Florida Department of Environmental Protection

Division of Environmental Assessment and Restoration

Estimated Nitrogen Loading to the Upper Floridan Aquifer:

Nitrogen Source Inventory and Loading Tool for Wakulla Spring

Celeste Lyon

Groundwater Management Section

October 17, 2017

Celeste.Lyon@dep.state.fl.us

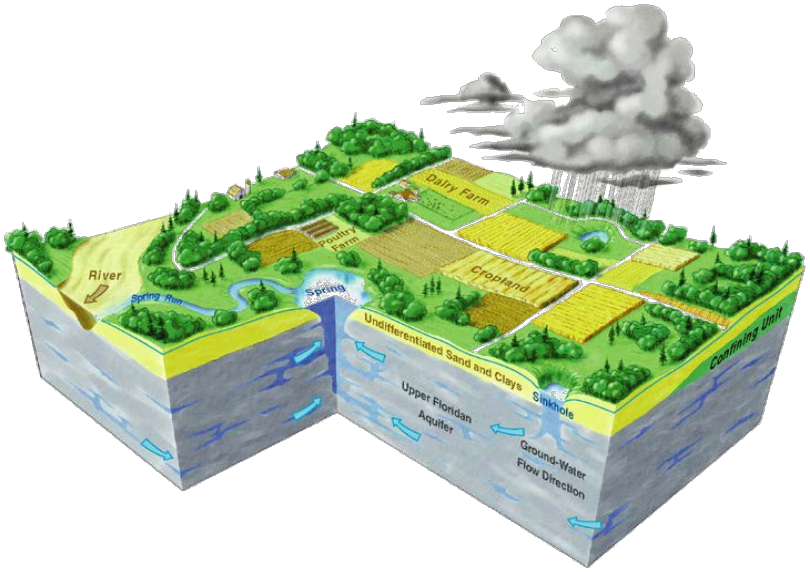
Brian.Katz@dep.state.fl.us

Nitrate-Impaired Spring Waters

- The water quality in several Outstanding Florida Springs, including Wakulla Spring, is impaired due to elevated nitrate concentrations
- Many sources contribute nitrogen in each springshed:
  - atmospheric deposition
  - urban turfgrass fertilizers
  - sports turfgrass fertilizers
  - septic tanks
  - land application of wastewater
  - livestock manure
  - farm fertilizers

Wakulla NSILT Updates

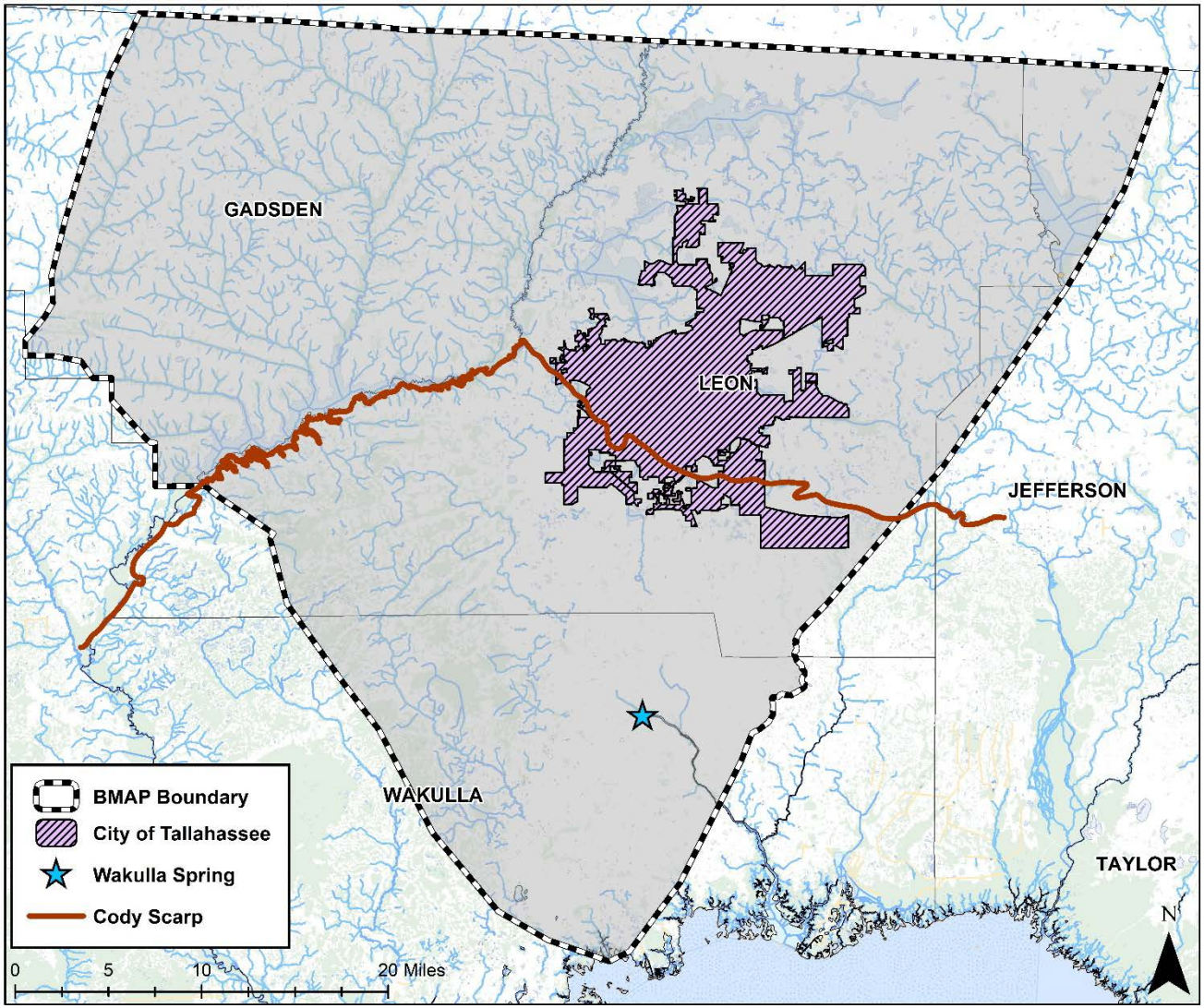
- Original NSILT completed in 2012
- Several updates were required for the NSILTS to meet the language requirements set forth by the Florida Springs and Aquifer Protection Act.
  - Updated methodology to bring NSILT in line with other NSILTs
  - Extensive literature review and stakeholder feedback
  - 5 year update



