



SWIL Model for Load Estimations and Allocations in the Indian River Lagoon (IRL) Basin Management Action Plans (BMAPs)

January 8, 2019



Agenda

- **Objective**
- **Background**
 - IRL Total Maximum Daily Loads (TMDLs)
 - IRL Basin Management Action Plans (BMAPs)
 - SWIL
- **Proposed Load Estimation Approach**
 - Load Estimation Tool
- **Proposed Allocation Approach**
 - Boundary Changes
 - Allocations Under Current TMDL
 - Considerations
 - Steps
- **Discussion/Questions**



Objective

The goal of this effort is to estimate loads for current conditions across the IRL BMAPs and to develop allocations using the Spatial Watershed Iterative Loading (SWIL) model 4.0 and the adopted TMDLs.



Background

IRL Impairments and TMDLs

IRL BMAPs

SWIL



Background

IRL Impairments and TMDLs

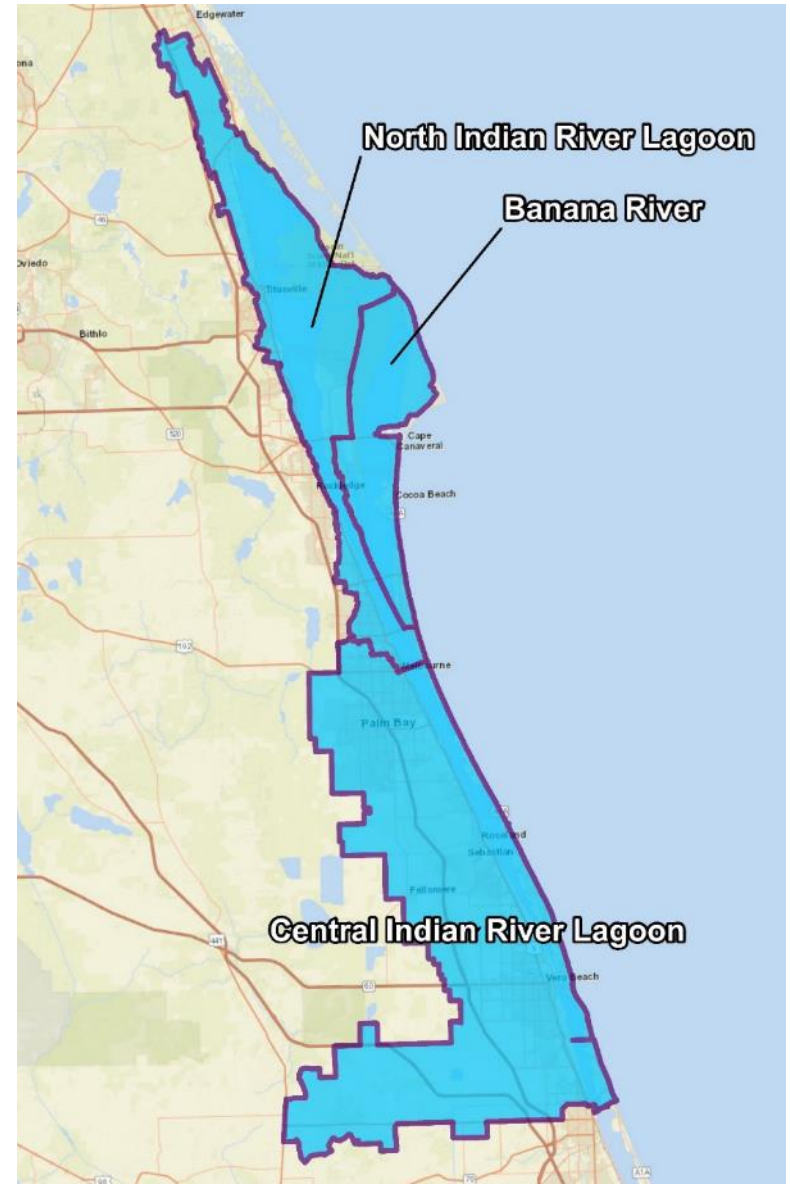
- DEP has identified the Central IRL (CIRL), North IRL (NIRL), and Banana River Lagoon (BRL) as impaired waterbodies due to nutrient over-enrichment. The CIRL includes the South IRL (SIRL) area.
- TMDLs for 13 waterbody identification areas (WBIDs) in CIRL, NIRL, and BRL were developed in March 2009.
- The TMDL includes loads (in pounds per year [lbs/yr]) **AND** percent reductions required in each WBID for both total nitrogen (TN) and total phosphorus (TP).
- Each TMDL was established based on a relationship between TN and TP loads and seagrass depth limits.
- Nutrient loading estimates were calculated using the Pollution Load Screening Model (PLSM) and the Hydrologic Simulation Program FORTTRAN (HSPF) to represent loads for the year 2000.
- Seagrass depth limits were developed by St. Johns River Water Management District (SJRWMD) from a 1943 to 2001 series of photo-interpreted seagrass coverages.



