Better Understanding the Impact of Onsite Sewage System on Quality of Florida Groundwater and Springs

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Division of Disease Control and Health Protection
Florida Department of Health

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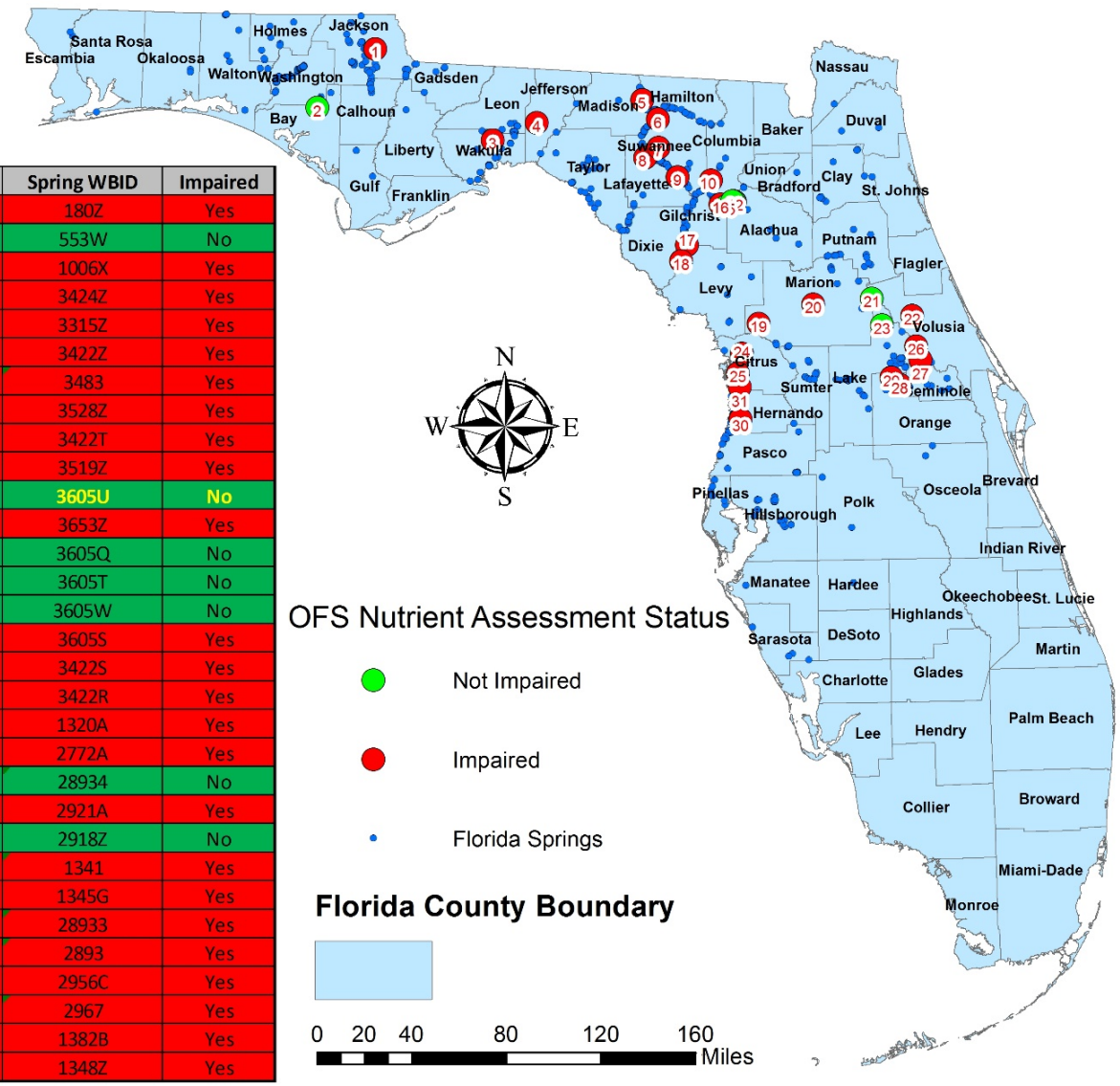
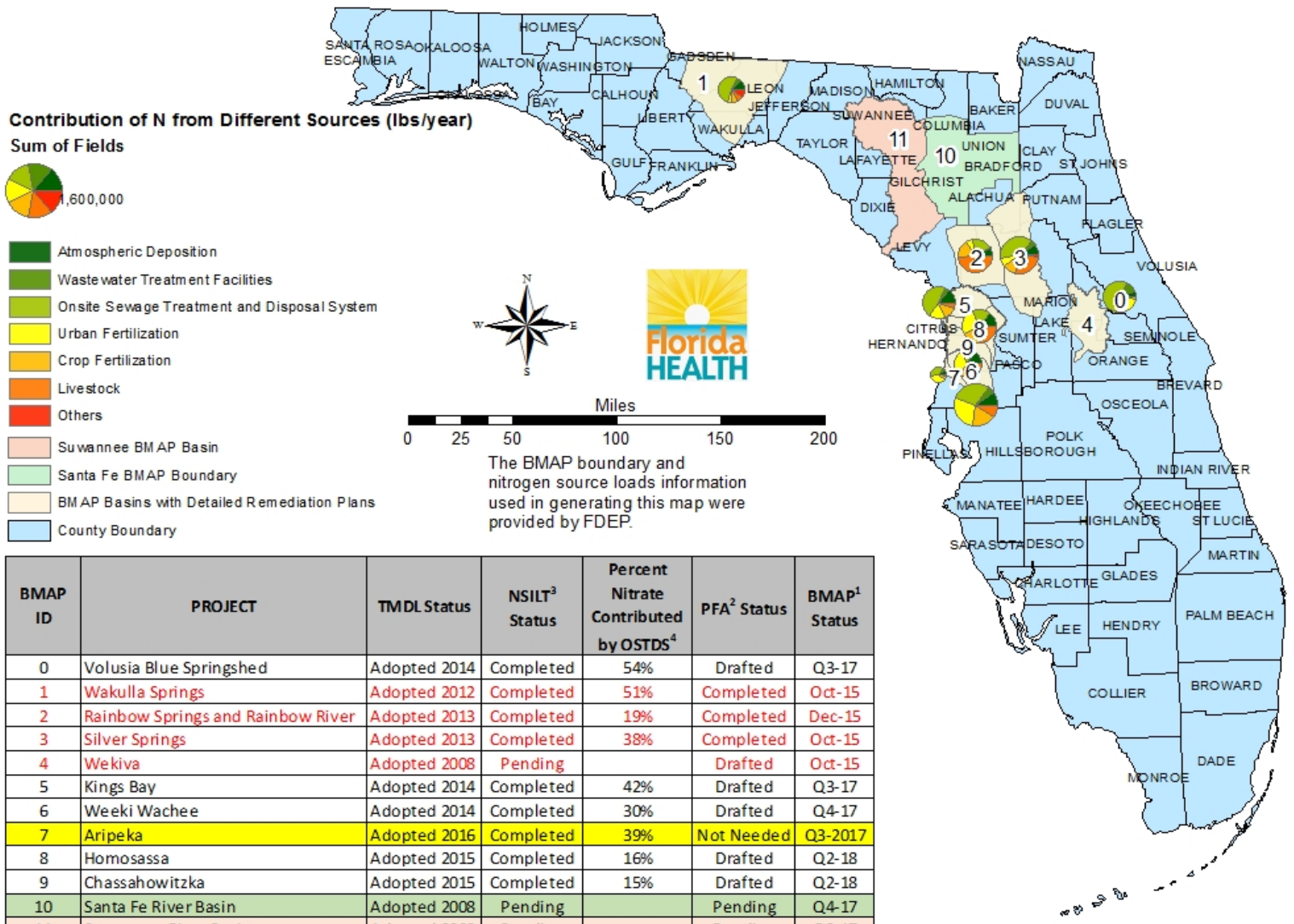
Spring No.	Spring Name	Spring WBID	Impaired
1	Jackson Blue	180Z	Yes
2	Gainer	553W	No
3	Wakulla	1006X	Yes
4	Wacissa	3424Z	Yes
5	Madison Blue	3315Z	Yes
6	Falmouth	3422Z	Yes
7	Peacock	3483	Yes
8	Lafayette Blue	3528Z	Yes
9	Troy	3422T	Yes
10	Ichetucknee	3519Z	Yes
11	Santa Fe	3605U	No
12	Hornsby	3653Z	Yes
13	Treehouse	3605Q	No
14	Columbia	3605T	No
15	Poe	3605W	No
16	Devil's Ear	3605S	Yes
17	Fanning	3422S	Yes
18	Manatee	3422R	Yes
19	Rainbow	1320A	Yes
20	Silver	2772A	Yes
21	Silver Glen	28934	No
22	DeLeon	2921A	Yes
23	Alexander	2918Z	No
24	Kings Bay	1341	Yes
25	Homosassa	1345G	Yes
26	Volusia Blue	28933	Yes
27	Gemini	2893	Yes
28	Wekiwa	2956C	Yes
29	Rock	2967	Yes
30	Weeki Wachee	1382B	Yes
31	Chassahowitzka	1348Z	Yes



