

Spatial Watershed Iterative Loading (SWIL) Model for Use With the Indian River Lagoon (IRL) Basin Management Action Plans (BMAPs) Load Estimations and Allocations

DRAFT Proposed Path Forward

1.1 Objective

Currently, load allocations have been developed for the Northern Indian River Lagoon (NIRL) and a portion of the Banana River Lagoon (BRL), but not for the whole of BRL and CIRL. The goal of this effort is to develop load estimations for current conditions across the IRL BMAPs to develop allocations using the Spatial Watershed Iterative Loading (SWIL) model 4.0 and the adopted total maximum daily loads (TMDLs).

1.2 Background

The Florida Department of Environmental Protection (DEP) has identified the Indian River Lagoon and Banana River Lagoon as impaired waterbodies due to nutrient over-enrichment. TMDLs for 13 waterbody identification areas (WBIDs) in IRL 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 FORTAN (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, and every two years SJRWMD develops spatial seagrass coverage for compliance measurements. In 2013, BMAPs for NIRL, Central Indian River Lagoon (CIRL), and BRL were developed to implement the TMDLs in IRL.

The Spatial Watershed Iterative Loading (SWIL) model was developed under an Interlocal Agreement and a Joint Participation Agreement to incorporate more available data, more recent conditions, and more temporally fine datasets. SWIL is a custom ESRI ArcGIS toolset, originally designed to provide a continuous monthly simulation of runoff (surface and baseflows) over a 16-year period, yielding a more robust representation of pollutant loadings and freshwater volumes in the IRL. The latest version of SWIL used currently is version 4.0. The specific goal of SWIL 4.0 is to provide monthly estimated total nitrogen and phosphorus loads from January 1995 through August 2015 for 70 subsegments of the Lagoon watershed (*Adapted from Spatial Watershed Iterative Loading (SWIL) 4.0 Model Update, Appendix A, Applied Ecology Inc. 2017*).

