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January 14, 2020

Via electronic mail to Theodore.Saltos@FloridaDEP.gov

Re: St. Lucie River and Estuary Basin Management Action Plan Draft Update
Public Comment Period
Martin County Comments on Draft BMAP Update

Dear Mr. Saltos,

The Martin County Board of County Commissioners (Martin County or the County), on behalf of its 147,000 residents, appreciates the opportunity to provide comments on the Florida Department of Environmental Protection's (DEP) St. Lucie River and Estuary Basin Management Action Plan (BMAP) Draft Update. This letter expresses the County's concerns and recommendations regarding updates to the BMAP modeling approach, proposed management practices for managing nutrient reductions, the revised monitoring plan, and numerical errors found on the County's project list.

I. WaSh Model Concerns

The WaSh model serves as the basis for the Total Maximum Daily Load (TMDL), as well as the load allocation reductions mandated through the BMAP. As such, it is critical that the model accurately represents not only the existing conditions of the St. Lucie Estuary (SLE) system, but also the response of the estuary to specific actions taken to achieve nutrient load reductions that would result in the water quality improvements sought. With this as the guiding principle, a review of the WaSh model developed for the SLE for the determination of the TMDL indicated several concerns related to model assumptions and the overall calibration process. Several of these concerns are detailed below:

1. WaSh Model: Lake Okeechobee Future TN load

Lake Okeechobee is presently the single largest TN load source to SLE when calculated on an annual basis; therefore, controlling TN-loaded effluent from Lake Okeechobee remains critical to water quality improvements in SLE. It is of great concern that the SLE TMDL assumes that future load reductions from the Lake will occur. The SLE TMDL (FDEP, 2008) states that:

"Through modeling work done by SFWMD it has been determined that through the reduction of TP levels, TN levels will also decrease to a value of approximately 1.4 mg/L (Tom James, SFWMD, Pers. Comm. 2008)."

Therefore, achieving the goals of the SLE TMDL depends heavily on an unsubstantiated assumption with no reported analysis that TN reductions in the Lake can be calculated as a simple correlation with TP levels. Without a TMDL for TN in Lake Okeechobee, it is impossible to verify this claim. This is especially problematic due to the large-scale episodic TN releases that adversely impact SLE water quality, as illustrated in Figure 1. For example, in 2004 and 2005, TN values during the highest Lake Okeechobee releases exceeded 2.5 mg/L and were consistently well above the long-term TN average for Lake Okeechobee releases of 1.84 mg/L. In order to understand the profound impact of TN concentrations from Lake Okeechobee releases on downstream estuarine water quality, especially during time periods of significant freshwater discharge from the Lake, a more accurate data-driven representation of TN concentrations associated with likely future Lake releases is needed for the TMDL.

Recently, researchers from University of Florida indicated similar concerns related to the need for nitrogen management within the lake, where they concluded:

"Without decreasing nutrient concentrations in the discharged lake water, the only way to reduce loading to the estuaries is to curtail releases of water from the lake to the estuaries. A strategy that combines reducing N concentrations and reducing releases to the estuaries during wet periods would be the best way to reduce the deleterious impacts of N loading into the sensitive northern estuaries. Potentially valuable strategies for reducing N loading from the lake include: establishing a nitrogen Total Maximum Daily Load (TMDL) and Basin Management Action Plan (BMAP) for Lake Okeechobee; managing Lake Okeechobee to increase denitrification within the lake; and/or building stormwater treatment areas east and west of the lake to remove nitrogen before water is discharged to the estuaries."