Statutory Mandate

Protection of Water Quality in Outstanding Florida Springs (OFSs) (Florida Statute Section 373.807)

- Identify all OFSs impaired for nutrients by July 1 of 2018
- Adopt basin management action plan (BMAP) within two years of the adoption of the total maximum daily load (TMDL) (the latest July 1, 2018)
- Target achieving TMDL goals in 20 years
- Develop Onsite Sewage Treatment and Disposal System (OSTDS) remediation plans for basin where OSTDSs contribute more than 20% of nonpoint source loads or if FDEP considers an OSTDS plan is needed



BMAP ID	PROJECT	TMDL Status	NSILT[3] Status	Percent Nitrate Contributed by OSTDS[4]	PFA[2] Status	BMAP[1] Status
0	Volusia Blue Springshed	Adopted 2014	Completed	54%	Drafted	Q3-17
1	Wakulla Springs	Adopted 2012	Completed	51%	Completed	Oct-15
2	Rainbow Springs and Rainbow River	Adopted 2013	Completed	19%	Completed	Dec-15
3	Silver Springs	Adopted 2013	Completed	38%	Completed	Oct-15
4	Wekiva	Adopted 2008	Pending		Drafted	Oct-15
5	Kings Bay	Adopted 2014	Completed	42%	Drafted	Q3-17
6	Weeki Wachee	Adopted 2014	Completed	30%	Drafted	Q4-17
7	Aripeka	Adopted 2016	Completed	39%	Not Needed	Q3-2017
8	Homosassa	Adopted 2015	Completed	16%	Drafted	Q2-18
9	Chassahowitzka	Adopted 2015	Completed	15%	Drafted	Q2-18
10	Santa Fe River Basin	Adopted 2008	Pending		Pending	Q4-17
11	Suwannee River Basin	Adopted 2008	Pending		Pending	Q3-17

