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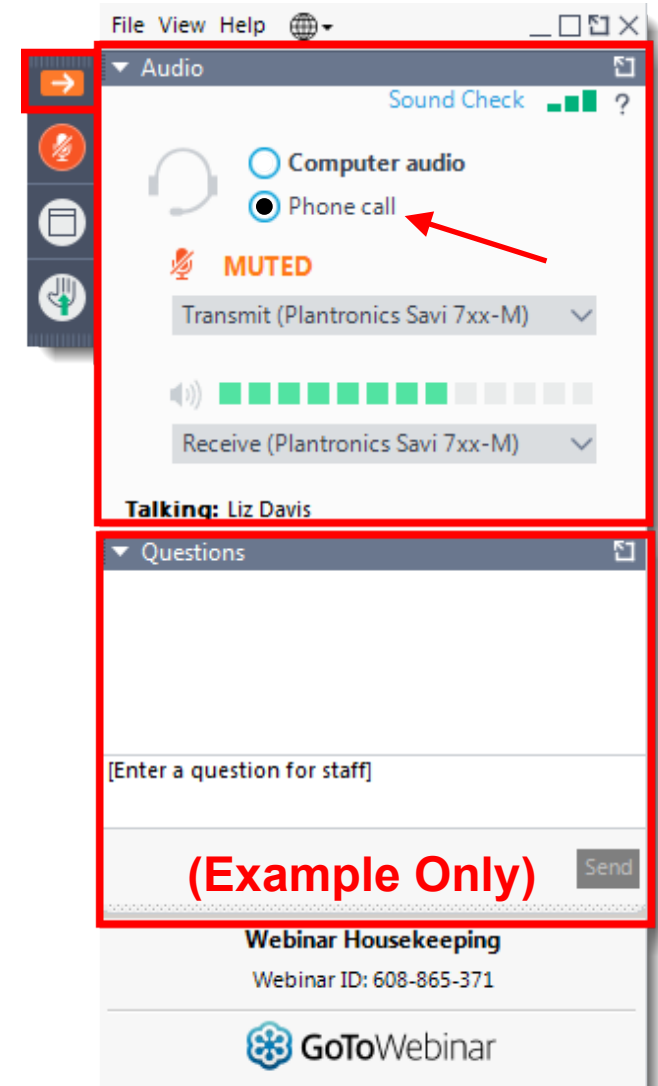
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Spatial Watershed Iterative Loading (SWIL) Model Hydrological and Water Quality Calibration Results

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GoToWebinar | 04/30/2024



AGENDA

Presentation Agenda

- SWIL 5.0 Status.
- Calibration Efforts:
 - Hydrology.
 - Water quality.
- Model Performance.
- Next Steps:
 - Calibrated model run.
 - Baseline natural run.
 - LET development.

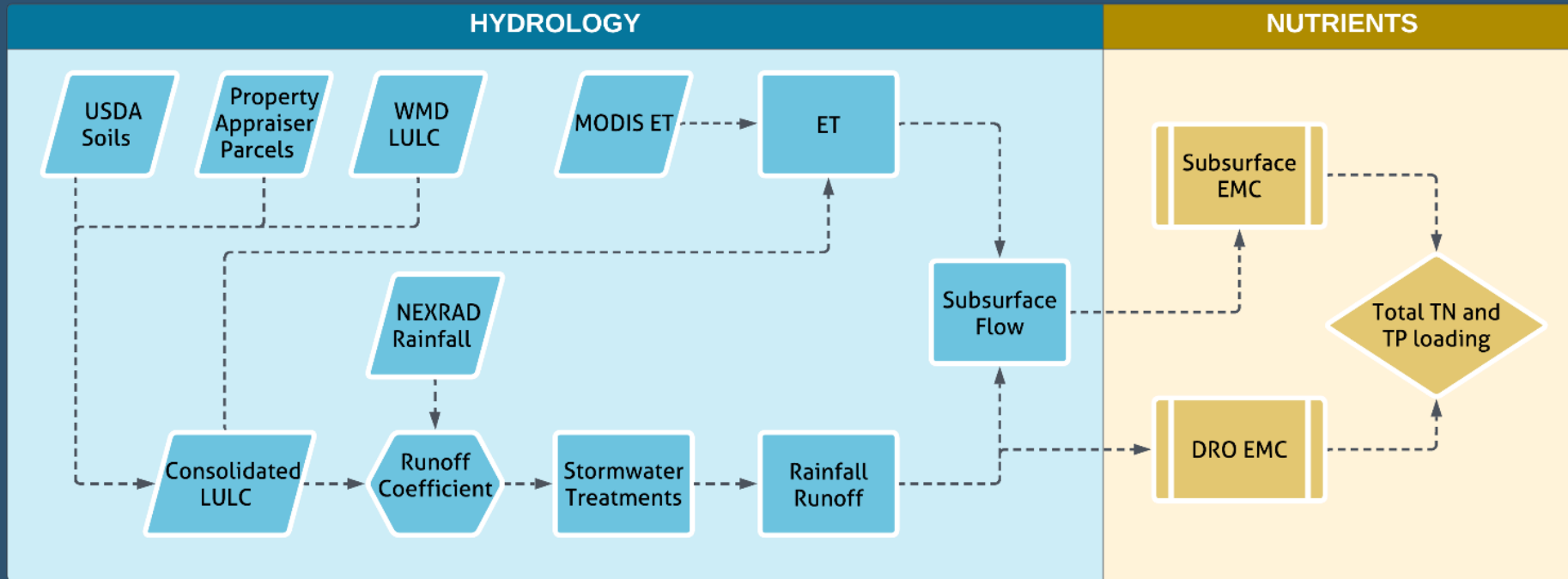
SWIL HYDROLOGICAL AND WATER QUALITY CALIBRATION

DRAFT MEMORANDUM

**TASK 6 AND TASK 7 OF THE SPATIAL WATERSHED
ITERATIVE LOADING MODEL UPDATE**



SWIL MODEL OVERVIEW



- SWIL model estimates monthly total nitrogen (TN) and total phosphorus (TP) loading of a defined basin for both direct runoff (DRO) and subsurface flow (SSF).
- Volumes of water are estimated using land use land cover (LULC), property appraiser, NEXRAD rainfall, and MODIS evapotranspiration data.
- Event mean concentrations (EMC) were established for both DRO and SSF to convert volume of water to mass of nutrient.

