	115.5	3,707.6
F2	15.3	15.3	371.0	91.8	92.5	185.1	2,832.0
F3	29.3	29.3	365.5	152.7	282.3	266.8	7,817.4
F4	42.5	41.6	398.7	91.8	373.7	288.1	11,985.0
F6	9.5	9.5	162.3	91.8	365.2	206.4	1,960.8
F8	97.1	58.8	343.9	91.8	168.6	201.4	11,842.3
F9	16.8	16.3	363.9	361.3	247.8	324.3	5,286.1
F11	42.3	42.3	162.3	374.1	92.5	209.6	8,866.1
F13	17.0	17.0	314.9	317.9	307.45	313.4	5,327.8
F14	15.2	15.2	390.7	335.7	388.4	371.6	5,648.3
F15	47.8	47.8	389.3	347.1	370.3	368.9	17,633.4
F16	13.7	13.7	289.5	396.1	92.5	259.4	3,553.8
F17	24.7	24.7	162.3	91.8	92.5	115.5	2,852.9
F18	11.6	4.7	162.3	91.8	92.5	115.5	542.9
	Total:	**368.3**					**89,856.4**

Loadings – Site 10 Operations *(Cont.)*

Estimated TP Loading rate due to Reclaimed Water

Average Measured Flow to Site 10 (MGD)	1.5	
	Hay Fields	Citrus Groves
% Distribution of Flow based on Permit Limits (1.94 vs. 0.9 MGD)	0.68	0.32
Resulting Flow (MGD) to Hay Fields vs. Citrus Groves	1.02	0.47
Average Measured TP to Site 10 (mg/l)	1.6	1.6
Site 10 TP Loading[1] (lbs/yr)	4,971.2	2,290.6
Total Acreage on Site 10	478.1	277.4
Total Acreage in Lake Jesup Watershed	368.3 (77.0%)	43.8 (16%)
Resulting TP Loading in Lake Jesup Watershed from Site 10 (lbs/yr)	3827.8	366.5
Resulting TP Loading in Lake Jesup Watershed from Site 10 (lbs/ac/yr)	10.4	8.4

1. Hay Fields: (1.6 mg/l X 8.3454lb/MG) X (1.02MG/Day) X (365Days/yr) =4,971.2 lb/yr
Citrus Groves: (1.6 mg/l X 8.3454lb/MG) X (0.47MG/Day) X (365Days/yr) =2,290.6 lb/yr

Loadings – Site 10 Operations *(Cont.)*

Estimated TP Residual Loadings

Residual TN and TP Concentrations (% Dry Weight)

Year/Parameter	TN (%)	TP (%)
2002	7.22	3.22
2003	7.32	3.15
2004	6.43	3.02
2005	8.05	3.94

- 7 to 10 loads of residuals are hauled to Site 10 every week
- Biosolids are spread within 24 hours of land application
- Weight of sludge ranges between 13 to 15 tons per load

Loadings – Site 10 Operations *(Cont.)*

Estimated TP Residual Loading Rates

Average number of loads delivered per week (average of 7 to 10 loads per week)	8.5 loads/week
Average number of loads delivered per day	1.2 loads/day
Average ton of residuals per load (average of 13 to 15 tons per load)	14 tons/load
Total tons of residuals delivered per year[1]	6,132 tons/yr
Dry Weight of Solids Delivered per year[2]	920 tons/yr
Average of 2003-2005 Percent Dry Weight Values of TP	3.33%
Average TP Loading[3]	60,707 lb/yr
Average Loading Rate of TP applied to hayfields in watershed (lb/ac/yr)[4]	164.8 lb/ac/yr

1.14 tons/load X 1.2 loads/day X 365days/yr=6,132 tons/yr
2.6,132 tons/yr X 15% solids content = 920 tons/yr
3.920 tons/yr X 0.033 X 2000lb/ton = 60,707 lb/yr
4.(60,707 lb/yr) / (368.3 ac) = 164.8 lb/ac/yr

Loadings – Site 10 Operations *(Cont.)*

- **Estimated TP Loadings**
  - **Based on documentation for TN loading, in some years certain fields received only biosolids, reclaimed water and/or both)**
  - **Assumed same combination of biosolids and reclaimed water application for each of the fields that was documented for N loadings**