Establish Load Reduction Benchmarks

PROJECT	Total Nitrate Loads to Groundwater (lb-N/yr.)	Percent Nitrate Contributed by OSTDS
Volusia Blue Springshed	514,095	54%
Wakulla Springs	341,848	30%
Rainbow Springs and Rainbow River	602,405	19%
Silver Springs	752,979	38%
Wekiva		
Kings Bay	592,440	42%
Weeki Wachee	940,143	30%
Aripeka	137,929	39%
Homosassa	582,076	16%
Chassahowitzka	380,462	15%

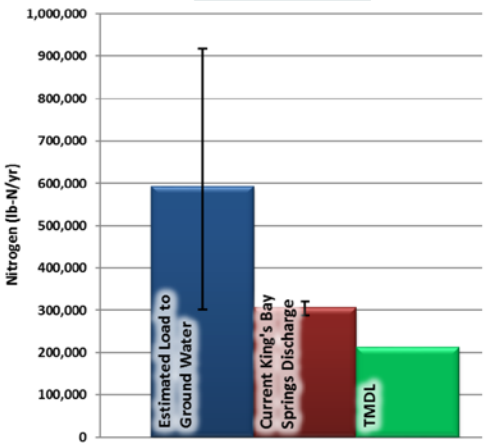
Nitrogen Source Inventory Loading Tool (NSILT)

a) Major sources included:
   i. Atmospheric deposition
   ii. OSTDS
   iii. Wastewater Treatment Plants
   iv. Urban turf grass and golf course fertilization
   v. Agricultural fertilization
   vi. Livestock

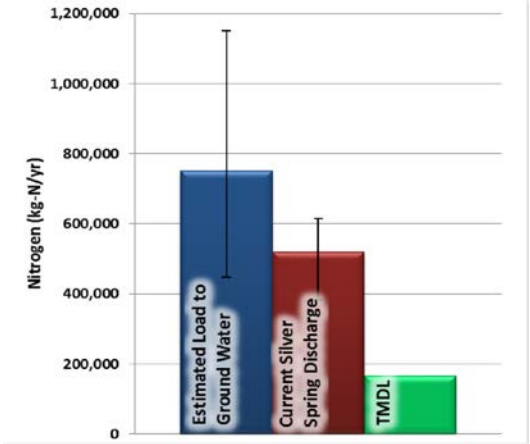
b) Attenuation: soil attenuation rate and recharge factors