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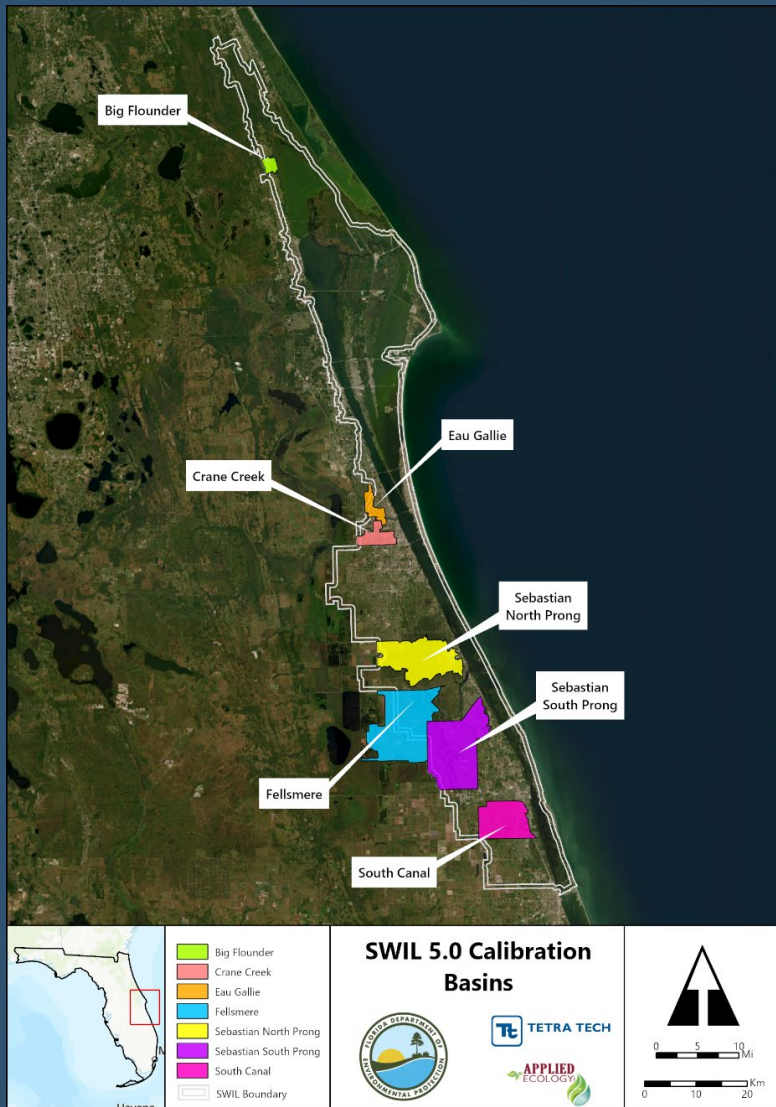


SWIL 5.0 Optimization

SWIL Hydrological and Water
Quality Calibration Results



SWIL 5.0 CALIBRATION BASINS



Calibration Basins:

- Big Flounder.
- Eau Gallie.
- Crane Creek.
- Sebastian North Prong.
- Sebastian South Prong.
- Fellsmere.
- South Canal.

Basin Selection: Important that the basins are reflective of the diverse LULC combinations identified across the IRL. Balance of agricultural, developed, and natural LULC.

Characterization of the calibration basins presented to stakeholders on March 23, 2023.



SWIL 5.0 CALIBRATION OPTIMIZATION PROCESS

Microsoft Excel Solver Add-in:

- Used to identify calibration factors which minimize the error between the model outputs and observed data.
- Evolutionary Solver tests thousands of possible factor combinations to determine the global optimal combination.
- Constraints were applied based on DEP input and available literature.
- Primary performance goals vary between components.

Percent Bias (PBIAS): Measures the average tendency of the simulated data to be larger or smaller than the observed values.

- PBIAS goal: -25% to +25%.

Nash-Sutcliffe Efficiency (NSE): Measure of the predictive skill of models to estimate values by indicating how well the plot of observed versus simulated data fits.

- NSE goal: > 0.50 .



SWIL 5.0 CALIBRATION

HYDROLOGY OPTIMIZATION

Hydrological Components:

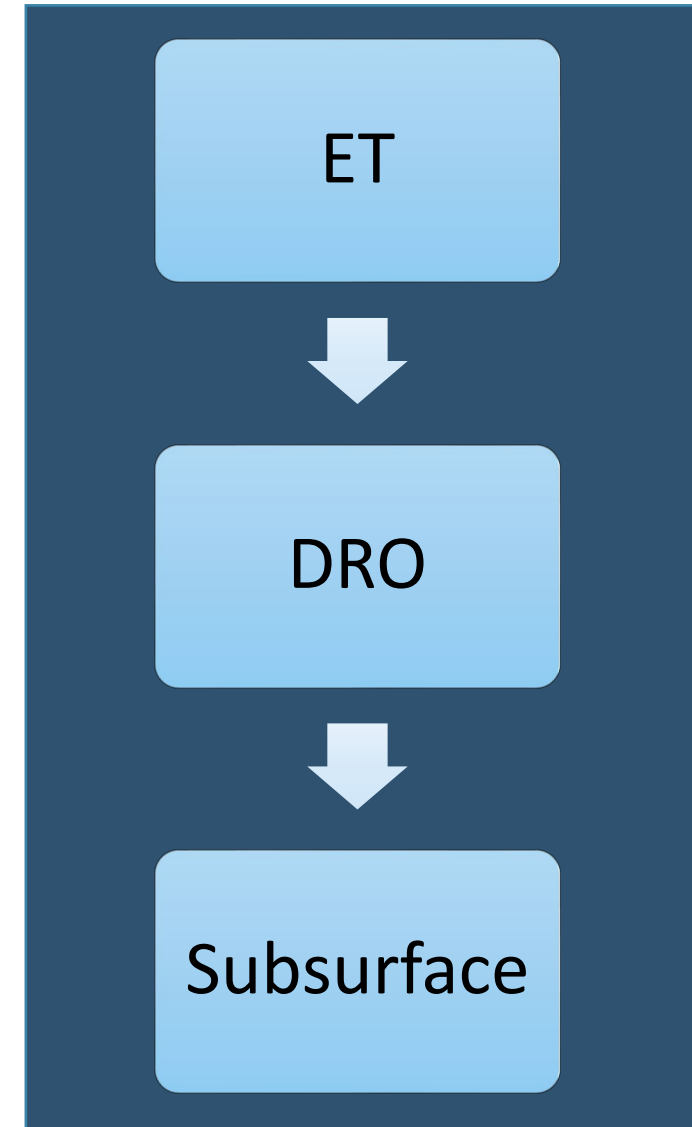
- Evapotranspiration (ET).
- DRO.
- SSF.