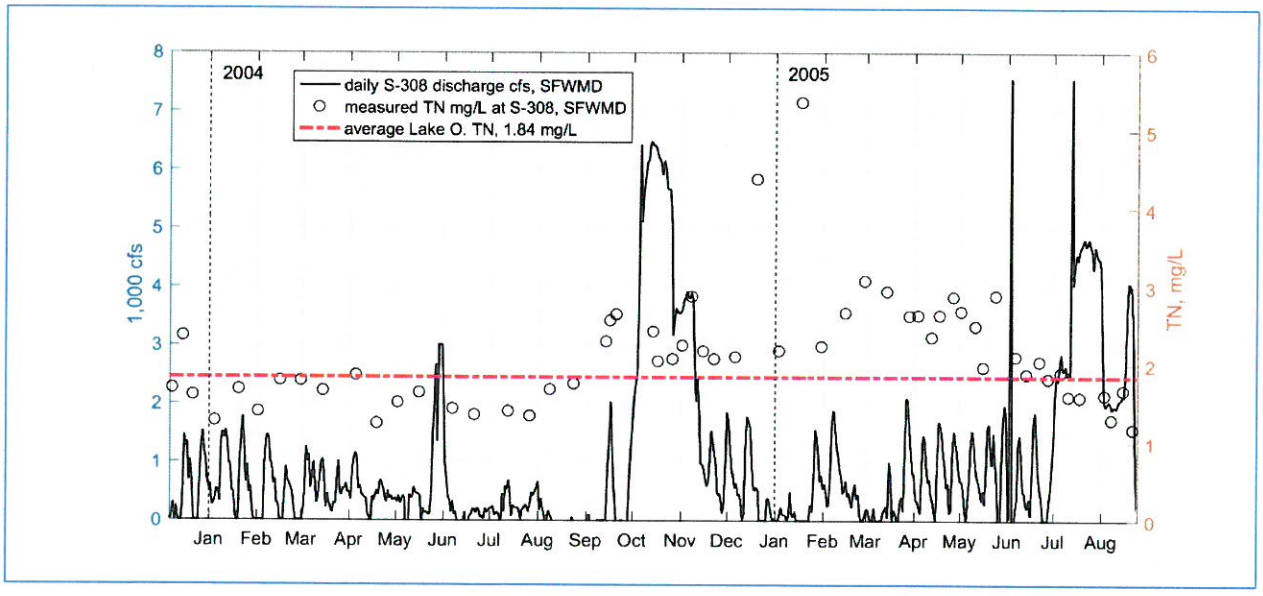

Figure 1. TN concentrations and flow rates from Lake Okeechobee releases for January 2004 and August 2005. The long-term average TN concentration for releases is shown by the dashed red line with a value of 1.84 mg/L.

2. WaSh Model: Estuary Representation

The WaSh model is primarily a watershed hydrologic and water quality model that incorporates a one-dimensional (1D) hydrodynamic model used to simulate flow through natural and man-made flow

channels. The 1D representation of the estuarine waters within SLE is simplistic and does not include a detailed representation of the complex hydrodynamic processes that influence water quality conditions within the SLE or surrounding water bodies. While the estuarine reach represented in the SLE WaSh model includes the north and south forks of the St. Lucie River, there are concerns regarding other modeled boundaries. The seaward boundary of the model is located inside the throat of St. Lucie Inlet and does not include any water exchange with the Atlantic Ocean. Further, the model does not include any representation of SLE interactions with the Indian River to the north or the Intracoastal Waterway to the south. These model simplifications prevent accurate representation of tidal mixing. Specifically, mixing dynamics of SLE waters with both the Indian River lagoon and the nearshore ocean waters offshore of the St. Lucie Inlet are critical to providing an accurate and complete evaluation of water quality within the estuarine complex. Figure 2 provides results from a two-dimensional (2D) hydrodynamic and salinity model that is under development as part of a separate Martin County project. These preliminary model results illustrate the significant influence of tidal mixing within the estuary complex and nearshore ocean area, where a freshwater release from Lake Okeechobee can have a marked impact on salinity levels (and likely associated TN levels) within Indian River and nearshore ocean waters. The 1D representation of the SLE within the WaSh model does not include these dynamics.

Further, numerous recent water quality modeling efforts have developed more accurate tools to assess TN concentrations within the SLE and adjacent waterbodies. Specifically, the SFWMD has developed a 3-dimensional hydrodynamic model with a water quality module (CH3D) for the SLE and the Indian River. There also is a 3-dimensional EFDC hydrodynamic model with a water quality component that was developed in 2012 (Wan, et al, 2012). Both models are superior to the WaSh model for simulating estuarine dynamics.