Background

IRL BMAPs

- IRL BMAPs adopted in 2013 to meet the TMDLs
 - **BRL**
 - Project Zone A: No allocations to date
 - Project Zone B: Allocations assigned
 - **CIRL**
 - No allocations to date
 - **NIRL**
 - Allocations assigned to Project Zones A and B





Background

Spatial Watershed Iterative Loading Model

- Developed under an Interlocal Agreement and a Joint Participation Agreement
- Part of a larger study to refine the TMDL
- Model Purpose:
 1. Provide more accurate loads both temporally and spatially, critical to building relationships to biological responses
 2. Allow flexibility for future allocation in an automated fashion
- Model Specs:
 - ❖ Python-based Spatial Model (GIS platform), Custom ESRI ArGIS Toolset
 - ❖ Iterative (many months at a time): originally designed to provide 16 years of monthly data
 - ❖ Initial development in 2012



SWIL Modeling Timeline

SWIL 1

- July 2012
- Initial Effort

SWIL 2

- Completed April 2014
- Response to FDEP comments
- Improve Speed & Use

SWIL 3

- April 2015
- Improve Calibration

SWIL 4A

- August 2015
- Mosquito Lagoon & all Central IRL

SWIL 4B

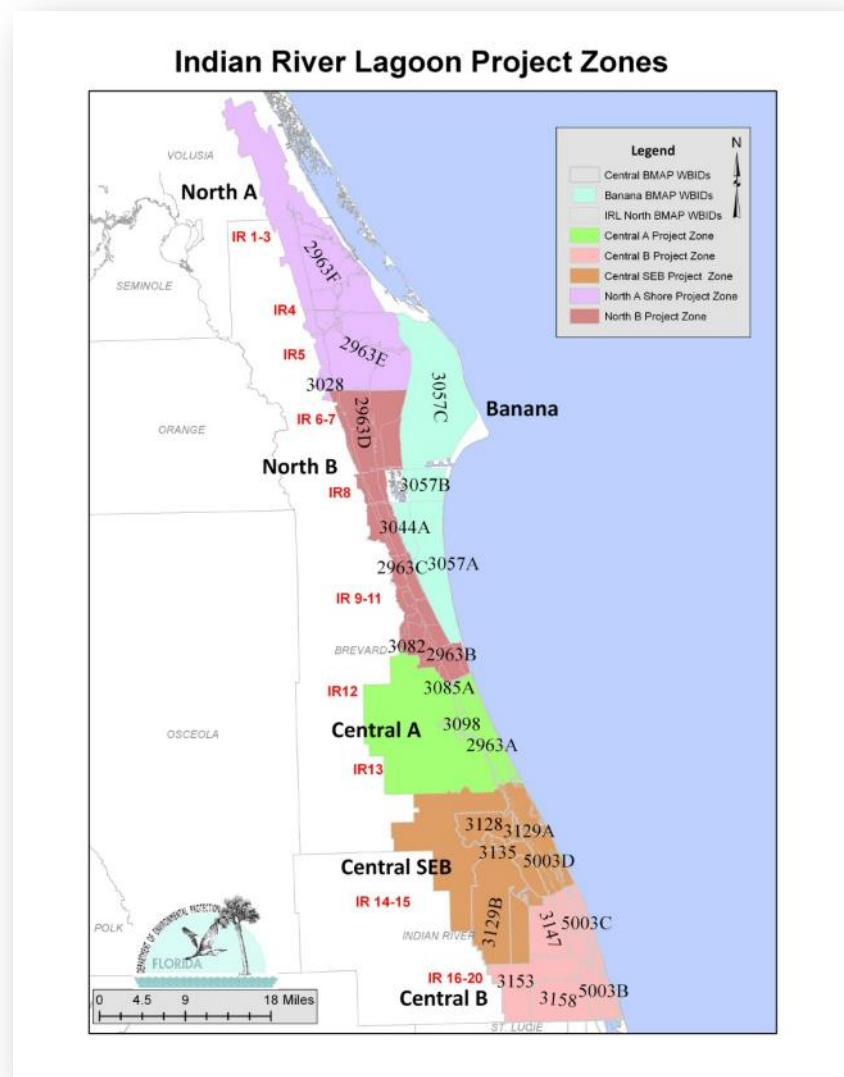
- December 2017
- All IRL (most of IRL)

- ❖ SWIL 4A version in terms of spatial boundaries
- ❖ SWIL 4B in terms of temporal coverage



IRL Model Update

- Add a decade of more recent data
- Improve spatial and temporal resolution
 - Rainfall
 - Air deposition
 - Basin boundaries
 - Land use and BMPs
 - Soil hydrologic groups
 - Stormwater runoff coefficients
 - Groundwater/base flow