ET: ET is estimated by the MODIS satellite ET, NEXRAD rainfall, and LULC:

- Undeveloped pervious.
- Developed pervious.
- Developed impervious.

DRO: DRO is estimated by NEXRAD rainfall and runoff coefficients determined by LULC and soil hydrology. Also includes stormwater treatment systems.

SSF: SSF is estimated as a product of ET and DRO. Lag factor used to determine the storage capacity and release of groundwater.





SWIL 5.0 CALIBRATION

ET OPTIMIZATION – STATISTICS

Basin	Monthly Volume	
	SWIL 5.0u	SWIL 5.0c
Eau Gallie	23.6%	1.1%
Crane Creek	18.3%	1.0%
Sebastian North Prong	61.1%	16.5%
Sebastian South Prong	20.0%	-8.1%
Fellsmere	30.4%	-3.2%
South Canal	33.9%	9.5%
Avg. PBIAS	31.2%	2.8%
Avg. Abs. PBIAS	31.2%	6.5%



SWIL 5.0 CALIBRATION

DRO OPTIMIZATION – SETUP

DRO Optimization Rules:

- Wetland and Upland LULC cannot have a final ROC value of 0.
- Wetland and Upland LULC must have final ROC values less than all other LULC.
- Rangeland, Agriculture, and Tree Crop LULC must have final ROC values less than Industrial and Commercial LULC.
- Mid Modified must have final ROC values greater than Low Modified.
- Industrial and Commercial must have greater final ROC values than Mid Modified.
- Low Density Residential must have final ROC values greater than Medium to High Density Residential.



SWIL 5.0 CALIBRATION

DRO OPTIMIZATION – GROUPS

An initial optimization run for all 30 LULC identified which LULC types had similar factor values and could be grouped together.

The reduction in the number of LULC types being calibrated from 30 to 10 reduced the runtime and increased the stability of each model run.

DRO Group	Calibration Factor
Pasture	2.5
Crops	1.0
Tree Crops	1.5
Low Modified	0.3
Mid Modified	0.4
Low Density Residential	0.8
Medium to High Density Residential	1.2
Commercial and Industrial	1.5
Upland	0.2
Wetland	0.2



SWIL 5.0 CALIBRATION

DRO OPTIMIZATION – STATISTICS

Basin	Monthly NSE		Monthly PBIAS	
	SWIL 5.0u	SWIL 5.0c	SWIL 5.0u	SWIL 5.0c
Eau Gallie	0.69	0.71	-11.9%	-5.5%
Crane Creek	0.72	0.69	17.3%	6.4%
Sebastian North Prong	0.63	0.63	33.8%	2.7%
Sebastian South Prong	0.66	0.67	-8.2%	-3.9%
Fellsmere	0.74	0.72	-9.8%	2.5%
South Canal	0.73	0.78	-9.7%	4.0%
Average	0.70	0.70	1.9%	1.0%
		Avg. Abs. PBIAS	15.1%	4.2%



SWIL 5.0 CALIBRATION

SSF OPTIMIZATION – STATISTICS

Station	Monthly Volume NSE		PBIAS	
	SWIL 5.0u	SWIL 5.0c	SWIL 5.0u	SWIL 5.0c
Eau Gallie	0.28	0.44	31.3%	-6.2%
Crane Creek	0.7	0.67	7.8%	-11.3%
Sebastian North Prong	0.39	0.64	52.3%	3.2%
Sebastian South Prong	0.65	0.63	23.6%	-18.8%
Fellsmere	-0.37	0.42	42.6%	-10.8%
South Canal	0.34	0.71	41.4%	-1.6%
Average	0.33	0.59	33.2%	-7.6%
		Average Abs. PBIAS	33.2%	8.7%



SWIL 5.0 CALIBRATION

TOTAL FLOW – STATISTICS

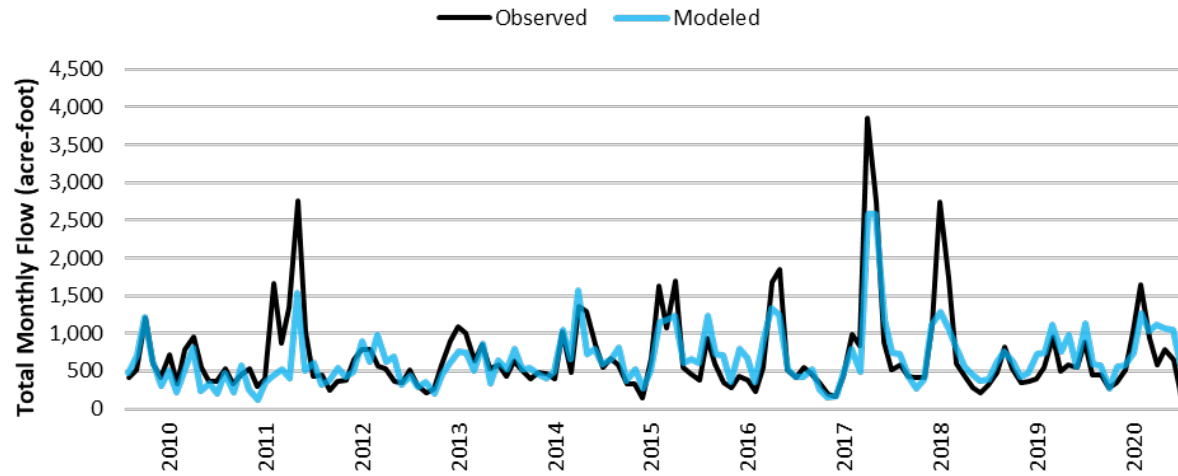
Station	Monthly NSE		Monthly PBIAS	
	SWIL 5.0u	SWIL 5.0c	SWIL 5.0u	SWIL 5.0c
Eau Gallie	0.47	0.52	19.5%	-3.4%
Crane Creek	0.64	0.67	14.9%	-3.2%
Sebastian North Prong	0.36	0.66	53.6%	6.0%
Sebastian South Prong	0.66	0.66	16.2%	-12.5%
Fellsmere	0.42	0.64	26.0%	-7.3%
South Canal	0.66	0.79	27.2%	2.5%
Average	0.53	0.53	26.2%	-2.9%
		Average Abs. PBIAS	26.2%	5.8%