Loadings – Site 10 Operations *(Cont.)*

Total Estimated TP Loading

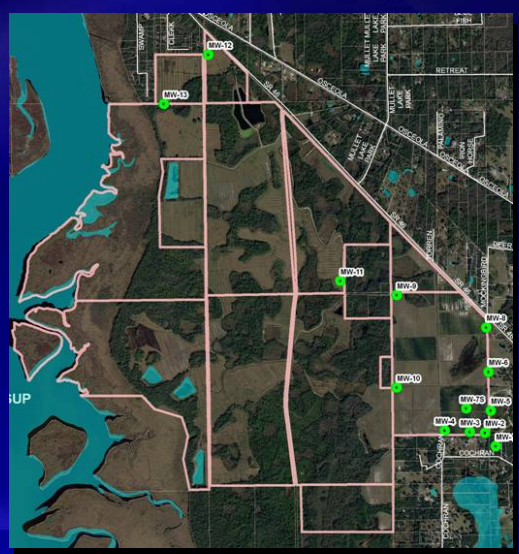
Resulting TP Loading in Lake Jesup Watershed from Reclaimed Water (from Table 1):					**10.4**	lbs/ac/yr	
Average Loading Rate of TP from Residuals applied to hayfields in watershed (Table 4):					**164.8**	lbs/ac/yr	
Field No.	**Total Acreage[1]**	**Acreage in Watershed**	**Estimated 2003 Loading Rate (lb/ac)**	**Estimated 2004 Loading Rate (lb/ac)**	**Estimated 2005 Loading Rate (lb/ac)**	**Average TP Loading Rate 2003-2005 (lb/ac/yr)**	**TP Loading in Watershed[2] (lb/yr)**
F1			R	R	R		
	32.2	32.1	10.4	10.4	10.4	10.4	333.8
F2			B&R	R	R		
	15.3	15.3	175.2	10.4	10.4	65.3	999.6
F3			B&R	B&R	B&R		
	29.3	29.3	175.2	175.2	175.2	175.2	5,133.4
F4			B&R	R	B		
	42.5	41.6	175.2	10.4	164.8	116.8	4,858.9
F6			R	R	B&R		
	9.5	9.5	10.4	10.4	175.2	65.3	620.7
F8			B&R	R	B&R		
	97.1	58.8	175.2	10.4	175.2	120.3	7,071.7
F9			B&R	B	B&R		
	16.8	16.3	175.2	164.8	175.2	171.7	2,799.3
F11			R	B&R	R		
	42.3	42.3	10.4	175.2	10.4	65.3	2,763.6
F13			B&R	B	B		
	17	17	175.2	164.8	164.8	168.3	2,860.5
F14			B	B&R	B		
	15.2	15.2	164.8	175.2	164.8	168.3	2,557.7
F15			B&R	B	B		
	47.8	47.8	175.2	164.8	164.8	168.3	8,043.1
F16			B&R	B	R		
	13.7	13.7	175.2	164.8	10.4	116.8	1,600.2
F17			R	R	R		
	24.7	24.7	10.4	10.4	10.4	10.4	256.9
F18			R	R	R		
	11.6	4.7	10.4	10.4	10.4	10.4	48.9
Total Acres in Watershed:		**368.3**			**Total Loading in Watershed:**		**39,948.1**

R - Reclaimed Only
B - Biosolids Only
B&R - Biosolids and Reclaimed

1. Field acreages were obtained from a GIS layer originally provided by the City showing the field locations. These were then subsequently edited to match the extents shown on the CP&H plans and verified using the 2004 aerial digital orthophoto quads available from the SJRWMD. Acreages were then calculated using GIS capabilities.
2. Product of loading rate (lb/yr/ac) x area

Loadings – Groundwater

- Estimate potential nutrient loading to Lake Jesup through groundwater seepage
  - Natural groundwater flow direction is towards Lake Jesup
  - 13 monitoring wells at Site 10 (water levels and nitrate levels)
  - Historical lake level data for Lake Jesup



Loadings – Groundwater *(Cont.)*

- Dupuit equation used to estimate the groundwater flow rate in an unconfined aquifer

$$q = \frac{K_h}{2x}\left(h_1^2 - h_2^2\right) = \frac{Q}{w}$$

- q= flow per unit width of aquifer or specific discharge (ft^2/day)
- K_h = horizontal hydraulic conductivity of the aquifer (ft/day)
- x = the horizontal distance between two points h1 and h2 (ft)
- h_1 = head at location 1 above the impermeable unit (ft)
- h_2 = head at location 2 above the impermeable unit (ft)
- W = cross-sectional flow width (ft)
- Q = volumetric groundwater flow rate (ft^3/day)