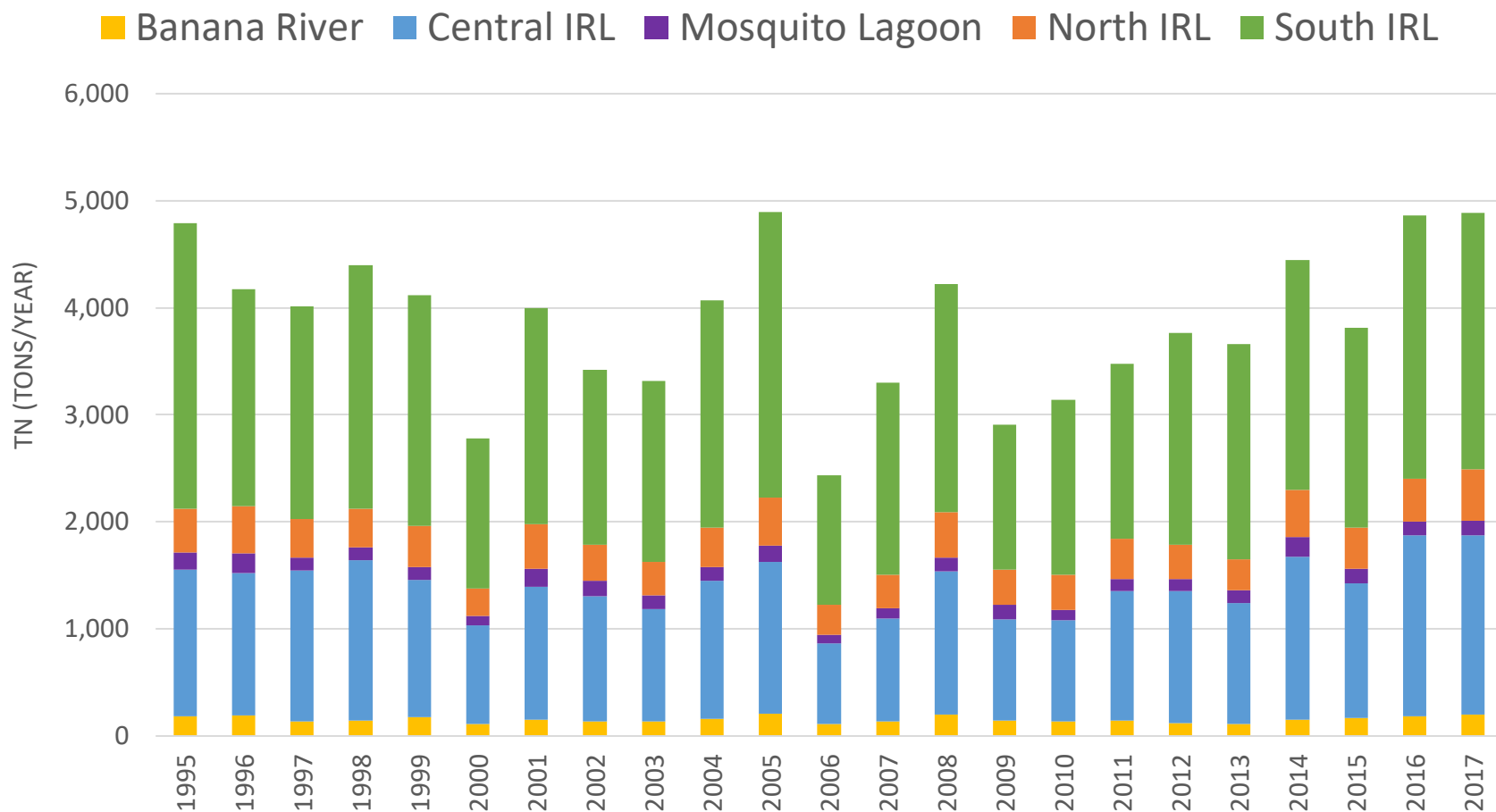


Key Differences

PLSM	SWIL
• One snapshot in time (1999/2000)	• Monthly 1995-2010 (since then expanded to 2015, 2017 ongoing)
• Annual Volumes and Loads	• Monthly and annual #s
• Baseflow and Direct Runoff values are not segregated	• Segregates direct runoff and baseflow values
• 1999 land use and soils, ERP boundaries	• Updated land use, 2010 soils & treatments
• Mean annual rainfall	• Spatial mean per segment
• Impoundments = reduce rainfall	• Impoundments by location and management scheme
• Original EMCs and C values	• Updated EMCs and C values
• Treatments as one size fits all	• Wet versus dry treatments