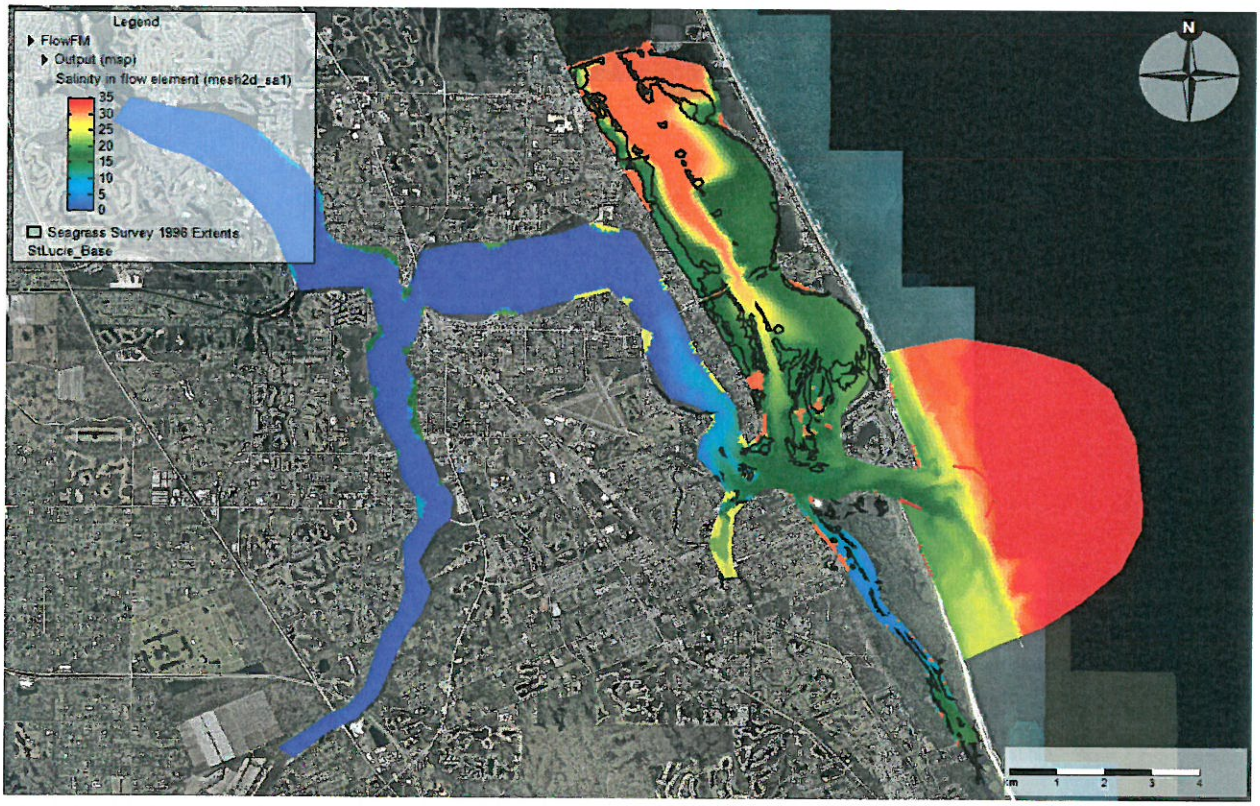

Figure 2. Results from a two-dimensional Delft3D model simulation of a high flow release from Lake Okeechobee indicating mixing of freshwater with both estuarine waters in the Indian River and the nearshore ocean area seaward of the St. Lucie Inlet.

3. WaSh Model Accuracy

It is well understood that any numerical model representation of a natural system (and/or a natural system modified through anthropogenic interventions) will not match the system dynamics perfectly, as models inherently simplify natural processes into equations that can be solved through numerical methods. The estuarine portion of the WaSh model specifically utilizes equations requiring numerous user-selected parameters to estimate the bio-geochemical processes within the bottom sediments and water column, as well as the physical dispersion of water in the estuary. The TMDL provides the values for these user-selected parameters; however, no information regarding a sensitivity analysis associated with these parameters or site-specific justification (i.e. data collected in the SLE to support the parameters selected) for specific parameters was provided. Therefore, it is unclear what impact these parameters have on the WaSh modeling output and its accuracy as a tool for management of SLE waters.

Estuarine modeling approaches that utilize site-specific data and assess which parameters are most important (through sensitivity analyses) typically lead to the most useful results. Considering the stated concerns related to the WaSh model calibration and potential accuracy of results, as described in detail below, further evaluation of modeling assumptions and/or user-selected parameters is warranted as part of the TMDL and associated BMAP process. As the BMAP stipulates specific load removal to reach the goals of the TMDL, numerical accuracy of the WaSh model is critical to ensure that watershed nitrogen management achieves the desired water quality improvements within estuarine waters. Below are some of the more critical concerns related to the WaSh model calibration:

a. The calibration targets used to indicate the performance of the WaSh model (Table 7, page 41 of Amec Foster Wheeler, 2018) allow for poor model performance in critical areas of the SLE, as indicated by numerous calibration statistics. One standard methodology for model calibration is to plot the measured versus modeled data and then perform a regression analysis on the results. This regression analysis provides a "best fit" to the data and yields an R^2 value that is a statistical measure of how close the data are to the fitted regression line. It should be noted that an R^2 of 0 indicates the model explains none of the variability of the response data relative to the mean and an R^2 of 1.0 indicates the model explains all of the variability of the response data relative to the mean. For the SLE WaSh model, a typical example of reported water quality calibration values is the TN calibration results for Station SE01 (Hell's Gate) and SE03 (Roosevelt Bridge), where the R^2 value was calculated as 0.44 and 0.41, respectively. For the SLE WaSh model, the general goal of the calibration process (through a series of simulations with different reasonable input parameters) is to maximize the R^2 value. An R^2 of 0.44 or 0.41 is not indicative of a good fit between the data and model. Rather, the results of the regression analysis between the TN data and model results indicate that the model can approximate the general trend of TN concentrations (i.e. the higher the TN load, the higher the TN in the SLE); however, the actual numerical predictions of TN by the model do not match the measured TN values. Figure 3 provides a general guide for R^2 values that are indicative of model performance relative to comparisons of model results to data, based on monthly model parameters. The R^2 value of 0.44 for TN calibration at SE01 and 0.41 for SE03 are lower than the values listed on Figure 3; therefore, the model performance for water quality calibration at these stations would be rated as 'poor'. Based on the results of the calibration regression analysis, it does not appear that the WaSh model

results accurately predict TN concentrations within the SLE.

b. The seaward boundary of the WaSh model representation of the SLE is within the St. Lucie Inlet throat, and the model does not include measured and modeled (as described above) tidal mixing between the SLE and the Indian River. This boundary condition should include a varying TN concentration over a tidal cycle, as lower TN waters from the ocean push into the estuary during flooding tides and higher TN SLE water drains from the estuary during ebbing tides. As developed, the data utilized for the seaward boundary of the WaSh model did not incorporate time-varying TN concentrations within the inlet throat, as this data does not exist. Not surprisingly, the WaSh model results for TN at the seaward boundary (Station SE11) also are a poor match with the data. In this case, the numerical bias between measured and modeled data sets was calculated to be 0.22 mg/L. The bias indicates that the model predicts a higher nitrogen concentration at the seaward boundary than the data show by an average value of 0.22 mg/L, which is 44% of the average TN concentration (~0.5 mg/L) measured at Station SE11. This is a clear indication that placing an "ocean" boundary within the St. Lucie Inlet does not appropriately capture the high salinity, low nutrient tidal influence of the Atlantic Ocean. This is essential when modeling an estuary that frequently exhibits low salinity and high nutrient concentrations. The seaward boundary condition for an estuarine water quality model should extend offshore into an area not typically influenced by nutrient loading from the watershed and where tidal variations in nutrient concentrations are captured.

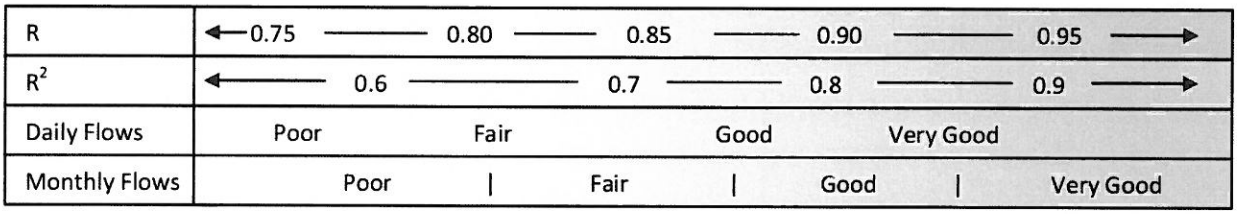

Figure 3. R and R^2 value ranges for model performance (from Duda, *et al.*, 2012).

II. Management Practices for Nutrient Load Reductions

As described in the 5-Year Review of the St. Lucie River and Estuary BMAP, the stakeholders within the watersheds of the SLE are proactively working towards achieving the load allocation goals set forth in the BMAP. As evidence of this commitment, these communities have achieved over 50% of the TMDL load reductions. However, as shown in Table 1, nearly all future load reduction needs are from agricultural sources. According to the Draft BMAP Update, only sixty-one (61) percent of the total acreage is enrolled for the entire study area. Basins 4/5 and 6 in Martin County have only 4% of the total agricultural acreage enrolled, which coincide with priority 1 and 2 basins for nutrient reduction identified in the Targeted Restoration Area study. Additional resources will be required to increase enrollment in this program, and the County urges DEP to ensure that agricultural interests perform required nitrogen load reductions within the timeframe of the BMAP process.

Entity	Starting N load	TMDL Required N reduction	N load reduction as of June 2018
Agriculture	1,563,122	812,924	303,920
Non-agriculture watershed loads	866,466	238,836	229,391
Total watershed	2,429,588	1,051,760	533,311

Table 1. Watershed N load breakdown by agricultural and non-agriculture sources. Data obtained from the June 2018 5-Year Review of the St. Lucie River and Estuary Basin Management Action Plan.