Loadings – Groundwater *(Cont.)*

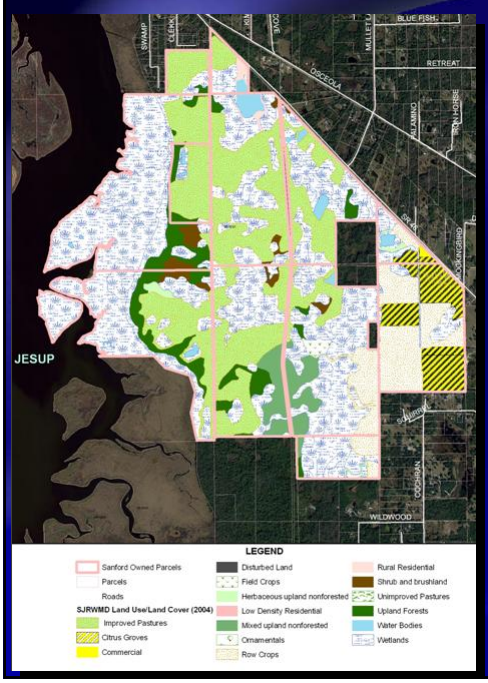
Groundwater flow rate parameters

Parameter	*Description*	*Units*	*Average Value*
K_h	*Horizontal hydraulic conductivity*	*ft/day*	*3.5*
x	*Horizontal distance between MW-13 and Lake Jesup*	*feet*	*1,471*
h_1	*Head in MW-13*	*feet*	*33.6*
h_2	*Head in Lake Jesup*	*feet*	*27.51*
q	*Flow per unit width to Lake*	ft^2/day	*0.44*
w	*Cross-section width*	*feet*	*12,000*
Q	*Volumetric GW flow rate*	ft^3/day	*5,173*

Loadings – Groundwater *(Cont.)*

Mass Loading of Nitrate to Lake Jesup

Well	Water Level (ft)	x (ft)	h1 (ft)	h2 (ft)	q (ft^2/d)	w (ft)	Q (ft^3/day)	C (mg/l)	M (lb/day)
MW-1	23.3	10514.4	48.3	27.5	0.26	12000	3145.9	0.02	0.003
MW-2	41.2	10269.2	66.2	27.5	0.62	12000	7419.7	0.01	0.006
MW-3	42.5	9840.0	67.5	27.5	0.67	12000	8097.8	3.81	1.925
MW-4	45.2	9196.3	70.2	27.5	0.79	12000	9534.8	0.01	0.009
MW-5	29.3	10483.7	54.3	27.5	0.37	12000	4382.6	2.05	0.562
MW-6	32.4	10667.7	57.4	27.5	0.42	12000	5005.2	2.77	0.867
MW-7s	39.3	9778.7	64.3	27.5	0.60	12000	7250.9	9.89	4.476
MW-8	27.6	10851.6	52.6	27.5	0.32	12000	3887.1	0.04	0.009
MW-9	18.2	9012.3	43.2	27.5	0.21	12000	2577.1	0.03	0.005
MW-10	14.9	8062.2	39.9	27.5	0.18	12000	2174.5	1.39	0.189
MW-11	15.8	5119.3	40.8	27.5	0.31	12000	3724.1	0.02	0.004
MW-12	13.3	3126.7	38.3	27.5	0.40	12000	4743.5	0.02	0.005
MW-13	8.6	1471.4	33.6	27.5	0.44	12000	5306.7	0.02	0.008
				Average	***0.43***	***12000***	***5173.07***	***1.54***	***0.50***



Loadings – Surface Runoff

- Watershed Management Model (WMM)
- Conceptually evaluate TP and TN loadings
- Update loading analysis using land use that is representative of land cover
- Also accounted for BMP treatment (wet detention ponds)