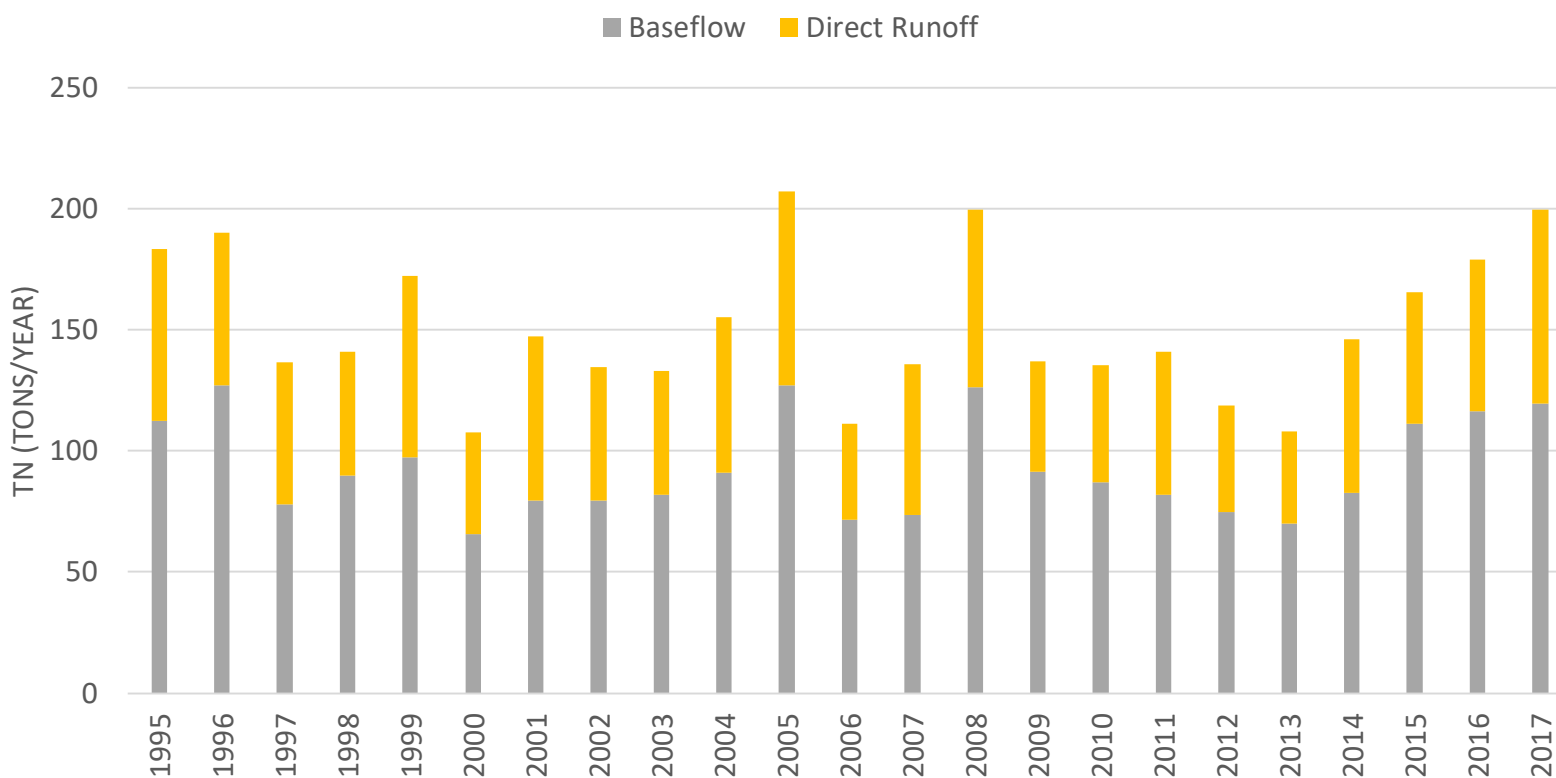
Latest SWIL: TN Load Distribution





Latest SWIL TN Load: Banana River

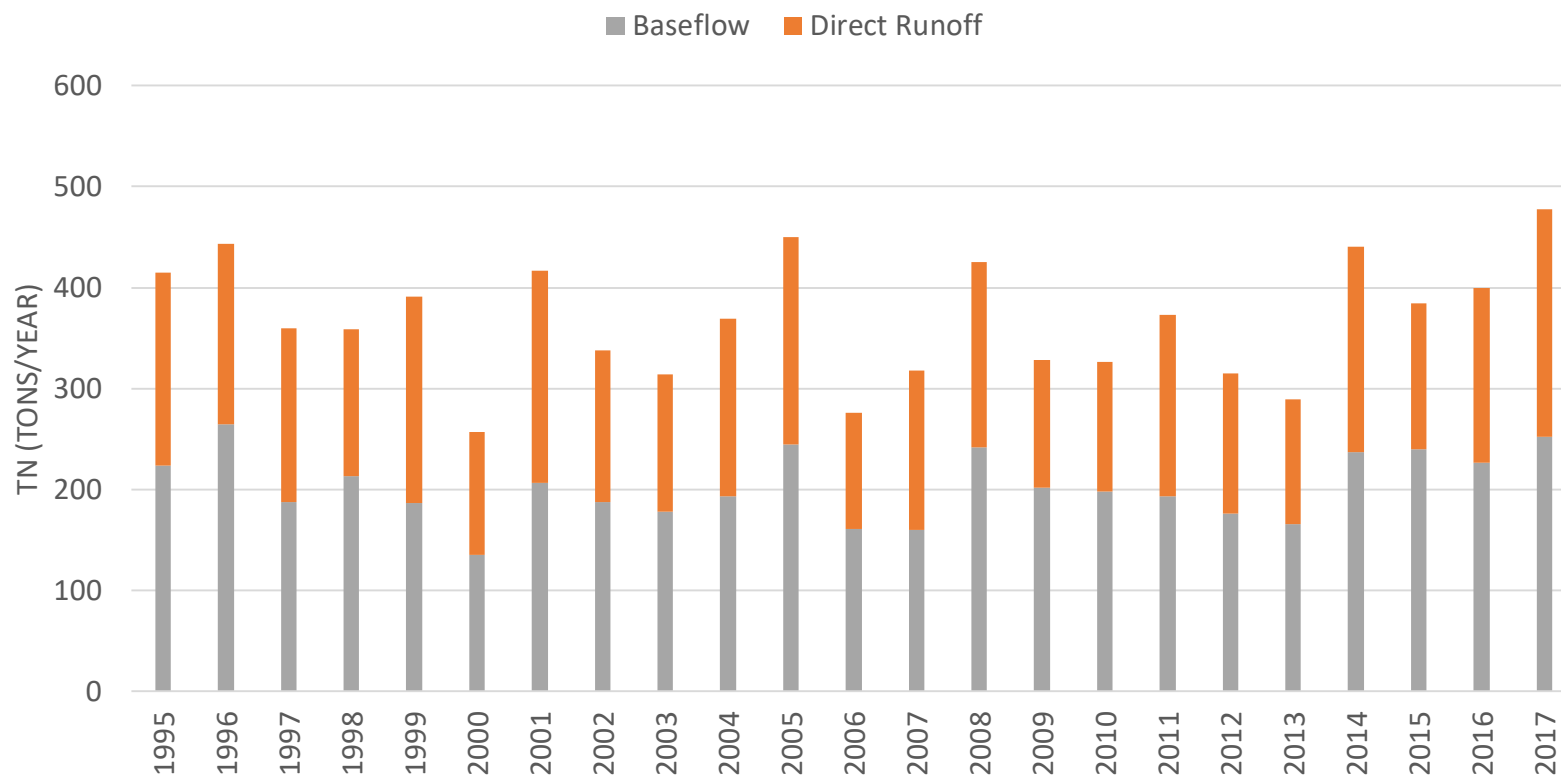
Total Nitrogen Distribution in the Banana River