III. Monitoring Plan Recommendations and TMDL Compliance

It is the understanding of the County that the South Florida Water Management District (SFWMD) is instructed by DEP to conduct water quality sampling at the Roosevelt Bridge (Station SE03) approximately once per month. Since the Roosevelt Bridge is the designated compliance point for the SLE TMDL, this irregular and infrequent sampling protocol is insufficient in determining the current trends and health of the estuary. Monthly sampling results at the Roosevelt Bridge are reported as a yearly average in the South Florida Environmental Report and used by DEP to track progress toward achieving the TMDL. Monthly, unsystematic sampling does not account for tidal influences, extreme rain and stormwater runoff events, or high discharge events from Lake Okeechobee. Moreover, the County is concerned that a yearly average of these measurements masks the true conditions in the St. Lucie Estuary, as is the case with all bimodal distributions. The County recommends that sampling protocols at the Roosevelt Bridge significantly increase in frequency and/or that an automated water quality sampler is installed near the bridge to ensure that the dynamic nature, status and trends of the St. Lucie Estuary are adequately reflected in publicly available data and the South Florida Environmental Report.

The sole focus on phosphorus in Lake Okeechobee management is a flaw in this review for TMDL compliance for TN and TP in its receiving waters. Recent research indicates that HAB-impacted lakes such as Lake Okeechobee exhibit varying nutrient loading and cycling patterns that include periods of both P and N limitation. In summer months, N is often the limiting factor when meteorological conditions are conducive to HABs, leading to the introduction of these HABs, notably *Microcystis*, into the lagoon. At the very least, this management protocol is "shifting the eutrophication burden to vulnerable ecosystems downstream" (Paerl, 2016). The combination of limited sampling at the Roosevelt Bridge and the lack of an established nitrogen TMDL for Lake Okeechobee makes it nearly impossible to track nitrogen TMDL progress for the St. Lucie River and Estuary Basin. The DEP has reiterated that the St. Lucie River and Estuary Basin TMDL assumes that the Lake Okeechobee TMDL has been met. However, since there is no established nitrogen TMDL for Lake Okeechobee, no entities or stakeholders are currently responsible for nitrogen loading coming from the Lake. This loading may be further increased should the FDACS agricultural BMP program fail to meet their estimated reductions. If the TMDL is not met by the time the BMAP deadline is reached in 2028, the County is concerned that the DEP may reassign allocations to BMAP stakeholders, rendering the County responsible for nitrogen loading from Lake Okeechobee discharges and agricultural runoff, and the costs associated with meeting additional nutrient reduction criteria. The County requests that the DEP provide a plan of action to prevent the County from being held responsible for Lake Okeechobee and agricultural nitrogen loading into the SLE.

Although the WaSh model simulates water quality conditions on an hourly time step, the TMDL tends to focus on average annual conditions, and does not specifically consider impacts from high flow events from Lake Okeechobee. These events have been shown to have a substantial adverse impact to SLE water quality and need to be incorporated into any modeling and/or monitoring effort for the SLE. Figure

4 illustrates the long-term monthly water quality measurements at the TMDL Compliance Station (SE03 at the Roosevelt Bridge), as well as the mean TN (0.99 mg/L) and standard deviation (±0.43 mg/L). While there generally is a seasonal variation due to wet and dry time of year, the highest TN concentrations are all related to significant water releases from Lake Okeechobee. Therefore, the primary reason for the relatively large variability in the monitoring results (i.e. the standard deviation of ±0.43 mg/L) is discharges from the Lake.