NSILT Nitrogen Load, Spring Vent Nitrogen Load, And TMDL

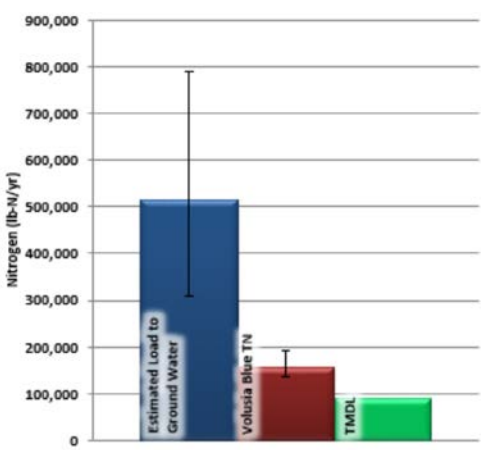
NSILT Load | Spring Vent Load | TMDL



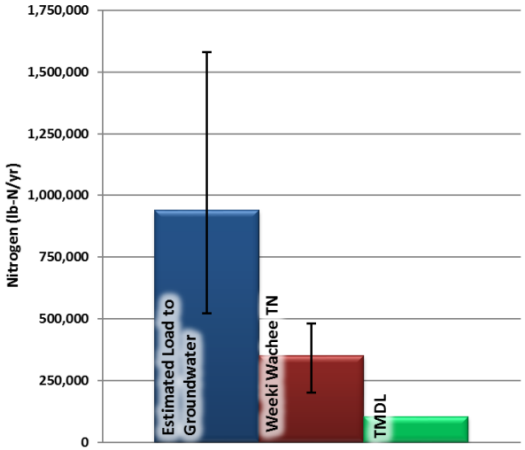
Kings Bay Springs



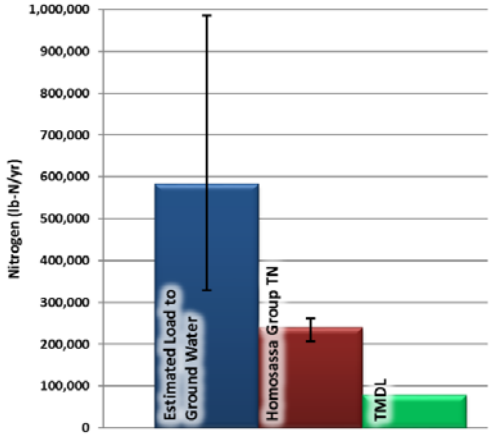
Silver Springs



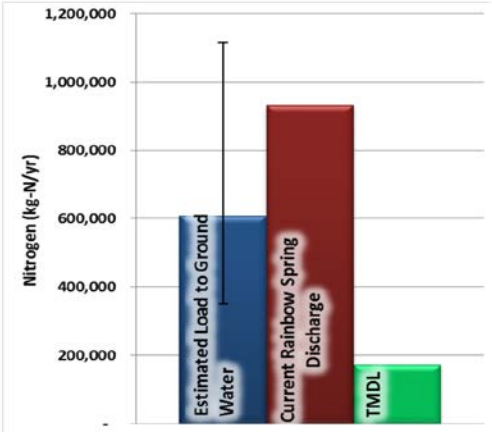
Volusia Blue Springs



Weeki Wachee Springs



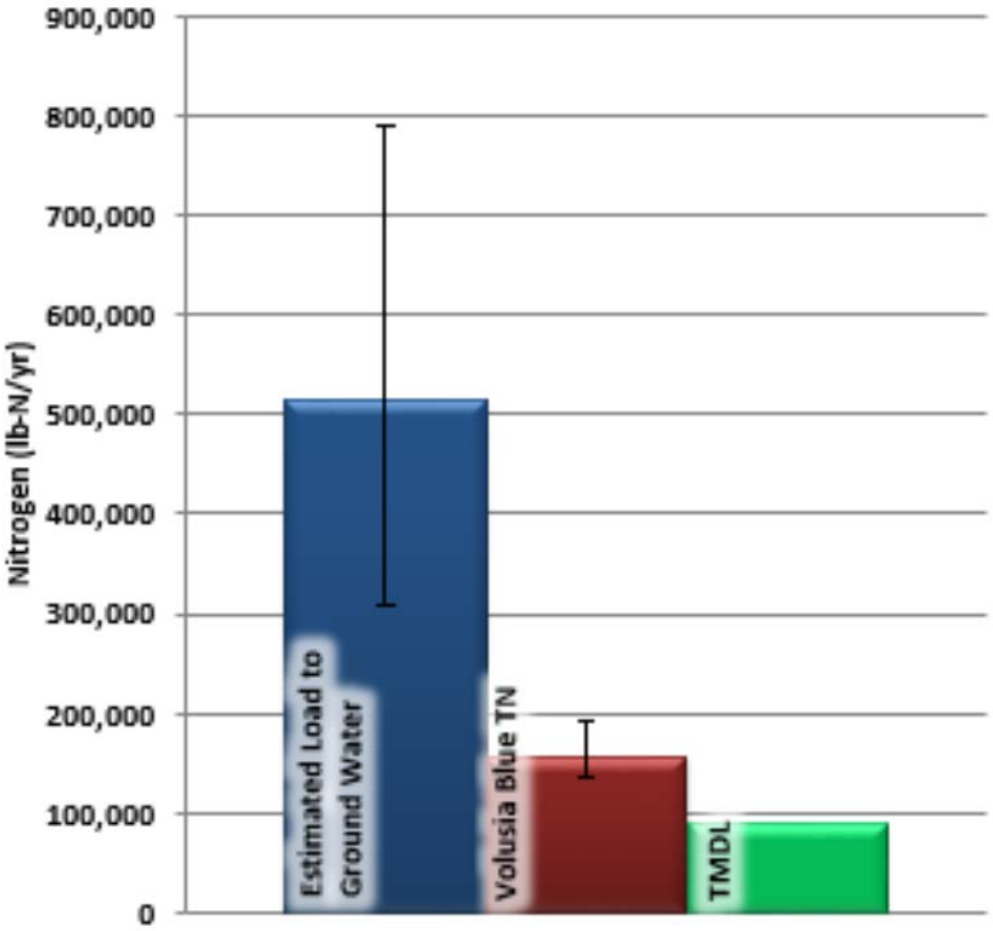
Homosassa Springs



Rainbow Springs

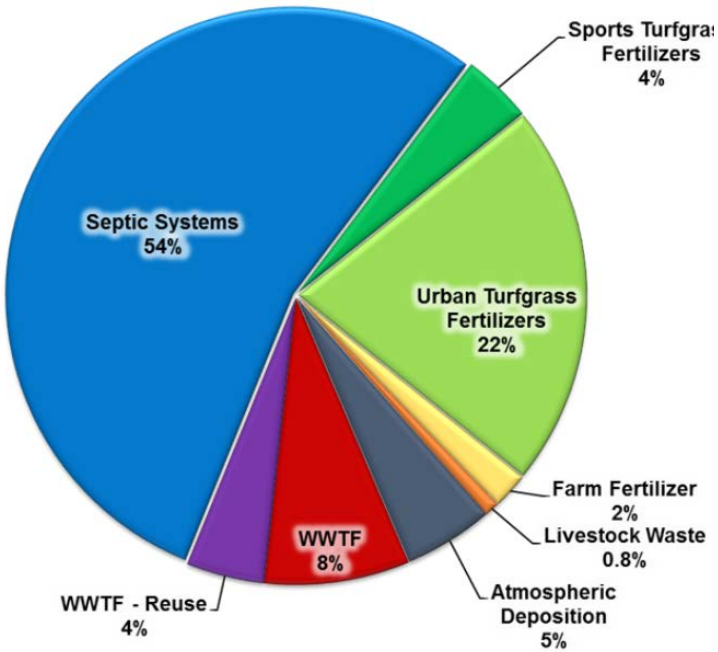
Percent Reduction Needed to Achieve TMDL?