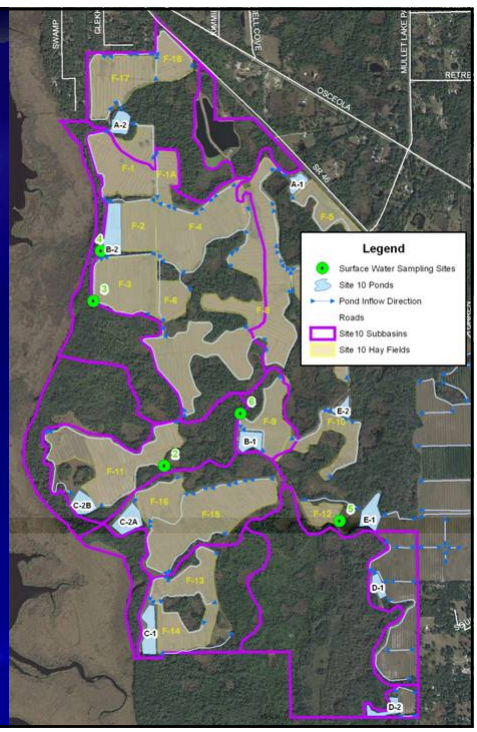
Loadings – Surface Runoff *(Cont.)*

Event Mean Concentrations

SJRWMD Land Use Land Cover (2004)	Consolidated WMM Land Use	TP (mg/l)	TN (mg/l)
Improved Pastures	Agriculture – Pasture[1]	0.48	2.48
Row Crops	Agriculture – Row Crops[1]	0.56	2.68
Herbaceous upland nonforested; Shrub and brushland; Mixed upland nonforested; Pine flatwoods; Upland mixed coniferous/hardwood	Forest/Rural Open	0.05	1.25
	Industrial	0.31	1.79
Low Density Residential	Low Density Residential	0.44	1.97
Reservoirs	Water	0.11	1.28
Bay swamp; Mixed wetland hardwoods; Cabbage palm hammock; Cypress; Hydric pine flatwoods; Wetland forested mixed; Freshwater marshes; Emergent aquatic vegetation; Mixed scrub-shrub wetland – these areas represent impacted wetlands based (FDEP 2005)	Wetlands	0.19	1.60
Unimpacted wetlands (taken from FDEP 2005)	Wetlands 2	0.06	1.25

Loadings – Surface Runoff *(Cont.)*

- WMM Results
  - 4 to 7 lbs/ac/yr for TN
  - 0.2 to 0.7 lbs/ac/yr for TP
- Stormwater Sampling
  - 4 sites sampled within tributary area
  - 3 sites are within swales prior to pond discharge
  - 1 site within pond



Loadings – Surface Runoff *(Cont.)*

Surface Water Concentration & EMC Comparisons

	TP	TN
EMC (mg/l)	0.48	2.48
Range of Measured Concentration (mg/l)	0.15 to 1.05	2.4 to 2.8
Median Concentration (mg/l)	0.35	2.10
Mean Concentration (mg/l)	0.64	2.57

Summary & Conclusions

- Site 10 Operations
  - Total estimated loading of TN at Site 10 due to both biosolids and reclaimed water application is 89,856 lb/yr
  - Total estimated loading of TP due to both biosolids and reclaimed water application is estimated to be 39,948 lb/yr
  - Does not account for plant uptake or soil absorption (should be considered when determining the overall potential net loading to the watershed)

Summary & Conclusions *(Cont.)*

- Groundwater
  - Average nitrate mass loading to Lake Jesup is estimated to be 0.50 lb/day or 182 lbs/year (TP data not available)
  - Compared to background conditions (early 1990s), nitrate concentrations in several of the wells have decreased over time while levels have increased in others
  - Wells closest to the lake (MW-12 and MW-13) have consistently had relatively low levels of nitrate (i.e., 0.02 mg/l) over the period of interest

Summary & Conclusions *(Cont.)*

- Groundwater
  - Technical Subcommittee of the Working Group
    - FDEP has suggested to install some additional temporary SAS wells to collect more data closer to the lake

Summary & Conclusions *(Cont.)*

- Surface Loading Estimates Within Watershed
  - 6,107 lbs/yr of TN
  - 573 lbs/yr of TP
- Comparison to EMCs
  - Measured TN concentrations fairly consistent with the EMCs reported for unaffected pasture
  - Measured TP concentrations have a wider range
  - Mean TP concentration is somewhat higher than the EMC, while the median concentration is lower

Summary & Conclusions *(Cont.)*

Surface Loading Comparisons to the Lake Jesup Subwatershed

	Lake Jesup Subwatershed (FDEP)	Site 10 (CDM)	Percent of Total Estimated Loading
Simulated Mean TN loading (tons/yr)	61.3	3.05	5.0%
Simulated Mean TP loading (tons/yr)	5.1	0.29	5.7%

Summary & Conclusions *(Cont.)*

Surface Loading Comparisons to FDEP Predicted Loadings for Site 10

	Site 10 (FDEP)	Site 10 (CDM)	Percent of Total Estimated Loading
Simulated Mean TN loading (tons/yr)	9.5	3.05	32.1%
Simulated Mean TP loading (tons/yr)	0.62	0.29	47%

Site 10 Future still to be Determined

- **Possibilities**
  - **Receiving Area for Lake Jesup Dredging Spoils**
  - **Reclaimed Water from Site 10 to be sent to Volusia County**
  - **Surface Water Treatment Plant – to provide water to Cities of Oviedo & Winter Springs**

Questions??