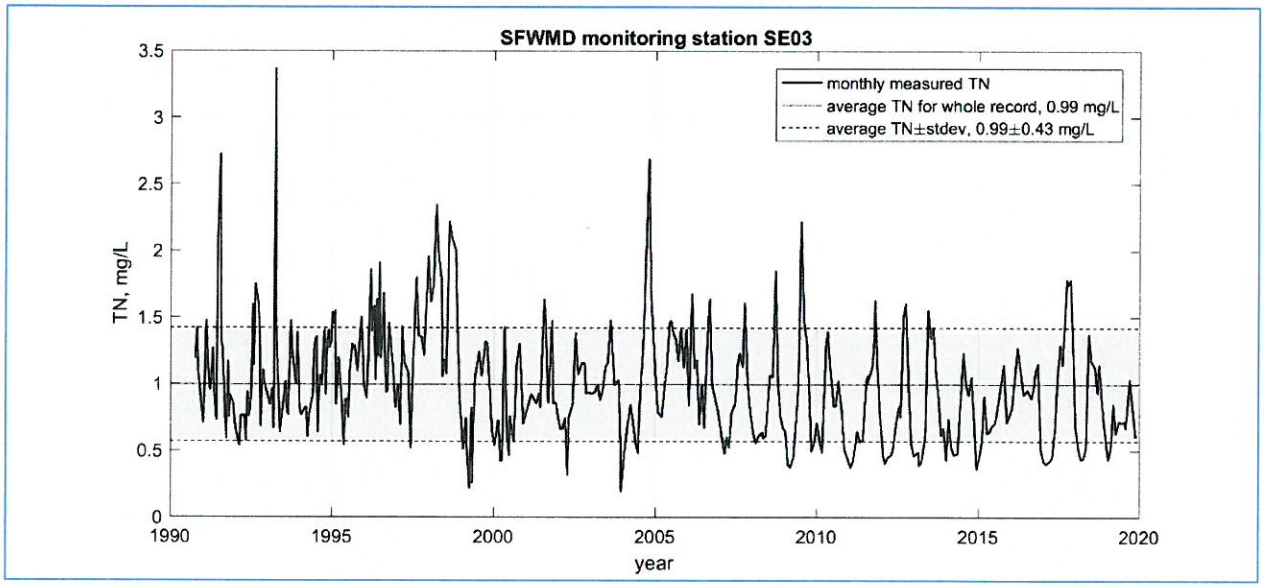

Figure 4. Results from SFWMD TN monthly monitoring at Station SE03, Roosevelt Bridge.

Due to the highly variable and episodic nature of the Lake Okeechobee releases, it likely is not possible for the County to meet the compliance TN concentration at SE03, especially since compliance is based on a 5-year average of all monthly sampling. To illustrate this point, Figure 5 shows that the variability of TN load derived from the Lake is extremely large, with the highest recent annual TN load from the Lake in excess of 6,000,000 pounds. On an annual basis, assuming no improvements to Lake Okeechobee management, less than half of the average annual TN load at the compliance point would be derived from estuarine watersheds. The majority of the TN load, on an annual basis, would be derived from the Lake. Historically, data shows that the annual TN load from Lake Okeechobee that is used in calculating the 5-year average can be more than five times the annual target TMDL load for the watersheds governed by the SLE TMDL and BMAP, further complicating compliance with the target TN load.

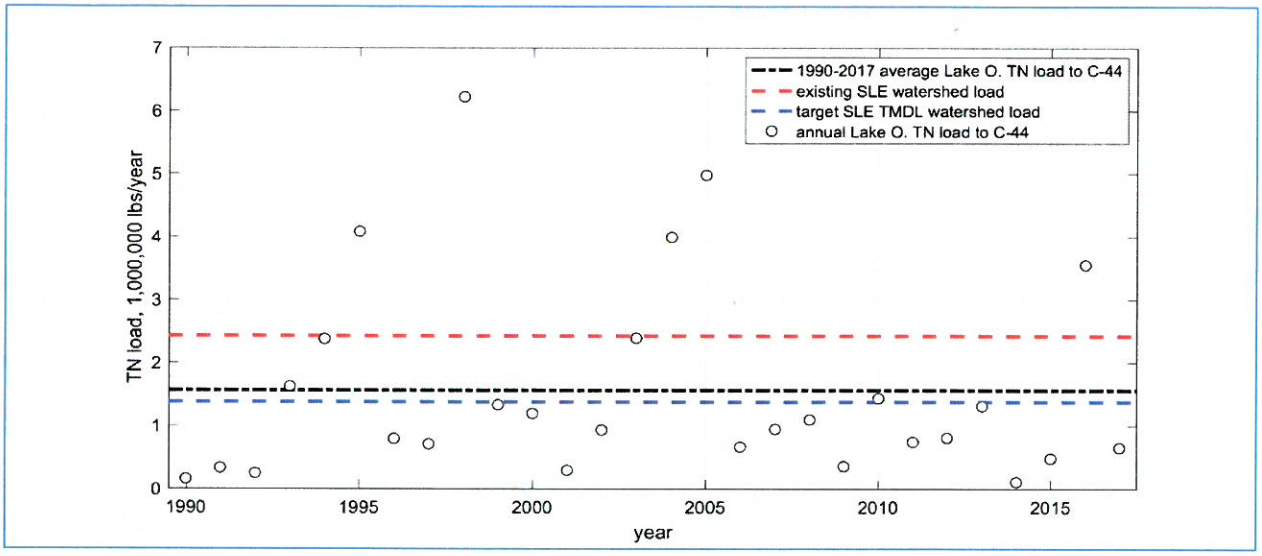

Figure 5. Annual TN loads from Lake Okeechobee compared to the SLE watershed TN loads and the long-term average Lake Okeechobee TN load.