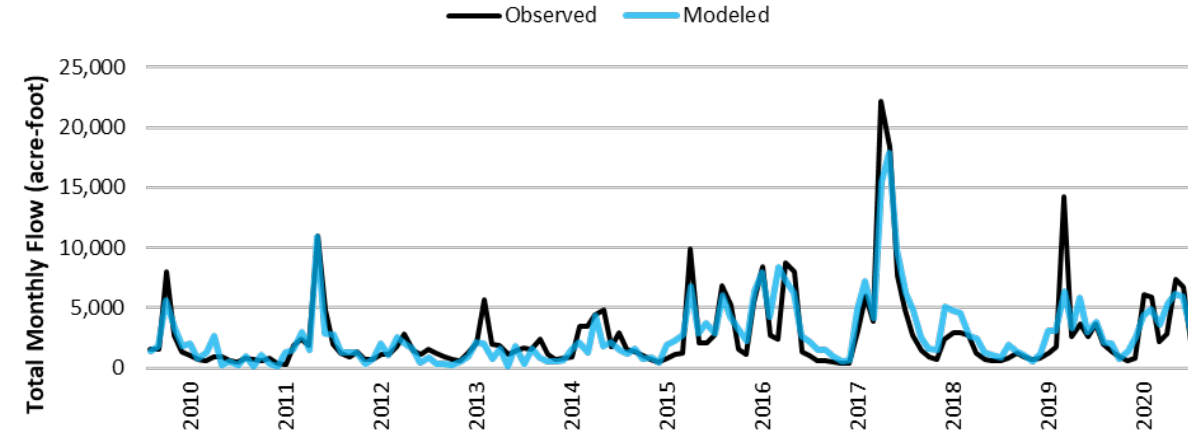
SWIL 5.0 CALIBRATION

TOTAL FLOW – GRAPHS

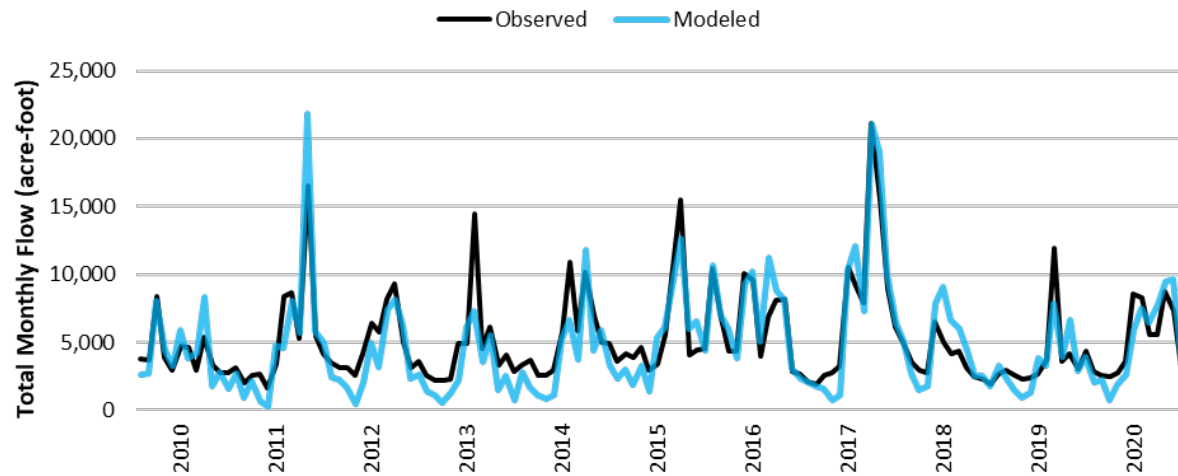
Observed and Modeled Monthly Sum of Total Flow for Eau Gallie



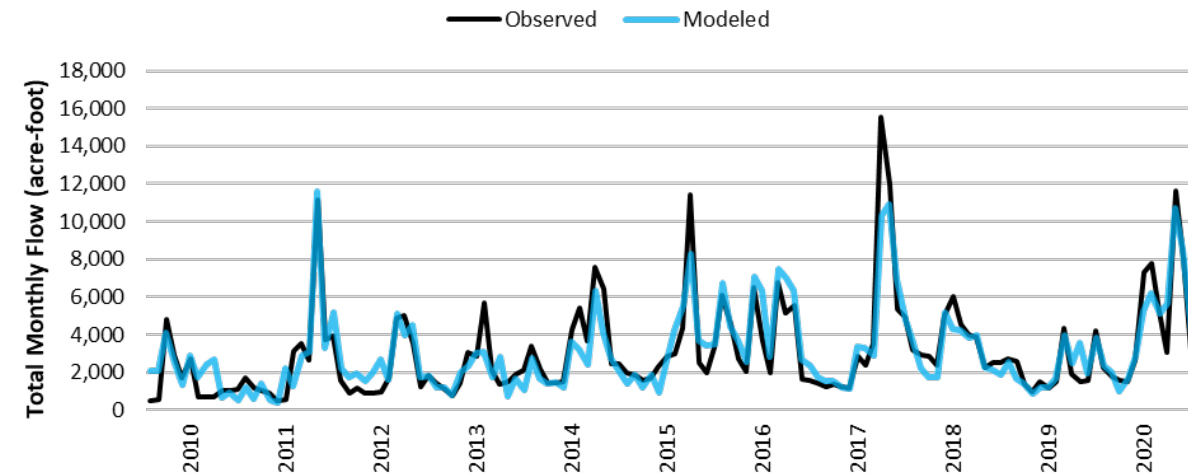
Observed and Modeled Monthly Sum of Total Flow for Sebastian North Prong



Observed and Modeled Monthly Sum of Total Flow for Fellsmere



Observed and Modeled Monthly Sum of Total Flow for South Canal





SWIL 5.0 CALIBRATION

WATER QUALITY OPTIMIZATION

SJRWMD
WQM

Acquire SJRWMD monthly surface water sampling data.