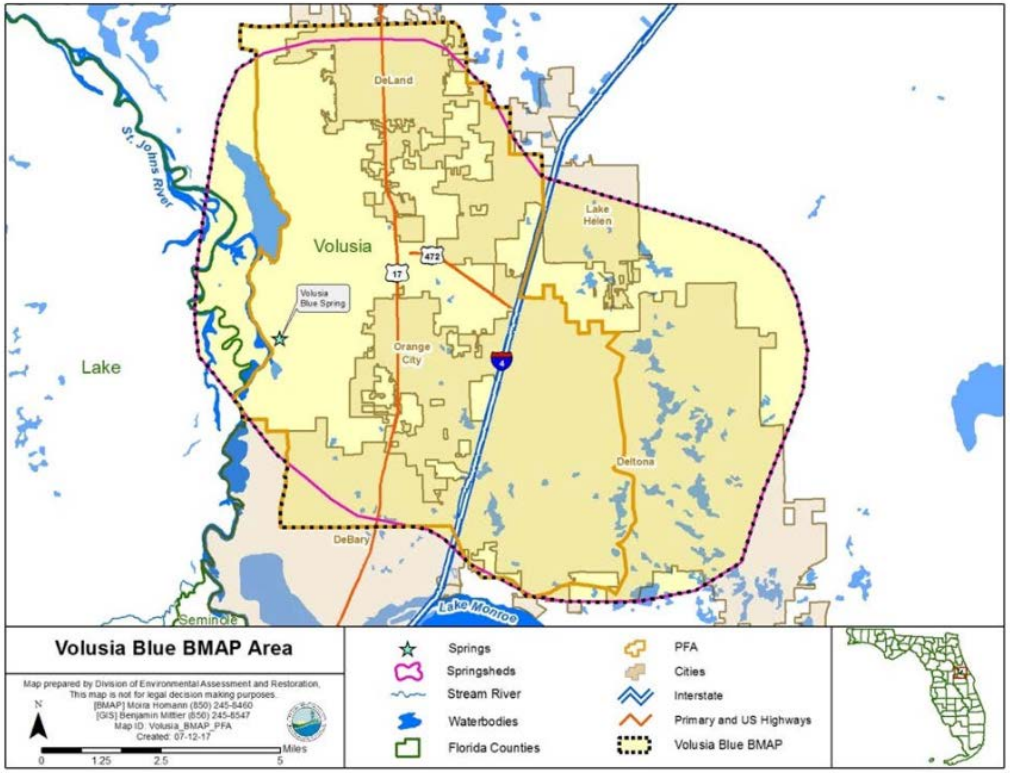
- Estimate by comparing spring vent load with spring vent TMDL?
- Estimate by comparing NSILT loads with spring vent TMDL?
- Estimate by comparing spring vent load with spring vent TMDL and apply percentage to NSILT loads?



NSILT Load Spring Vent Load TMDL

NSILT – Nitrogen Source Inventory Loading Tool

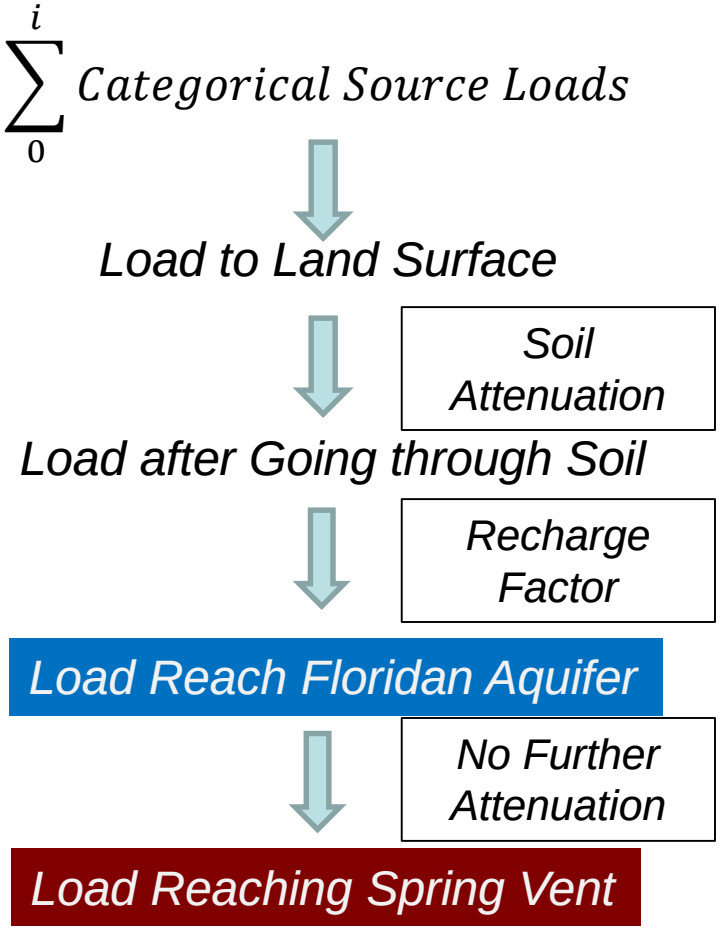




Volusia Blue BMAP Area, PFA, and Percent Contributions from All Sources

Total Load Reduction Needed: 48,743 lbs-N/year
Total Project Credits: 47,745 lbs-N/year
Remaining Needed Load Reduction: 997 lbs-N/year