Latest SWIL TN Load: North IRL

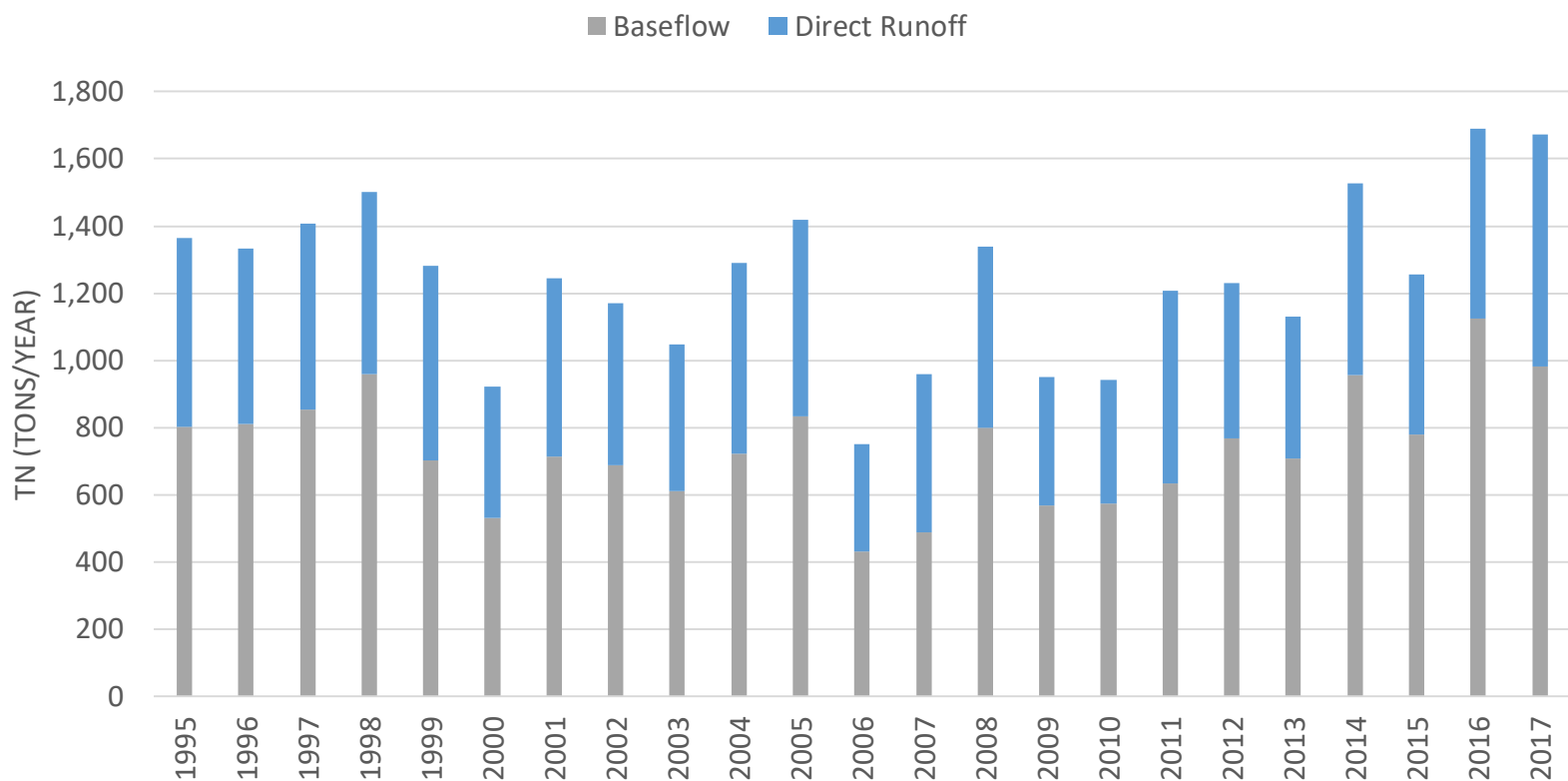
Total Nitrogen Distribution in the North IRL





Latest SWIL TN Load: Central IRL

Total Nitrogen Distribution in the Central IRL





Proposed Load Estimation Approach

Load Estimation Tool



Load Estimation Tool

Proposed Parameters

- The following are the proposed parameters to be used in the updated current conditions model run:
 - 50 x 50-meter (m) cell size (higher resolution than PLSM)
 - Land use is from 2015 and is derived from water management districts land use and property appraiser data and local government natural communities land cover, where available
 - Treatment layer (BMPs) also in sync with land use (2015)
 - Period of Record (POR) for Rainfall (**SEE NEXT SLIDE FOR OPTIONS**):
 - 2004 - 2017 **OR** 1995 - 2017
 - The POR should include a wide range of rainfall conditions to represent the variability in loading to the IRL
- Converting dynamic model run to static can be performed in one of two options
- Output would be static mean annual total and dry season (Jan-May totals) for volumes, TN and TP loads by cell size per unit acre
- **Note:** Retrofit projects are not included in the model and credit needs to be recalculated using the new model