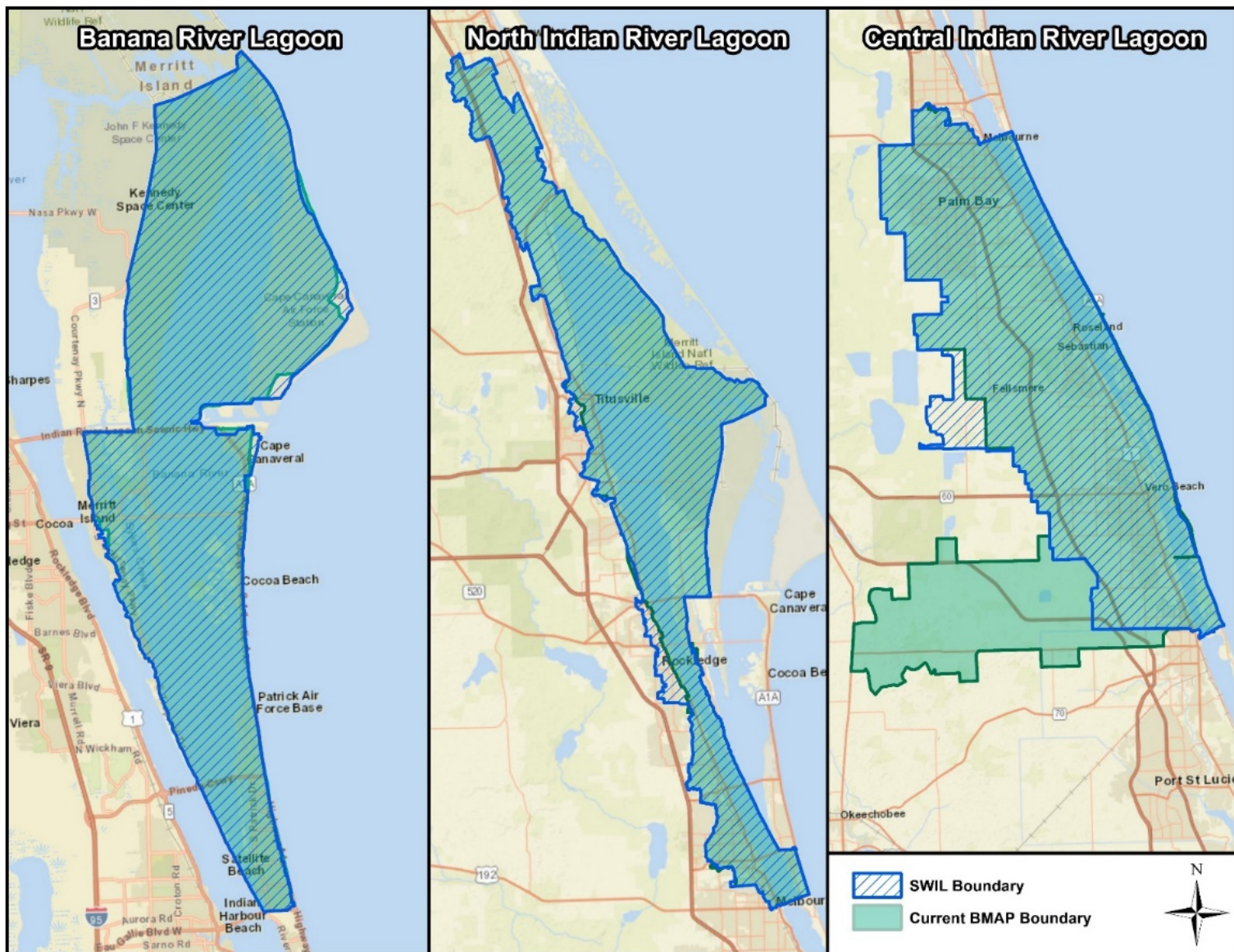
1.3 Proposed Load Estimation Approach

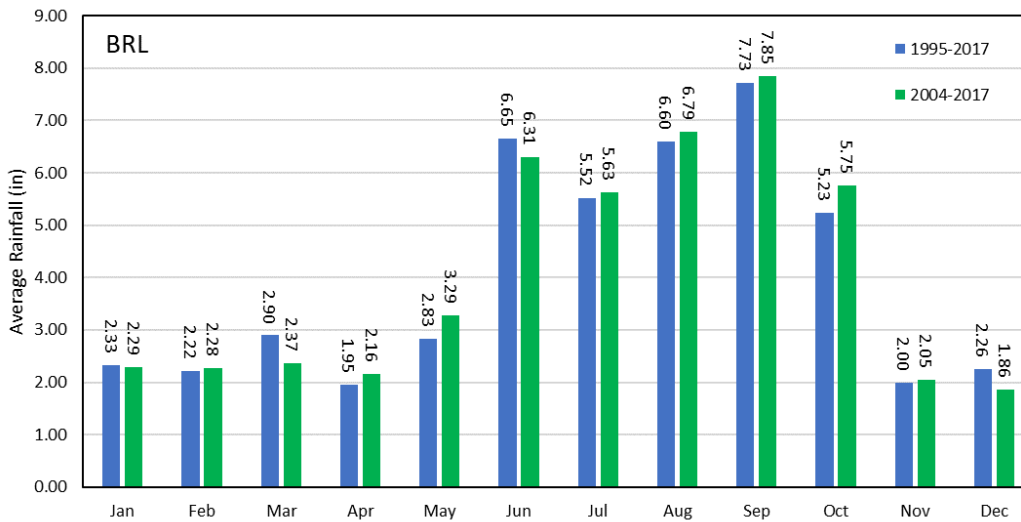
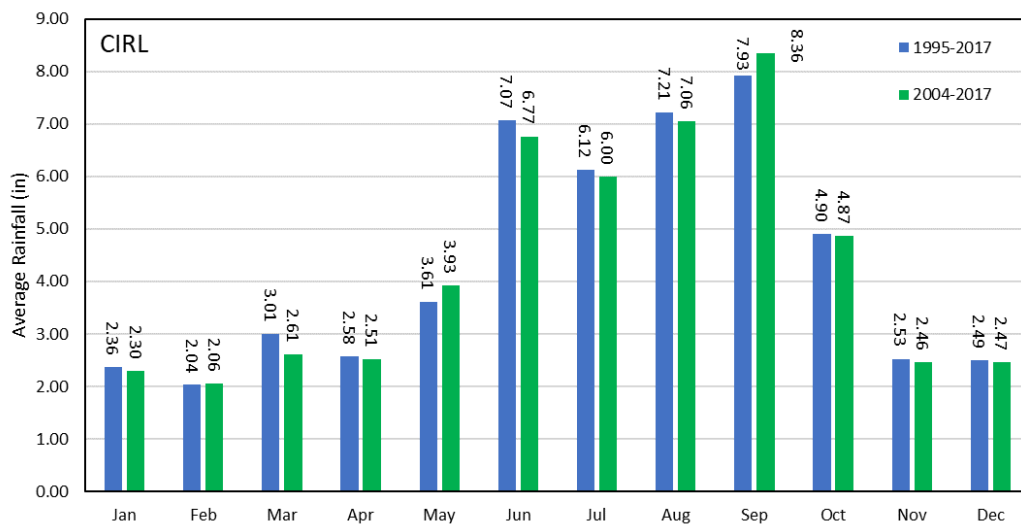
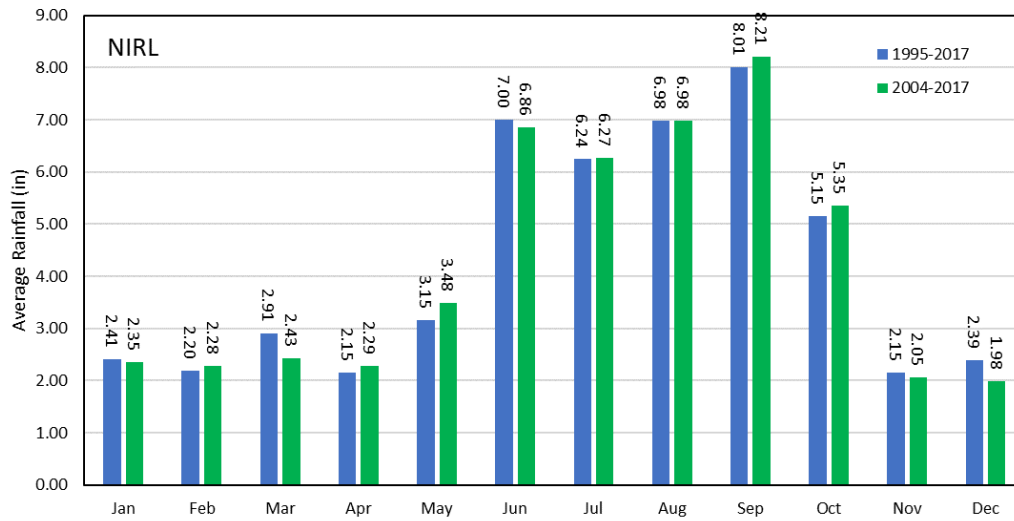
To develop current spatial loading estimates across the BMAPs, DEP is working with stakeholders and model developers (Applied Ecology Inc.) to develop a methodology to build a load estimation tool using SWIL 4.0. Using a defined representative period of record, Applied Ecology Inc. is contracted to run the SWIL 4.0 model to estimate current loading conditions. In using an updated loading model, there are a few considerations that must be addressed:

- The BMAP boundaries and the SWIL model boundary do not entirely align
 - DEP will correct the BMAP boundaries to correspond to the SWIL-modeled area
 - SWIL boundaries were developed according to most recent water management district watershed boundaries
 - Boundary changes will include:
 - Correcting the southern BMAP boundary area which is not currently in line with watershed boundaries from the two water management districts
 - Aligning the Project Zone boundaries with SWIL
 - See Figure on page 3
- 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
 - Period of Record (POR) for Rainfall: 2004 - 2017 or 1995 - 2017. The POR should include a wide range of rainfall conditions to represent the variability in loading to the IRL.
 - Option 1 is using 2004 - 2017 for the POR
 - Represents more recent conditions and is consistent with approaches loading 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
 - See figures on pages 4 and 5
 - Rainfall POR and Loading Averaging
 - Option 1 is to average rainfall monthly over the POR to create representative year for a single model run (e.g., average January rainfall, average February rainfall, etc.)
 - Option 2 is to complete model runs for each year of the POR using unique monthly rainfall values and average the resulting loads.