The episodic nature of the releases and the dramatic impact to estuarine water quality during the period of these releases cannot be overstated. Figures 6 and 7 show time periods that illustrate the influence of freshwater Lake Okeechobee releases on estuarine water quality, specifically TN concentrations at SE03. As shown in Figure 6, TN concentrations in early 2004 remained relatively low; however, the combination of summer rainfall events and two major hurricanes necessitated a sustained high rate discharge from Lake Okeechobee in October/November 2004. TN concentrations at SE03 peaked at nearly 3 mg/L during this discharge event and peaked at approximately 1.5 mg/L in subsequent substantial Lake discharges during the summer of 2005. Figure 7 illustrates TN concentrations at SE03 and Lake release rates for 2008. For a significant portion of 2008, when no flow from Lake Okeechobee occurred, the TN concentrations at SE03 were reduced to a point where they actually met the TMDL target. However, it is clear from the data that the Lake discharge during September and October during that same year were directly responsible for TN concentrations reaching nearly 2 mg/L. This data shows that inclusion of TN sampling events taken during these episodic, large Lake Okeechobee discharge events will prevent the County from achieving the TMDL target concentrations, regardless of TN reductions achieved within the watershed.

As releases from the Lake are not part of the mandated load allocations stipulated in the BMAP process, compliance monitoring should be limited to time periods when no water is being discharged from the Lake at the time of the sample, as well as for several days, or depending on appropriate residence time, prior to the sampling event . In this manner, the actual improvements associated with the BMAP load reductions can be measured relative to the water quality target stipulated in the TMDL. Although this type of sampling would certainly improve the likelihood that the County could meet the target TN concentration at SE03, it will not address the growing concern over needed management of the Lake Okeechobee discharges to reduce their dramatic adverse impact to the SLE and connected waterbodies. The County encourages DEP to take proactive steps towards establishing a Total Nitrogen TMDL for Lake Okeechobee that not only establishes maximum annual loading to the SLE, but also requires a limit to episodic releases of TN-laden water to the SLE on a shorter-term basis.

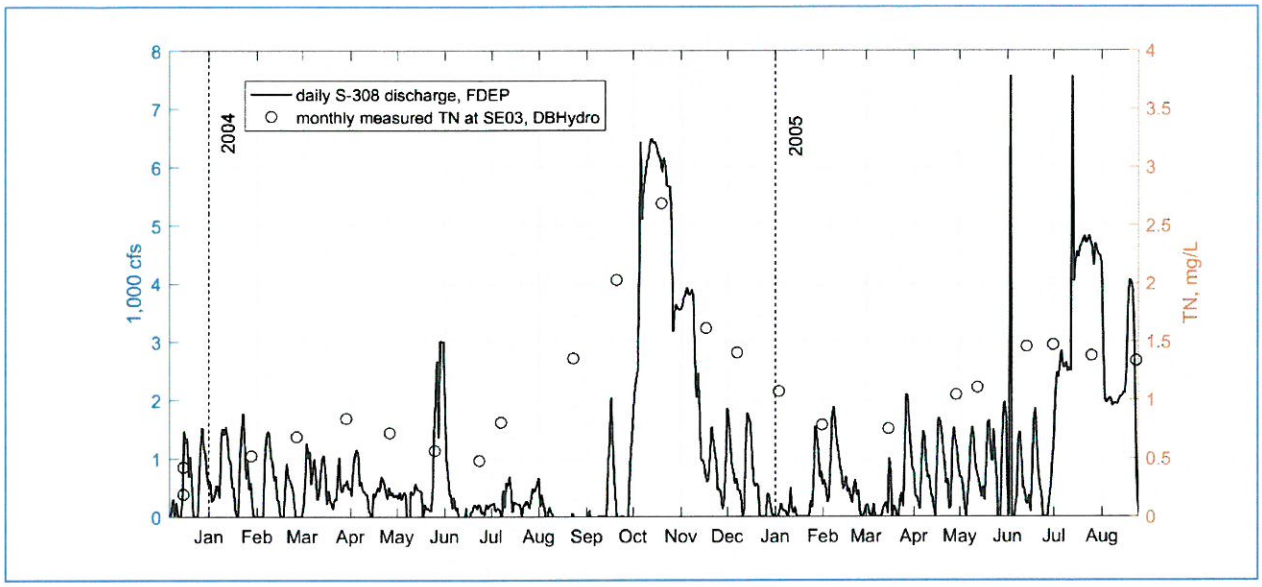

Figure 6. TN monthly sampling results from SE03 and flow rates from Lake Okeechobee releases for January 2004 and August 2005.