USGS
Hydrology

Acquire the corresponding USGS gauge monthly total discharge data.

Mass of TN
& TP

Estimate the mass of TN and TP loading with the SJRWMD and USGS monthly data.

Segregate
DRO and
SSF

Using the WHAT DRO and SSF estimations, identify SJRWMD sampling events that correspond with each state.

Calibrate
Subsurface

Calibrate the SSF TN and TP loadings based on percent of flow as SSF.

Calibrate
DRO/Total

Calibrate DRO TN and TP loadings based on percent flow as DRO.



SWIL 5.0 CALIBRATION

SSF WATER QUALITY OPTIMIZATION – GROUPS

The optimal SSF EMC calibration factors were identified based on grouping LULC types into 4 groups.

The nutrient contribution from each LULC group was determined by the percent area of each group per basin.

Group	TN EMC		TP EMC	
	Uncalibrated	Calibrated	Uncalibrated	Calibrated
Agriculture	0.35	1.36	0.13	0.29
Heavy Development	1.09	1.17	0.14	0.2
Light Development	0.35	1.24	0.13	0.17
Undeveloped	0.35	0.7	0.13	0.03
Average Concentration	0.53	1.12	0.13	0.17



SWIL 5.0 CALIBRATION

SSF WATER QUALITY OPTIMIZATION – STATISTICS

Basin	Monthly TN PBIAS	
	SWIL 5.0u	SWIL 5.0c
Eau Gallie	0.6%	-0.8%
Crane Creek	-10.5%	3.1%
Sebastian North Prong	-35.4%	-5.1%
Sebastian South Prong	-25.0%	7.0%
Fellsmere	-44.0%	0.7%
South Canal	-18.4%	0.0%
Average	-22.1%	0.8%

Basin	Monthly TP PBIAS	
	SWIL 5.0u	SWIL 5.0c
Eau Gallie	-14.6%	-27.0%
Crane Creek	47.0%	28.5%
Sebastian North Prong	95.8%	-12.2%
Sebastian South Prong	20.2%	-18.6%
Fellsmere	11.3%	4.6%
South Canal	21.6%	8.3%
Average	30.2%	-2.7%



SWIL 5.0 CALIBRATION

DRO OPTIMIZATION

DRO Optimization Rules:

- Upland and Wetland final TN and TP EMCs cannot be 0.
- Upland and Wetland final TN and TP EMCs must be lower than all other LULC.
- Low Density Residential final TN and TP EMCs must be lower than Medium to High Density Residential.



SWIL 5.0 CALIBRATION

DRO WATER QUALITY OPTIMIZATION – STATISTICS

Basin	Monthly TN PBIAS	
	SWIL 5.0u	SWIL 5.0c
Eau Gallie	23.3%	3.4%
Crane Creek	91.2%	5.4%
Sebastian North Prong	124.8%	-7.0%
Sebastian South Prong	86.6%	7.9%
Fellsmere	85.1%	-0.5%
South Canal	25.5%	-9.8%
Average	72.7%	-0.1%

Basin	Monthly TP PBIAS	
	SWIL 5.0u	SWIL 5.0c
Eau Gallie	-4.1%	-28.2%
Crane Creek	143.4%	23.8%
Sebastian North Prong	39.2%	13.2%
Sebastian South Prong	4.8%	-19.1%
Fellsmere	10.5%	-6.4%
South Canal	11.2%	-18.8%
Average	34.2%	-5.9%



SWIL 5.0 CALIBRATION

TOTAL FLOW WATER QUALITY OPTIMIZATION – STATISTICS

Basin	Monthly TN PBIAS	
	SWIL 5.0u	SWIL 5.0c
Eau Gallie	8.2%	0.5%
Crane Creek	13.7%	5.9%
Sebastian North Prong	12.4%	1.2%
Sebastian South Prong	9.7%	9.8%
Fellsmere	-1.2%	7.4%
South Canal	-0.3%	1.1%
Average	7.1%	4.3%

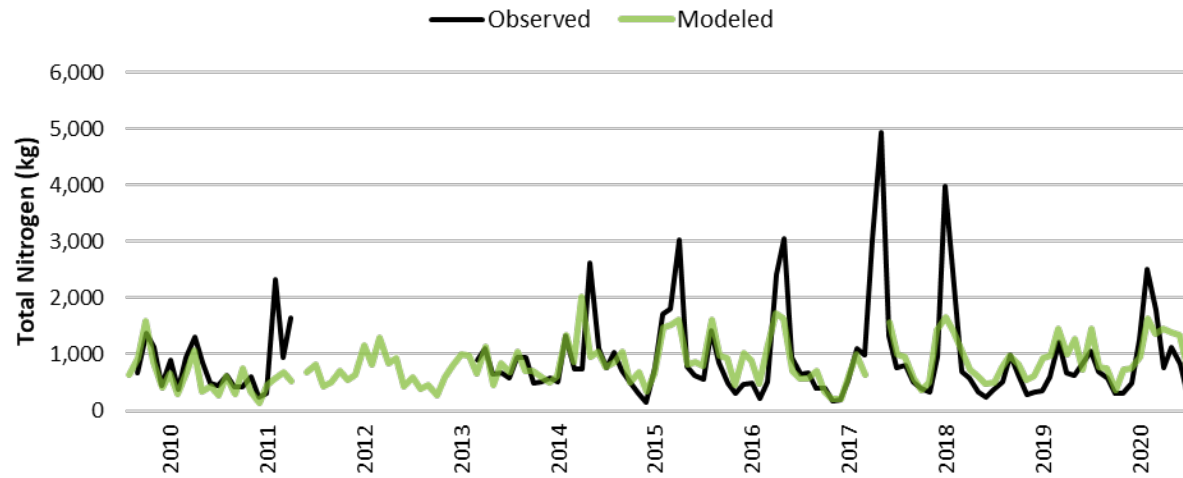
Basin	Monthly TP PBIAS	
	SWIL 5.0u	SWIL 5.0c
Eau Gallie	-13.4%	-29.4%
Crane Creek	65.5%	25.7%
Sebastian North Prong	104.1%	3.2%
Sebastian South Prong	28.5%	-12.3%
Fellsmere	35.9%	21.8%
South Canal	28.8%	7.9%
Average	41.6%	2.8%