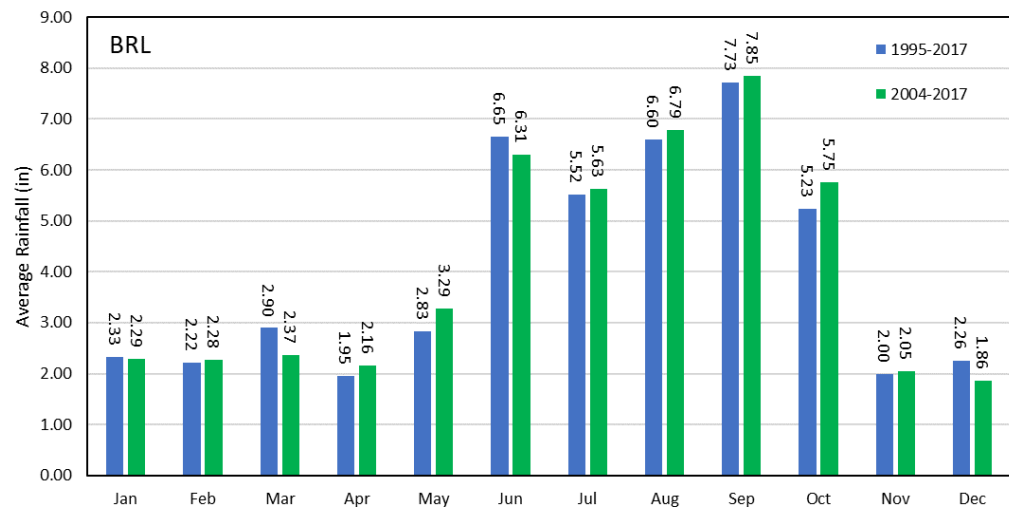
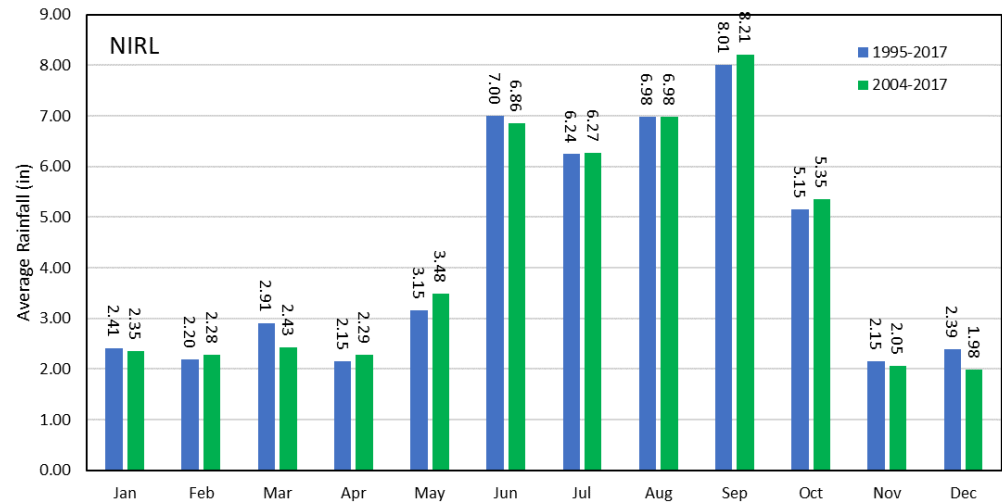


Load Estimation Tool

Rainfall POR Options

- **Option 1 is using 2004 - 2017 for the POR**
 - Represents more recent conditions and is consistent with approaches for load estimation models in other BMAPs
 - A more conservative estimate (more rainfall) for BRL
 - A less conservative estimate (less rainfall) for NIRL and CIRL
- **Option 2 is using 1995 - 2017 for the POR**
 - Utilizes all available data to capture more variability
 - A less conservative estimate (less rainfall) for BRL
 - A more conservative estimate (more rainfall) for NIRL and CIRL

Input/recommendations by January 14th





Load Estimation Tool

Rainfall Aggregation Options

- **Option 1** - Average monthly rainfall over the POR to create “representative year” for a single model run (e.g., average January rainfall, average February rainfall, etc.)
- **Option 2** - Complete model runs for each year of the POR using unique monthly rainfall values and then average the resulting loads.

Recommended

Option 1

Average Monthly Rainfall

● Single Year Model Run

● Results in Average Monthly and Annual Loads

Option 2

Unique Monthly Rainfall for POR

● Model Run for Every Year of POR

● Results in Monthly Loads, then Aggregate

- Both options result in average monthly and annual loads
- Option 2 is more computationally intensive and costly
- Results should be similar, thus ***Option 1 is recommended***