- With both options, the values are averages (either using the monthly averages or the annual averages)
- Option 2 is much more computationally intensive and costly
- Results should be similar, and thus Option 1 is recommended

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Month	BRL				CIRL				NIRL			
	Avg. Rainfall 1995-2017	Avg. Rainfall 2004-2017	Diff	%Diff	Avg. Rainfall 1995-2017	Avg. Rainfall 2004-2017	Diff	%Diff	Avg. Rainfall 1995-2017	Avg. Rainfall 2004-2017	Diff	%Diff
Jan	2.33	2.29	0.04	2%	2.36	2.30	0.07	3%	2.41	2.35	0.06	2%
Feb	2.22	2.28	-0.06	-2%	2.04	2.06	-0.02	-1%	2.20	2.28	-0.08	-4%
Mar	2.90	2.37	0.52	20%	3.01	2.61	0.40	14%	2.91	2.43	0.48	18%
Apr	1.95	2.16	-0.21	-10%	2.58	2.51	0.06	3%	2.15	2.29	-0.14	-6%
May	2.83	3.29	-0.46	-15%	3.61	3.93	-0.32	-8%	3.15	3.48	-0.33	-10%
Jun	6.65	6.31	0.35	5%	7.07	6.77	0.31	4%	7.00	6.86	0.13	2%
Jul	5.52	5.63	-0.11	-2%	6.12	6.00	0.12	2%	6.24	6.27	-0.02	0%
Aug	6.60	6.79	-0.19	-3%	7.21	7.06	0.16	2%	6.98	6.98	0.00	0%
Sep	7.73	7.85	-0.12	-2%	7.93	8.36	-0.43	-5%	8.01	8.21	-0.20	-2%
Oct	5.23	5.75	-0.52	-9%	4.90	4.87	0.02	0%	5.15	5.35	-0.20	-4%
Nov	2.00	2.05	-0.05	-2%	2.53	2.46	0.06	3%	2.15	2.05	0.10	5%
Dec	2.26	1.86	0.40	19%	2.49	2.47	0.03	1%	2.39	1.98	0.41	19%
Totals			-0.40				0.46				0.21	

1.4 Proposed Allocation Approach

- IRL rule language defines the TMDL with the PLSM loads as well as percent reductions by segment
 - The Florida Department of Environmental Protection (DEP) reviewed whether to use the percent reduction or the loading itself from the existing total maximum daily loads (TMDLs).
 - The **percent reduction is recommended** as it is more representative considering a different loading model was used in development of the TMDL loads in the rule.
 - 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 is recommended as it reflects the magnitude of the reductions from the TMDLs while referencing the loads from the SWIL 4.0 model.
 - Should an updated TMDL be adopted, allocations will be updated as well.
 - TMDL loads and percent reductions are in the table below. Additionally, the comparison tables on pages 6 and 7 compare the PLSM Loads and % reductions to the SWIL Loads from 2004-2014. *(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 comparison).*

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%	20,660	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%

TMDL % Reduction Applied to SWIL Loads (2004-2014)

Segment	Average Total Model TN SWIL 4.0 (2004-2014)	WBID	Segment Aggregates	Percent Reduction Per Rule	Required Reduction With PLSM from Table 6.3a	Required Reduction With SWIL 4.0 (04-14) Based on %Redux	Difference in Required Reduction (SWIL-PLSM[6.3a]) %Redux	% Diff
IR1-3	137,498.91	2963F	IR1-3	35%	46,646.00	48,124.62	1,478.62	3%
IR4	18,657.75	2963E	IR4+IR5	35%	50,666.00	77,747.42	27,081.42	53%
IR5	203,477.73							
IR6-7	143,265.93	2963D	IR6-7	36%	42,019.00	51,575.73	9,556.73	23%
IR8	41,158.75							
IR9-11	140,790.81	2963B + 2963C	IR8+IR9-11	36%	64,487.00	65,501.84	1,014.84	2%
TOTAL	684,849.88				203,818.00	242,949.61	39,131.61	19%
IR12	575,450.27							
IR13	87,683.76							
IR14-15	789,546.26	5003D+2936A	IR12+IR13+IR14-15	56%	722,532.00	813,500.96	90,968.96	13%
IR16-20	474,060.81							
IR21	16,603.73	5003B+5003C	IR16-20+IR21	56%	278,471.00	274,772.14	(3,698.86)	-1%
TOTAL	1,943,344.83				1,001,003.00	1,088,273.10	87,270.10	9%
BR1-2	156,091.96	3057C	BR1-2	67%	86,168.00	104,581.61	18,413.61	21%
BR3-5	57,783.11	3057A+3057B	BR3-5+BR7	59%	67,583.00	54,322.11	(13,260.89)	-20%
BR6	41,952.97	3044A	BR6	66%	30,724.00	27,688.96	(3,035.04)	-10%
BR7	34,288.26							
TOTAL	290,116.30				184,475.00	186,592.68	2,117.68	1%