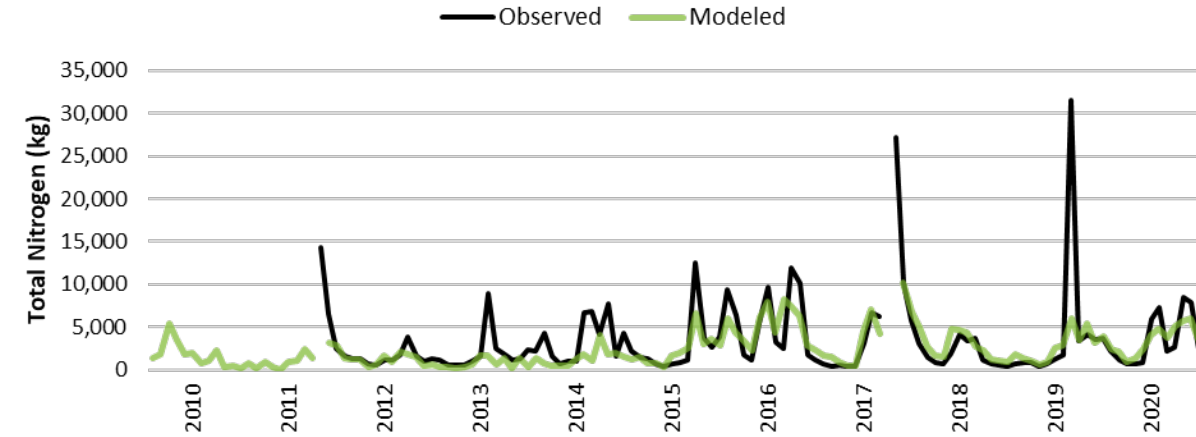
SWIL 5.0 CALIBRATION

TOTAL FLOW WATER QUALITY – TN GRAPHS

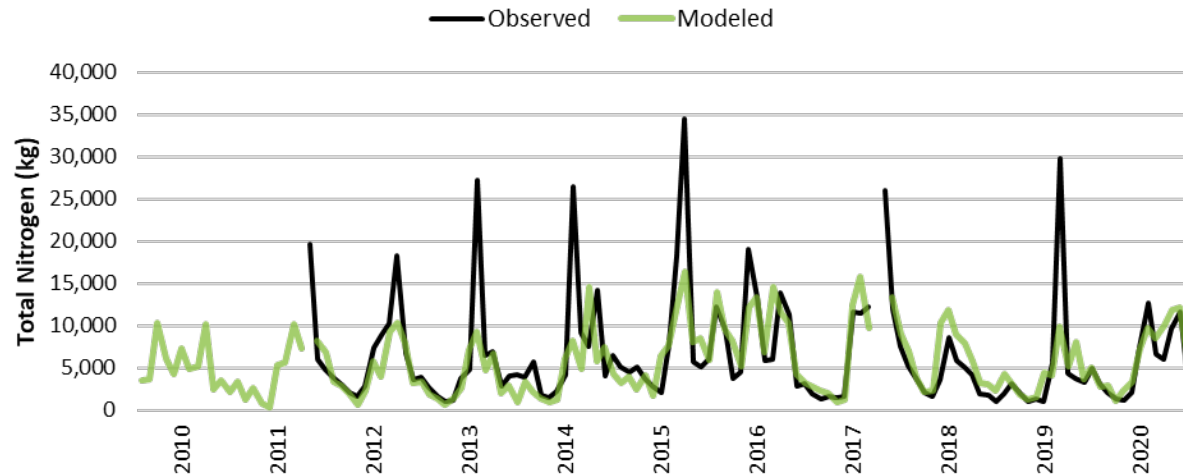
Observed and Modeled Monthly Sum of Total Nitrogen in Eau Gallie



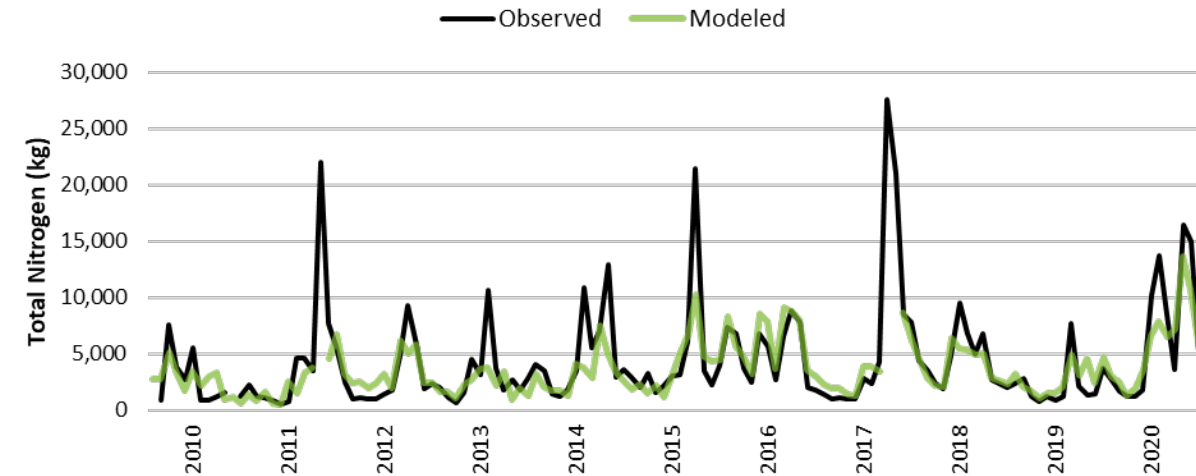
Observed and Modeled Monthly Sum of Total Nitrogen in Sebastian North Prong