Input/recommendations by January 14th



Proposed Allocation Approach

Boundary Changes

Allocations Under Current TMDL

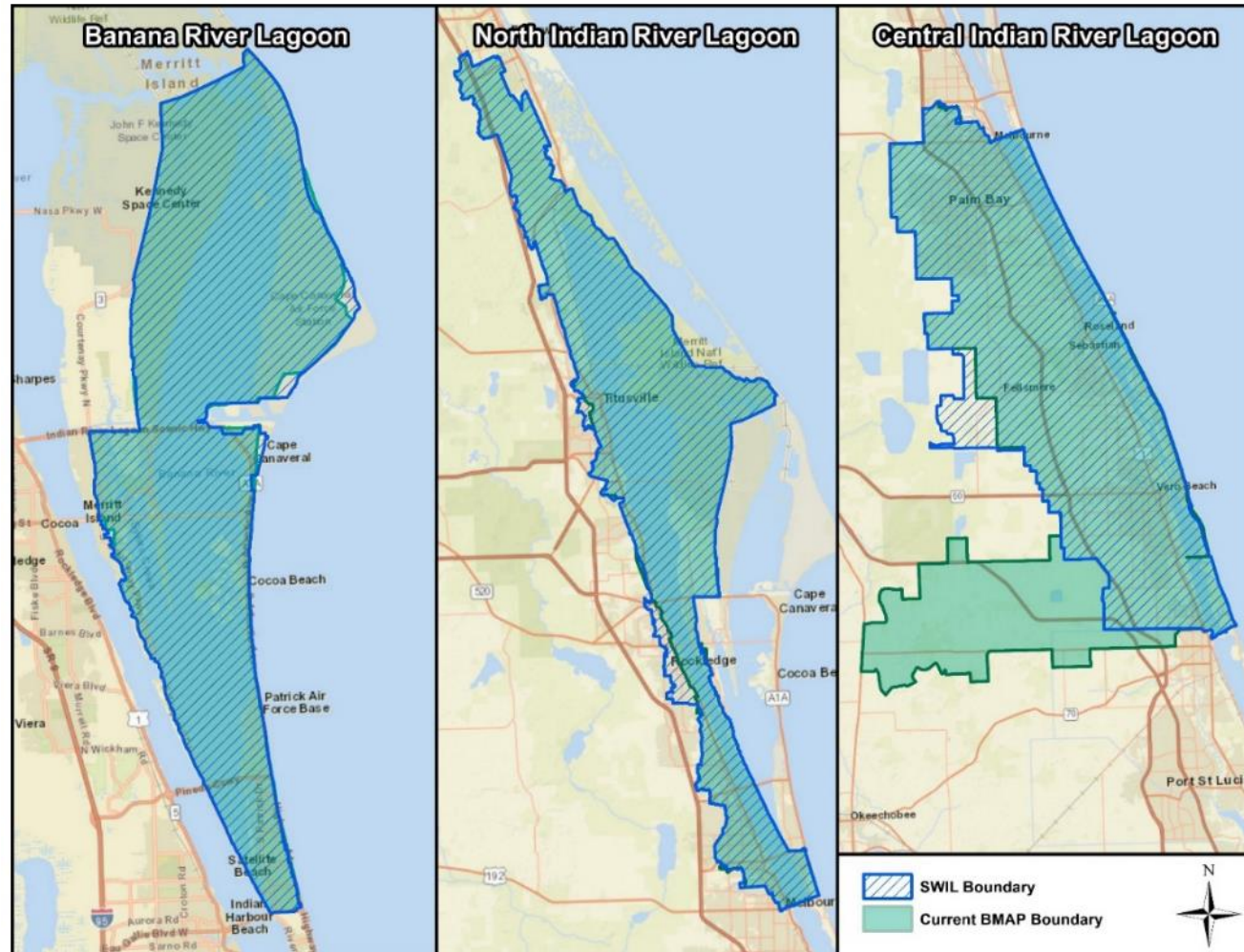
Considerations

Steps



Boundary Changes

- SWIL boundaries are based on:
 - Local input
 - WMD info
 - C-25 excluded (St. Lucie Basin)
- Boundary changes proposed include:
 - Correcting the BMAP boundaries
 - Aligning the Project Zone boundaries with SWIL





Allocation Approach

Allocations Under Current TMDL

- IRL rule language defines the TMDL with the PLSM loads as well as percent reductions by segment
 - **Option 1** is to apply the percent reduction from the TMDL.
 - **Option 2** is to apply the pounds per year reductions from the TMDL.
 - **Option 1 - percent reduction - is recommended** as it reflects the magnitude of the reductions from the TMDLs while relying on the loads from the SWIL 4.0 model.
- Should an updated TMDL be adopted, allocations will be updated as well.

WBID	TN			TP		
	Existing Nonpoint Load (lbs/yr)	LA (lbs/yr)	% Reduction	Existing Nonpoint Load (lbs/yr)	LA (lbs/yr)	% Reduction
2963F	134,968	88,322	35%	13,901	7,307	47%
2963E	146,598	95,932	35%	24,812	13,042	47%
2963D	115,901	73,882	36%	18,618	8,752	53%
2963B+2963C	178,946	114,459	36%	36,176	18,886	48%
5003D+2963A	1299,715	577,183	56%	210,596	109,055	48%
5003B+5003C	496,348	217,877	56%	98,411	50,857	48%
3057C	127,782	41,614	67%	20,680	5,874	72%
3057A+3057B	115,122	47,539	59%	24,597	8,916	64%
3044A	46,213	15,489	66%	9,724	2,907	70%

From IRL TMDL 2009

Input/recommendations by January 14th



Allocation Approach

Comparison of Options 1 and 2

						Option 1	Option 2		
Segment	Average Total Model TN SWIL 4.0 (2004-2014)	WBID	Load Allocation TMDL	Percent Reduction Per Rule	Required Reduction With PLSM from Table 6.3a	Required Reduction With SWIL 4.0 (04-14) Based on %Redux	% Diff	Required Reduction With SWIL 4.0 (04-14) Based on LA	% Diff
IR1-3	137,498.91	2963F	88322	35%	46,646.00	48,124.62	3%	49,176.91	5%
IR4	18,657.75	2963E	95932	35%	50,666.00	77,747.42	53%	126,203.48	149%
IR5	203,477.73								
IR6-7	143,265.93	2963D	73882	36%	42,019.00	51,575.73	23%	69,383.93	65%
IR8	41,158.75								
IR9-11	140,790.81	2963B + 2963C	114459	36%	64,487.00	65,501.84	2%	67,490.56	5%
TOTAL	684,849.88		372,595.00		203,818.00	242,949.61	19%	312,254.88	53%
IR12	575,450.27								
IR13	87,683.76								
IR14-15	789,546.26	5003D+2936A	577183	56%	722,532.00	813,500.96	13%	875,497.29	21%
IR16-20	474,060.81								
IR21	16,603.73	5003B+5003C	217877	56%	278,471.00	274,772.14	-1%	272,787.54	-2%
TOTAL	1,943,344.83		795,060.00		1,001,003.00	1,088,273.10	9%	1,148,284.83	15%
BR1-2	156,091.96	3057C	41614	67%	86,168.00	104,581.61	21%	114,477.96	33%
BR3-5	57,783.11	3057A+3057B	47539	59%	67,583.00	54,322.11	-20%	44,532.37	-34%
BR6	41,952.97	3044A	15489	66%	30,724.00	27,688.96	-10%	26,463.97	-14%
BR7	34,288.26								
TOTAL	290,116.30		104,642.00		184,475.00	186,592.68	1%	185,474.30	1%