Gap in Understanding the Relationship between NSILT Load and Spring Vent Load

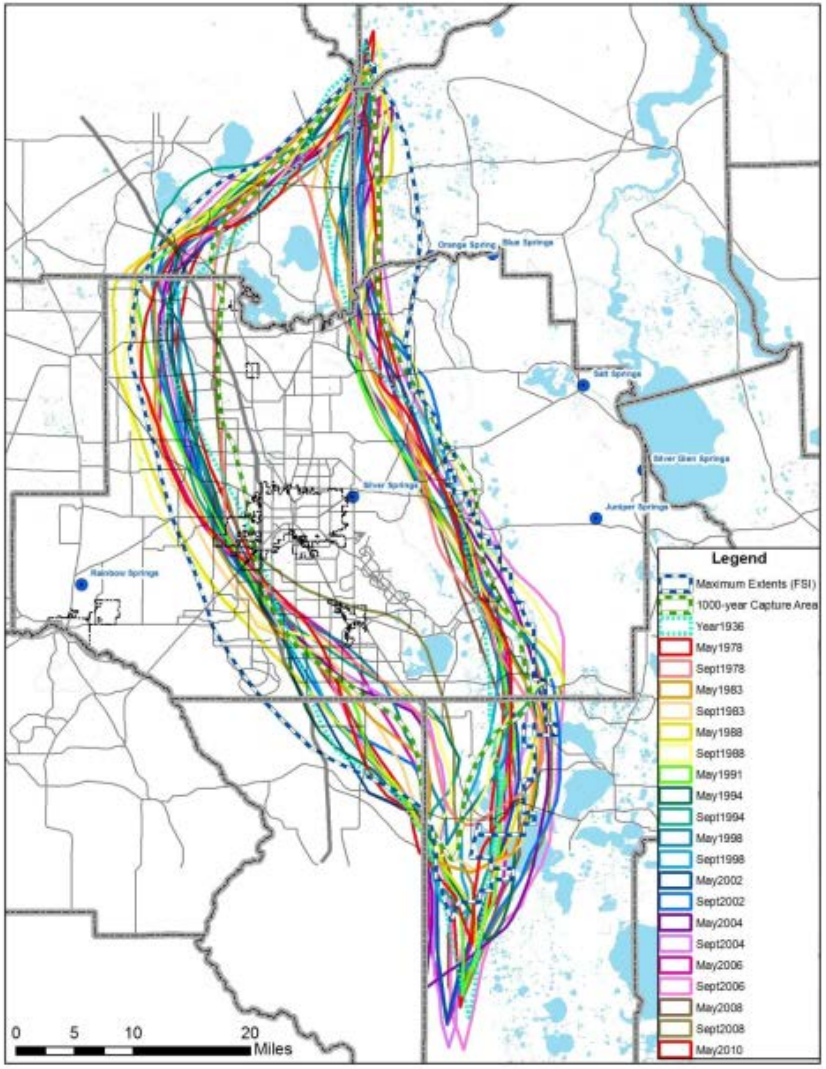


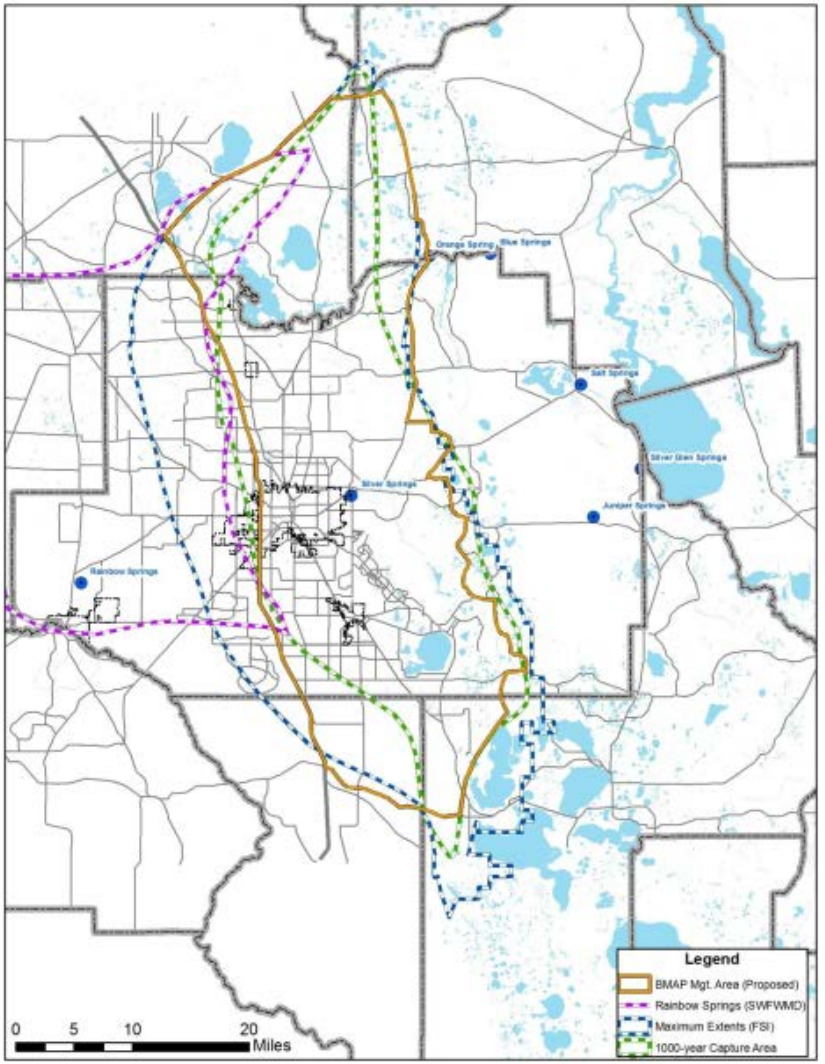
Accuracy of

- Estimating total loads to the springshed land?
- Setting soil attenuation rate?
- Setting recharge factor?
- Understanding nitrogen transport in groundwater?

Springshed Delineations

1. Different methods may produce different delineations
   - Potentiometric surface delineation
   - Groundwater flow modeling – 1000-year capture area.
2. Other factors also influence the delineation
   - Availability and location of monitoring wells
   - Hydrology of the year
   - Years and the number of years being included
3. Final BMAP boundary may not completely match the springshed boundary





Springshed and BMAP Boundary Delineation for Silver Spring (FDEP 2013)

Estimating Nitrogen Loads from OSTDS