Segment	Average Total Model TP SWIL 4.0 (2004-2014)	WBID	Segment Aggregates	Percent Reduction Per Rule	Required Reduction With PLSM from Table 6.3a	Required Reduction With SWIL 4.0 (04-14) Based on %Redux	Difference in Required Reduction (SWIL-PLSM[6.3a]) %Diff	% Diff
IR1-3	18,208.27	2963F	IR1-3	47%	6,594.00	8,557.89	1,963.89	30%
IR4	2,827.34	2963E	IR4+IR5	47%	11,770.00	12,661.56	891.56	8%
IR5	24,112.15							
IR6-7	20,628.97	2963D	IR6-7	53%	9,866.00	10,933.36	1,067.36	11%
IR8	6,122.77							
IR9-11	20,626.86	2963B + 2963C	IR8+IR9-11	48%	17,290.00	12,839.82	(4,450.18)	-26%
TOTAL	92,526.36				45,520.00	44,992.63	(527.37)	-1%
IR12	82,592.82							
IR13	11,647.17							
IR14-15	100,453.68	5003D+2936A	IR12+IR13+IR14-15	48%	101,541.00	93,452.96	(8,088.04)	-8%
IR16-20	64,592.12							
IR21	2,288.16	5003B+5003C	IR16-20+IR21	48%	47,554.00	32,102.53	(15,451.47)	-32%
TOTAL	261,573.95				149,095.00	125,555.49	(23,539.51)	-16%
BR1-2	19,136.05	3057C	BR1-2	72%	14,786.00	13,777.95	(1,008.05)	-7%
BR3-5	8,413.28	3057A+3057B	BR3-5+BR7	64%	15,681.00	8,668.63	(7,012.37)	-45%
BR6	5,585.20	3044A	BR6	70%	6,817.00	3,909.64	(2,907.36)	-43%
BR7	5,131.45							
TOTAL	38,265.98				37,284.00	26,356.23	(10,927.77)	-29%

TMDL Target lbs/yr Compared to SWIL Loads (2004-2014)

Segment	Average Total Model TN SWIL 4.0 (2004-2014)	WBID	Segment Aggregates	Non-point SWIL 4.0 (04-14)	Load Allocation TMDL	Required Reduction With PLSM from Table 6.3a	Required Reduction With SWIL 4.0 (04-14) Based on LA	Difference in Required Reduction (SWIL- PLSM[6.3a]) LA	% Diff
IR1-3	137,498.91	2963F	IR1-3	137,498.91	88322	46,646.00	49,176.91	2,530.91	5%
IR4	18,657.75	2963E	IR4+IR5	222,135.48	95932	50,666.00	126,203.48	75,537.48	149%
IR5	203,477.73								
IR6-7	143,265.93	2963D	IR6-7	143,265.93	73882	42,019.00	69,383.93	27,364.93	65%
IR8	41,158.75								
IR9-11	140,790.81	2963B + 2963C	IR8+IR9-11	181,949.56	114459	64,487.00	67,490.56	3,003.56	5%
TOTAL	684,849.88			684,849.88	372,595.00	203,818.00	312,254.88	108,436.88	53%
IR12	575,450.27								
IR13	87,683.76								
IR14-15	789,546.26	5003D+2936A	IR12+IR13+IR14-15	1,452,680.29	577183	722,532.00	875,497.29	152,965.29	21%
IR16-20	474,060.81								
IR21	16,603.73	5003B+5003C	IR16-20+IR21	490,664.54	217877	278,471.00	272,787.54	(5,683.46)	-2%
TOTAL	1,943,344.83			1,943,344.83	795,060.00	1,001,003.00	1,148,284.83	147,281.83	15%
BR1-2	156,091.96	3057C	BR1-2	156,091.96	41614	86,168.00	114,477.96	28,309.96	33%
BR3-5	57,783.11	3057A+3057B	BR3-5+BR7	92,071.37	47539	67,583.00	44,532.37	(23,050.63)	-34%
BR6	41,952.97	3044A	BR6	41,952.97	15489	30,724.00	26,463.97	(4,260.03)	-14%
BR7	34,288.26								
TOTAL	290,116.30			290,116.30	104,642.00	184,475.00	185,474.30	999.30	1%