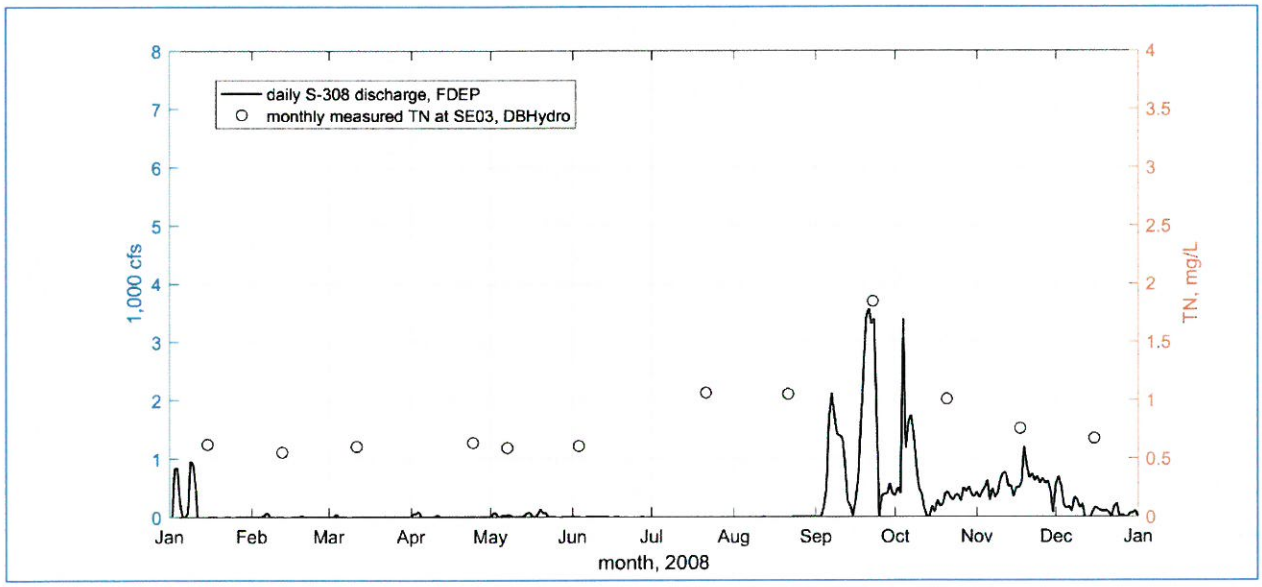

Figure 7. TN monthly sampling results from SE03 and flow rates from Lake Okeechobee releases for 2008

IV. Numerical Errors on County Project List

In Table 68 of the Draft BMAP Update, *Existing and planned projects in the South Coastal Basin*, County staff identified four numerical discrepancies for Total Nitrogen (TN) Reduction and Total Phosphorus (TP) Reduction for the following projects: Golden Gate Water Quality Retrofit Phase I and II, Golden Gate Water Quality Retrofit Phase III, Hibiscus Park Water Quality Retrofit Phase I and II, and Willoughby Creek STA. Nutrient reductions for these projects were listed correctly on an excel file sent by DEP to Katie Bowes on November 14, 2019, titled *Martin County_St. Lucie_Projects2019*. The

County requests that these errors be corrected on the Final BMAP Update. The following table shows the nutrient reductions on the correct spreadsheet compared to the errors found on the Draft BMAP Update.

Project Name	Correct Nutrient Reductions		Nutrient Reductions published in Draft BMAP Update	
	TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)
Golden Gate Water Quality Retrofit Phase I and II	1,149.9	279.5	TBD	TBD
Golden Gate Water Quality Retrofit Phase III	122.6	37.0	TBD	TBD
Hibiscus Park Water Quality Retrofit Phase I and II	23.8	7.1	TBD	TBD
Willoughby Creek STA	1,553.6	411.3	TBD	TBD

V. Conclusion

The ability of all BMAP stakeholders to meet the nitrogen and phosphorus TMDL's under this enforceable BMAP will continue to be jeopardized if the above concerns are not addressed. While the intention of the BMAP update is appreciated as a recognized approach to achieve better water quality within the Clean Water Act parameters, the updated modeling approach and changes to management and monitoring strategies are insufficient for achieving water quality restoration of the St. Lucie River and Estuary Basin, which is the primary goal of this process.

We look forward to working with the DEP throughout the BMAP process and sincerely appreciate the extension for submitting public comments. Should you or anyone on your staff have any questions or concerns, please do not hesitate to contact me.

Sincerely,

Don Donaldson, P.E.
Deputy County Administrator

References

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