The load comparison tables do not reflect the same values as would the updated loading estimation coverage proposed by this document. The period of record for the updated load estimation model will be different, and therefore the tables should only be used for general



Allocation Approach

Allocation Considerations

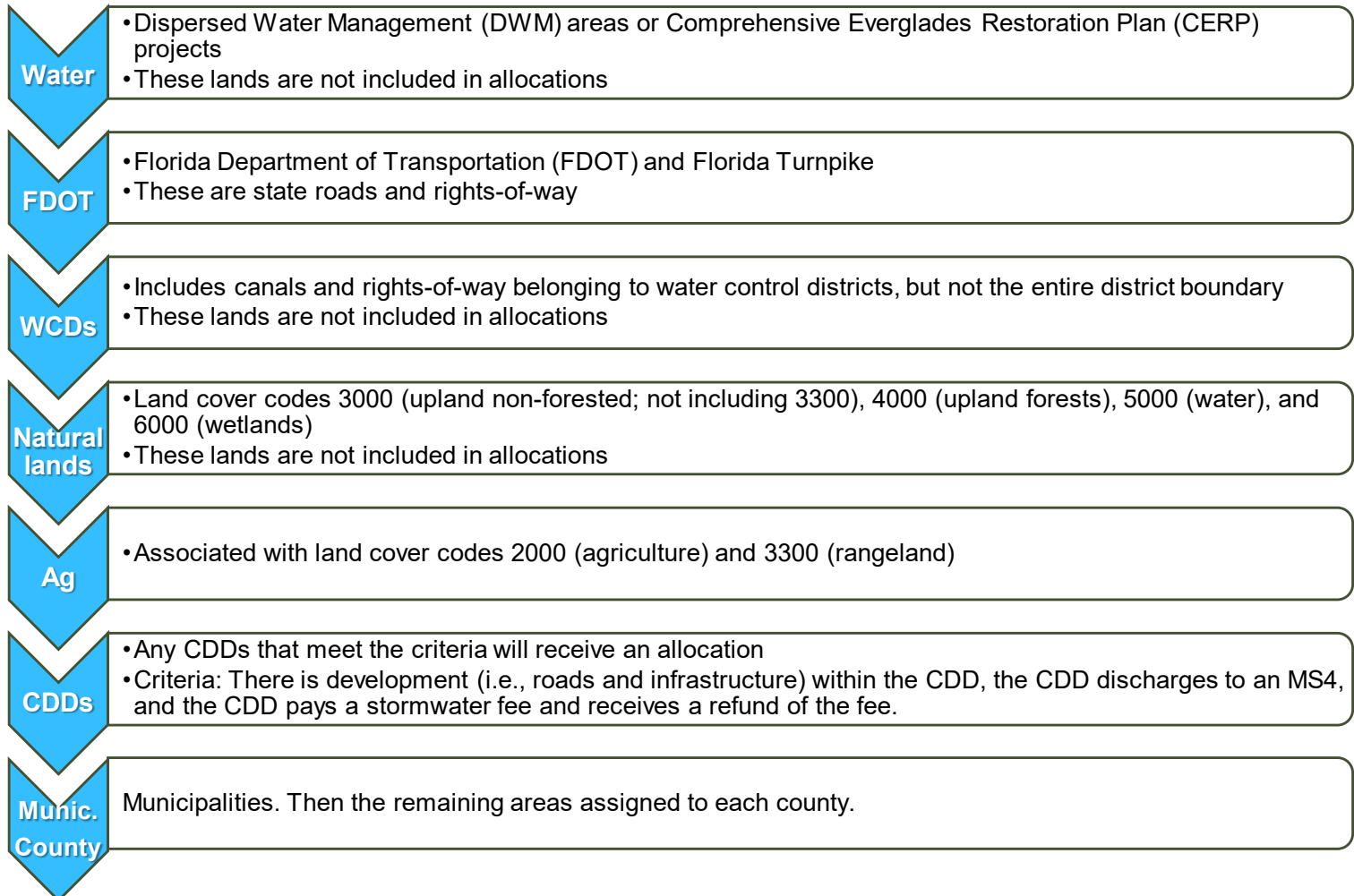
- The recommended option for calculating the IRL reductions using the SWIL and the TMDLs is as follows:
 - **For the current loads**, SWIL will be used to calculate the TN and TP loads for each segment based on the current (2015) land use.
 - **For the target loads**, the TMDL percent reductions will be applied to the current SWIL loading estimate for each segment to reduce the loads to levels expected to promote restoration.
 - **For the total required reductions**, the difference between the current SWIL loading estimate and the TMDL loading within a segment will be the total required reductions.
- Within each segment, jurisdictional boundaries will be used to determine required reductions for each entity.
- DEP will provide the jurisdictional boundaries to each stakeholder for review prior to using them for individual allocations.
- Existing best management practices are included in the SWIL Model estimates.



Allocation Approach

Allocation Steps

For entity/jurisdictional allocations, DEP will clip/erase from SWIL load estimation tool to determine each entity's responsible acres by sub-basin. The individual entity shapefiles will be created by clipping out areas sequentially, as follows:





Discussion/Questions?

- *Rainfall POR*
 - Option 1 (More Recent POR = 2007 to 2017)
 - Option 2 (Whole POR = 1994 to 2017)
- *Rainfall Aggregation*
 - Option 1 (Single Model Run)
 - Option 2 (Model Run for Every Year)
- *Allocation Approach*
 - Option 1 (percent reduction from the TMDL)
 - Option 2 (lbs/yr reductions from the TMDL)



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