Observed and Modeled Monthly Sum of Total Nitrogen in Fellsmere



Observed and Modeled Monthly Sum of Total Nitrogen in South Canal

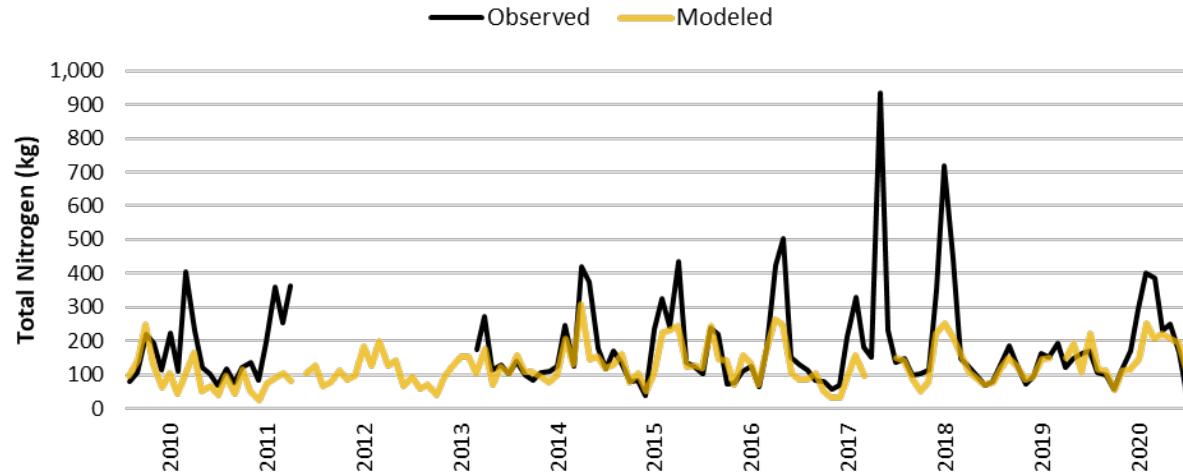




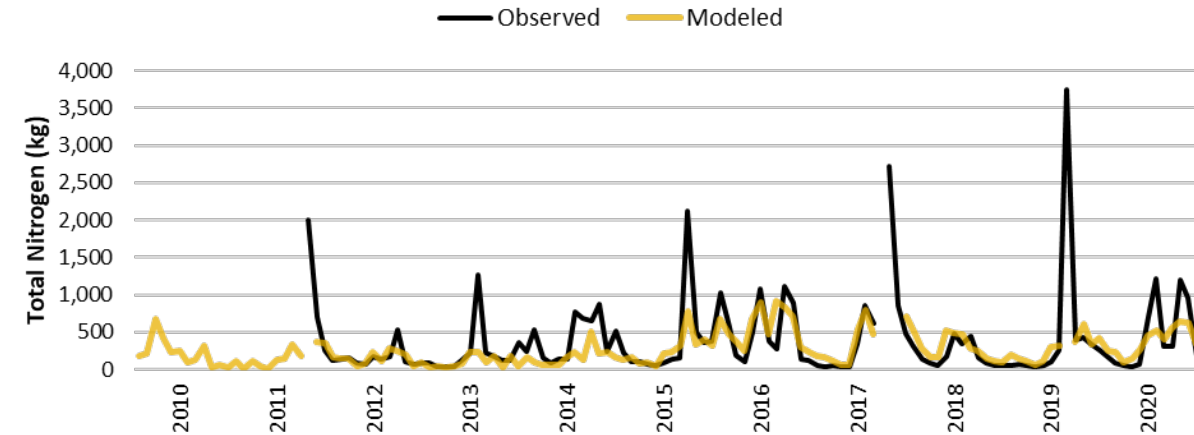
SWIL 5.0 CALIBRATION

TOTAL FLOW WATER QUALITY – TP GRAPHS

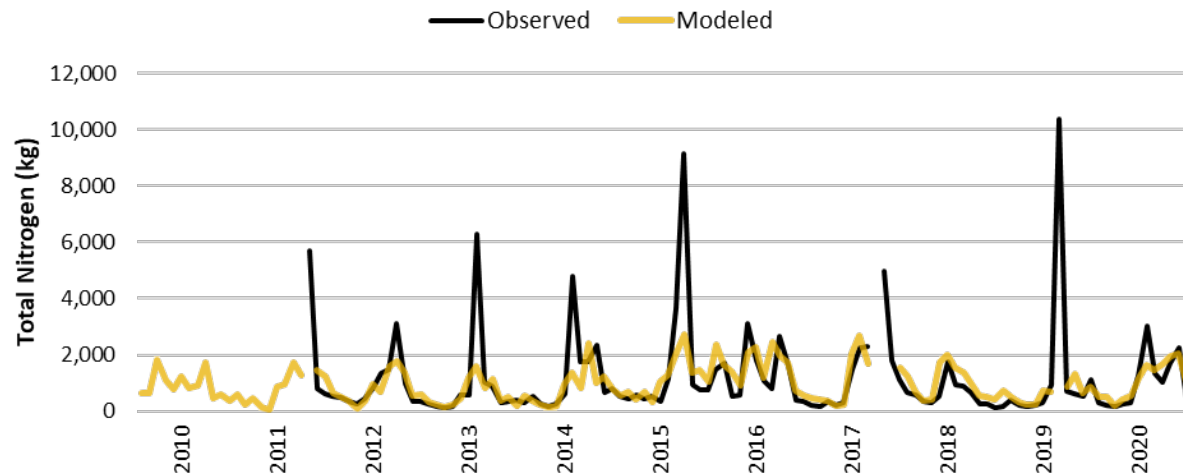
Observed and Modeled Monthly Sum of Total Phosphorus in Eau Gallie