(Method by The Florida Department of Environmental Protection-FDEP)

$$L = N * P * I * (1-D) * R$$

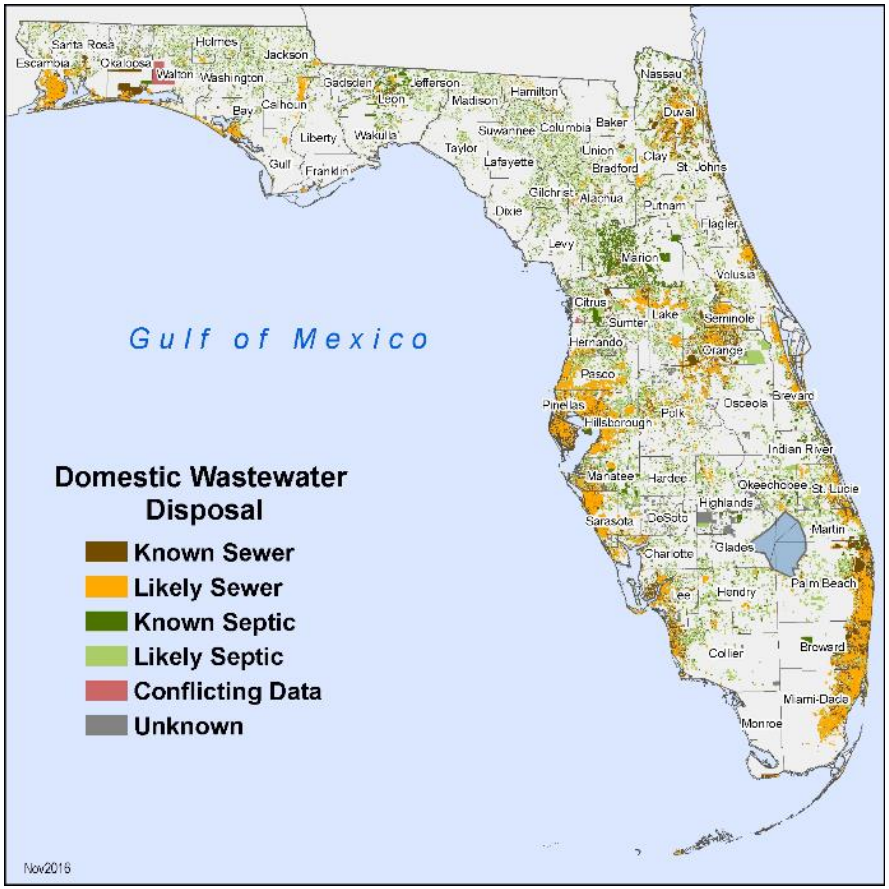
Where,

- **L:** the total nitrogen load reaching the Upper Floridan Aquifer
- N: number of OSTDSs in the springshed
- P: number of people per household
- I: per capita nitrogen load
- D: soil attenuation rate
- R: Floridan Aquifer recharge factor

Number of OSTDS in Spring Basins

Inventory Website

http://floridahealth.gov/flwmi



Distribution of OSTDS Count Categories

Row Labels	Kings Bay/Crystal River		Silver Spring		Volusia Blue Spring	
	Counts	Percent	Counts	Percent	Counts	Percent
KnownSeptic	13,169	44.8%	54,016	69.8%	15,013	31.6%
LikelySeptic	15,446	52.6%	17,924	23.2%	27,446	57.8%
SWLSeptic	4	0.0%	2,522	3.3%	184	0.4%
UNDT	427	1.5%	128	0.2%	6	0.0%
UNK	321	1.1%	2,754	3.6%	4,821	10.2%
Total	29,367	100.0%	77,344	100.0%	47,470	100.0%