Segment	Average Total Model TP SWIL 4.0 (2004-2014)	WBID	Segment Aggregates	Non-point SWIL 4.0 (04-14)	Load Allocation TMDL	Required Reduction With PLSM from Table 6.3a	Required Reduction With SWIL 4.0 (04-14) Based on LA	Difference in Required Reduction (SWIL- PLSM[6.3a]) LA	% Diff
IR1-3	18,208.27	2963F	IR1-3	18,208.27	7307	6,594.00	10,901.27	4,307.27	65%
IR4	2,827.34	2963E	IR4+IR5	26,939.49	13042	11,770.00	13,897.49	2,127.49	18%
IR5	24,112.15								
IR6-7	20,628.97	2963D	IR6-7	20,628.97	8752	9,866.00	11,876.97	2,010.97	20%
IR8	6,122.77								
IR9-11	20,626.86	2963B + 2963C	IR8+IR9-11	26,749.63	18886	17,290.00	7,863.63	(9,426.37)	-55%
TOTAL	92,526.36			92,526.36	47,987.00	45,520.00	44,539.36	(980.64)	-2%
IR12	82,592.82								
IR13	11,647.17								
IR14-15	100,453.68	5003D+2936A	IR12+IR13+IR14-15	194,693.67	109055	101,541.00	85,638.67	(15,902.33)	-16%
IR16-20	64,592.12								
IR21	2,288.16	5003B+5003C	IR16-20+IR21	66,880.28	50857	47,554.00	16,023.28	(31,530.72)	-66%
TOTAL	261,573.95			261,573.95	159,912.00	149,095.00	101,661.95	(47,433.05)	-32%
BR1-2	19,136.05	3057C	BR1-2	19,136.05	5874	14,786.00	13,262.05	(1,523.95)	-10%
BR3-5	8,413.28	3057A+3057B	BR3-5+BR7	13,544.73	8916	15,681.00	4,628.73	(11,052.27)	-70%
BR6	5,585.20	3044A	BR6	5,585.20	2907	6,817.00	2,678.20	(4,138.80)	-61%
BR7	5,131.45								
TOTAL	38,265.98			38,265.98	17,697.00	37,284.00	20,568.98	(16,715.02)	-45%

- Existing best management practices for development are included in the SWIL Model estimates
- DEP will provide the jurisdictional boundaries to each stakeholder for review prior to using them for individual allocations
- The recommended option for calculating the IRL reductions using the SWIL and the TMDLs is as follows, and other options can be considered:
 - **For the current loads**, as described above, 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
 - **For entity/jurisdictional allocations**, DEP plans to clip and erase from the SWIL load estimation GIS coverage to create separate shapefiles with each entity's responsible acres by sub-basin. This clipping is done using the appropriate boundaries reviewed by each entity. The individual entity shapefiles were created by clipping out areas sequentially, as follows:
 - Water (e.g., Dispersed Water Management [DWM] areas or Comprehensive Everglades Restoration Plan [CERP] projects [construction or design status]). These lands are not included in allocations
 - Florida Department of Transportation (FDOT) and Florida Turnpike roads and rights-of-way
 - Water control districts (WCDs) and other special districts. This includes canals and rights-of-way belonging to water control districts, but not the entire district boundary. These lands are not included in allocations
 - Natural lands, associated with land cover codes 3000 (upland non-forested; not including 3300), 4000 (upland forests), 5000 (water), and 6000 (wetlands). These lands are not included in allocations.
 - Agriculture, associated with land cover codes 2000 (agriculture) and 3300 (rangeland).
 - Community development districts (CDDs), if they merit an allocation because they have the following attributes:
 - There is development (i.e., roads and infrastructure) within the CDD.
 - The CDD discharges to an MS4.
 - The CDD pays a stormwater fee and receives a refund of the fee.
 - Municipalities and counties
 - Remaining areas assigned to each county
 - Once clipping is completed, each entity's current TN and TP loads are calculated and their percentage of the overall anthropogenic loads within a segment are calculated. Their percentage of the anthropogenic load is multiplied by the total reductions needed for that segment and that is their assigned annual load reduction.
- Other options for discussion?