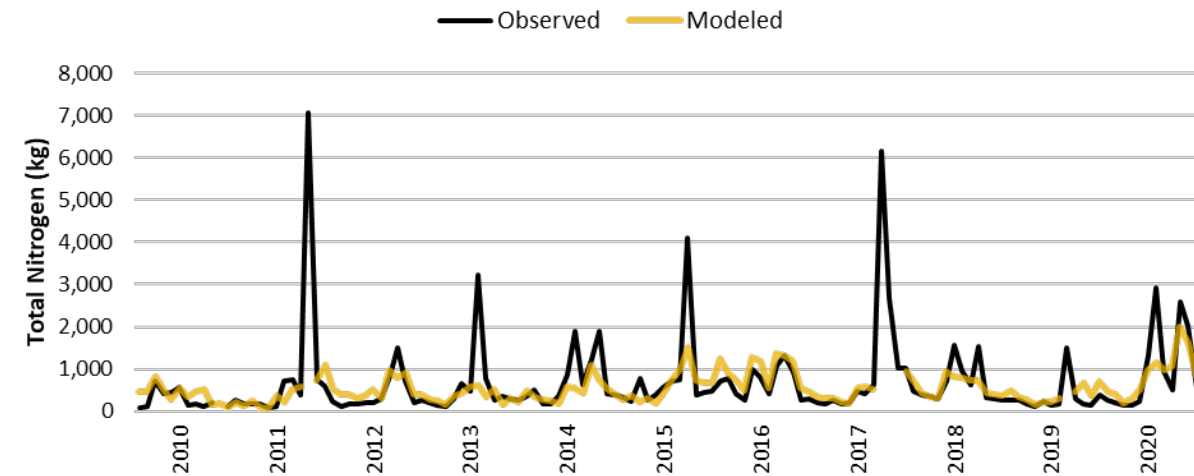
Observed and Modeled Monthly Sum of Total Phosphorus in Sebastian North Prong



Observed and Modeled Monthly Sum of Total Phosphorus in Fellsmere



Observed and Modeled Monthly Sum of Total Phosphorus in South Canal





SWIL 5.0 CALIBRATION OPTIMIZATION SUMMARY

Hydrology:

- ET and DRO were within model goal ranges for all basins.
- SSF NSE was slightly below the goal of 0.50 for Eau Gallie and Fellsmere.
- Total flow was within model goal ranges for all basins.

Water Quality:

- SSF.
- DRO.



NEXT STEPS/TASKS

FINAL MODEL DEVELOPMENT

Fully Calibrated Model Run:

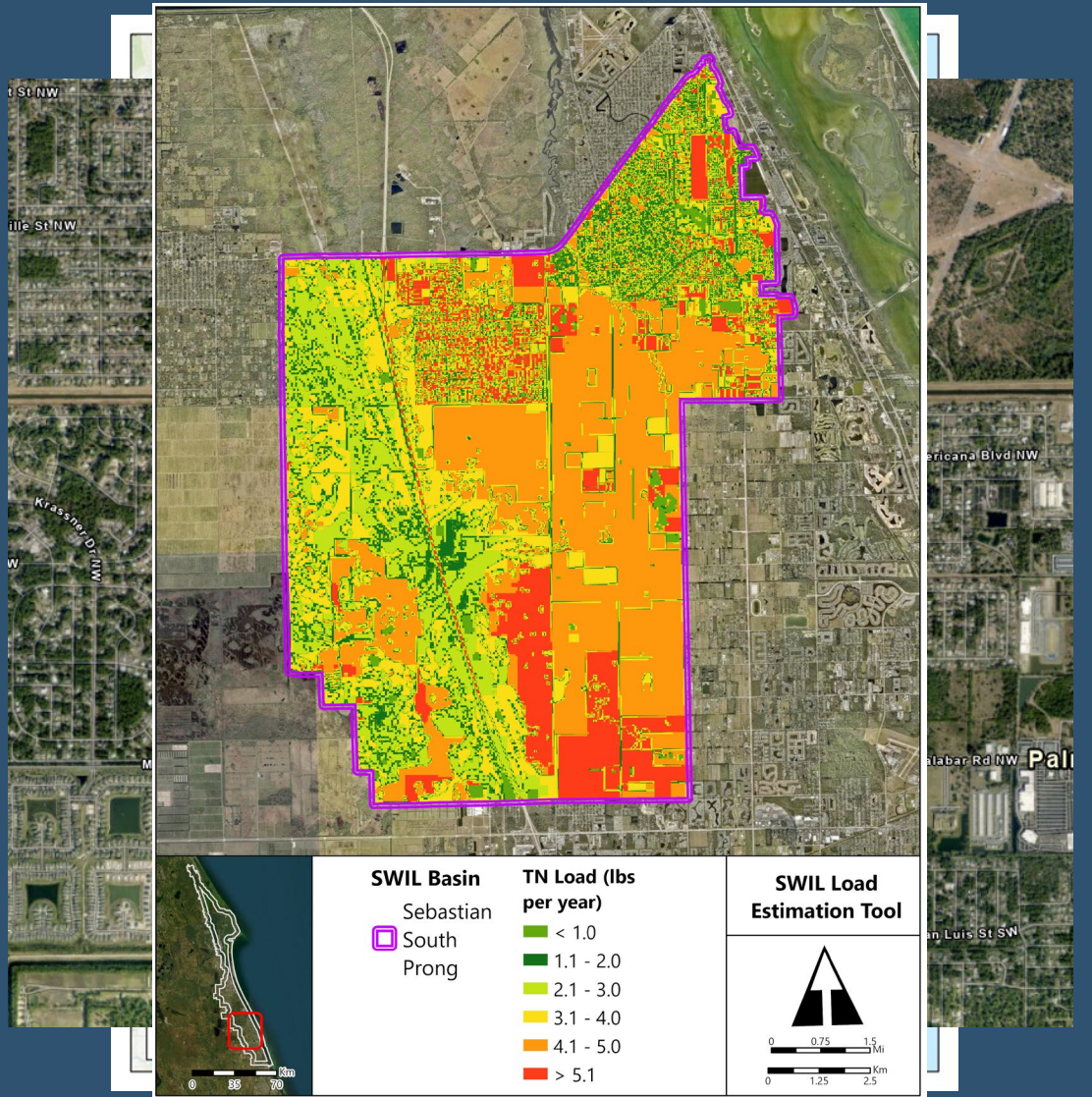
- Entire Indian River Lagoon Watershed from 2010 to 2020.

Baseline Natural Model Run:

- 1943 SJRWMD LULC.

SWIL LET:

- 50-meter grid of period of record TN and TP loading.





THANK YOU

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