Row Labels	Weeki Wachee Springs		Homosassa Springs		Rainbow Spring	
	Counts	Percent	Counts	Percent	Counts	Percent
KnownSeptic	12,571	35.7%	4,845	29.6%	26,761	62.0%
LikelySeptic	21,224	60.3%	8,610	52.6%	9,959	23.1%
SWLSeptic	125	0.4%	5	0.0%	197	0.5%
UNDT	11	0.0%	2,357	14.4%	70	0.2%
UNK	1,282	3.6%	556	3.4%	6,187	14.3%
Total	35,213	100.0%	16,373	100.0%	43,174	100.0%

Occupied and Vacant Housing Units in Spring Counties

Occupancy	Citrus County		Hernando County		Pasco County	
	Counts	Percent	Counts	Percent	Counts	Percent
Total housing units	78,026	100	84,504	100	228,928	100
Occupied housing units	63,304	81.1	71,745	84.9	189,612	82.8
Vacant housing units	14,722	18.9	12,759	15.1	39,316	17.2
Occupancy	**Volusia County**		**Marion County**		**Alachua County**	
	Counts	Percent	Counts	Percent	Counts	Percent
Total housing units	254,226	100	164,050	100	112,766	100
Occupied housing units	208,236	81.9	137,726	84	100,516	89.1
Vacant housing units	45,990	18.1	26,324	16	12,250	10.9

Number of People Per Household

FDEP Approach:

1. County-wide average of people per household:

   County population/Occupied housing units
2. The people per household adjusted by hours at work and school, which is 43.5 hours or 26% of a week
3. Depending on percent county population in the school and working group, reduces effective number per household by 13%
4. Reduces amount of nitrogen being produced for each OSTDS unit by about 13%, which may cause underestimation

Per Capita Loads of Nitrogen Based on Published Literatures

(FDEP Used 9.012 lbs/yr./person)

Study Grouping	TN (mg/L)	Flow (gpd)	Persons	Input/ capita (lb/yr)	Data source
Florida Studies	57	400	5	13.9	Anderson, 1998
(pre-Wekiva)	62	180	4	8.5	Nielsen et al. 2002, McAvoy et al. 2002
Wekiva Studies	74	315	5	14.2	Seminole Site, 2007
	43	450	4	14.7	Lake Site, 2007
	69	35	1	7.3	Orange Site, 2007
Water Environmental Research Foundation Study Wakulla Sites (means)	44	59	2	3.9	F1 Lowe et al. 2009
	74	125	4	7	F2 Lowe et al. 2009
	68	139	2	14.1	F3 Lowe et al. 2009
	68	141	2	14	F4 Lowe et al. 2009
	44	137	3	6.4	F5 Lowe et al. 2009
	71	105	3	7.7	F6 Lowe et al. 2009
Wakulla (medians)	54	104	2.5	6.8	LT site, Katz et al 2010
	30	431	4	9.8	HK site, Katz et al 2010
	47	161	2	11.5	YG site, Katz et al 2010
Average	**57**			**10**	

Soil Nitrogen Attenuation Rate

- Typical Literature Values 10%-50%
- FDOH and FDEP recent Wekiva Basin studies: 40%
- Used by FDEP for NSILT analyses: 50%
- Estimates are based on the highest concentrations underneath a drainfield
- Measurements usually for at least 24 inches of water table separation
- Plume attenuation part of soil attenuation or part of groundwater attenuation

Soil Nitrogen Attenuation Rate

County	Percent OSTDS at 24 inches Water Table Separation	
	>= 24 inches	< 24" inches
Alachua	85%	15%
Hernando	91%	9%
Marion	93%	7%
Pasco	75%	25%
Volusia	68%	32%

Groundwater Recharge Factor

Additional nitrogen attenuation factors related to recharge rates were assigned as follows:

- 10 % in high recharge rate areas (≥10 in/yr)
- 50 % in medium recharge rate areas (3 to 10 in/yr)
- 90% in low recharge rate area (0 to 3 in/yr)

Interpreted as diversion of water as it travels to the Upper Floridan Aquifer or as reactive losses along the travel path. Plume-scale attenuation included.

No Further Attenuation Once Nitrate Enters Upper Floridan Aquifer

- Heffernan et al (2012) estimate an average of 32% denitrification in the Upper Floridan Aquifer
- Varies between springs
- Historic variations in loading, are we seeing older, higher loading (net reduction from converting from ag to houses)

Summary

1. N: Number of OSTDS in a basin can be refined, but likely will not reduce the OSTDS loads significantly.
2. P: Number of people per household can be refined, but will not reduce the OSTDS loads.
3. I: Per capita loads estimated as the average of case studies; the statistical distribution of the loading values may be better due to large variation of hydraulic loads and nitrogen concentrations
4. D: Soil attenuation rate may be refined through distribution of water table separation based on permit data.
5. R: Recharging factor a sensitive parameter.
6. Transport of nitrogen once reaching the groundwater is a big unknown.

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