Nitrogen Source Inventory and Loading Tool

- Estimate N loading to groundwater with BMAP areas
- Identify sources for which reductions in N loading could achieve restoration of impaired waters
- We customize the inventory for each spring basin or BMAP area to account for hydrogeologic and land use differences
- Inventories have been completed for Jackson Blue, Volusia Blue, Silver, Rainbow, the Springs Coast Springs, and springs in the Suwannee Basin

Wakulla BMAP

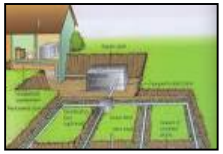


Estimating Nitrogen Loads to Groundwater

Steps:

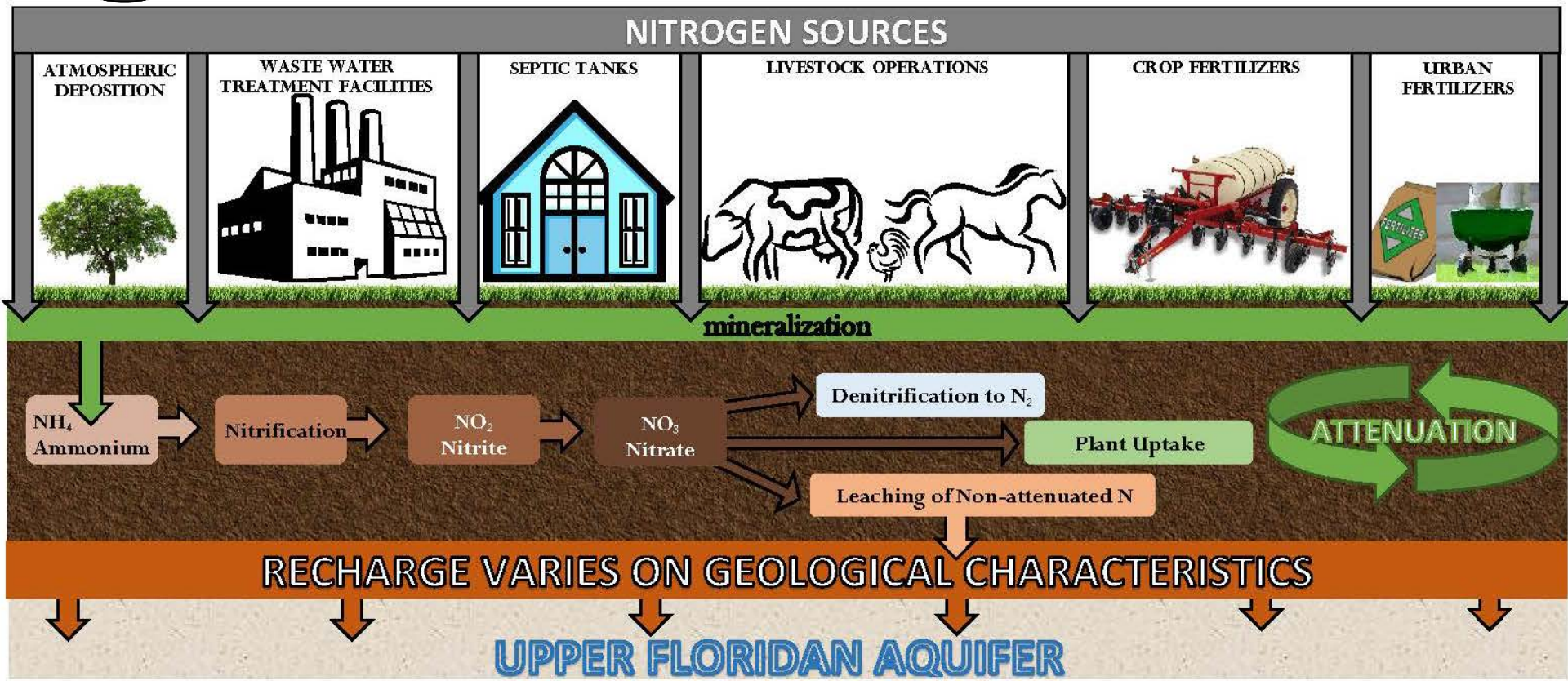
1. Estimate the inputs of nitrogen to the land surface from the source inventory information (best available and most current).
2. Apply attenuation factors based on the various environmental processes that could transform the various forms of nitrogen in the subsurface (such as denitrification, nitrification of ammonia, uptake by plants, mineralization of organic nitrogen).
3. Apply areal weighting factors that are based on the rate of recharge to groundwater to estimate nitrogen loads to groundwater.
4. Fine-tune estimates after getting feedback from stakeholders.







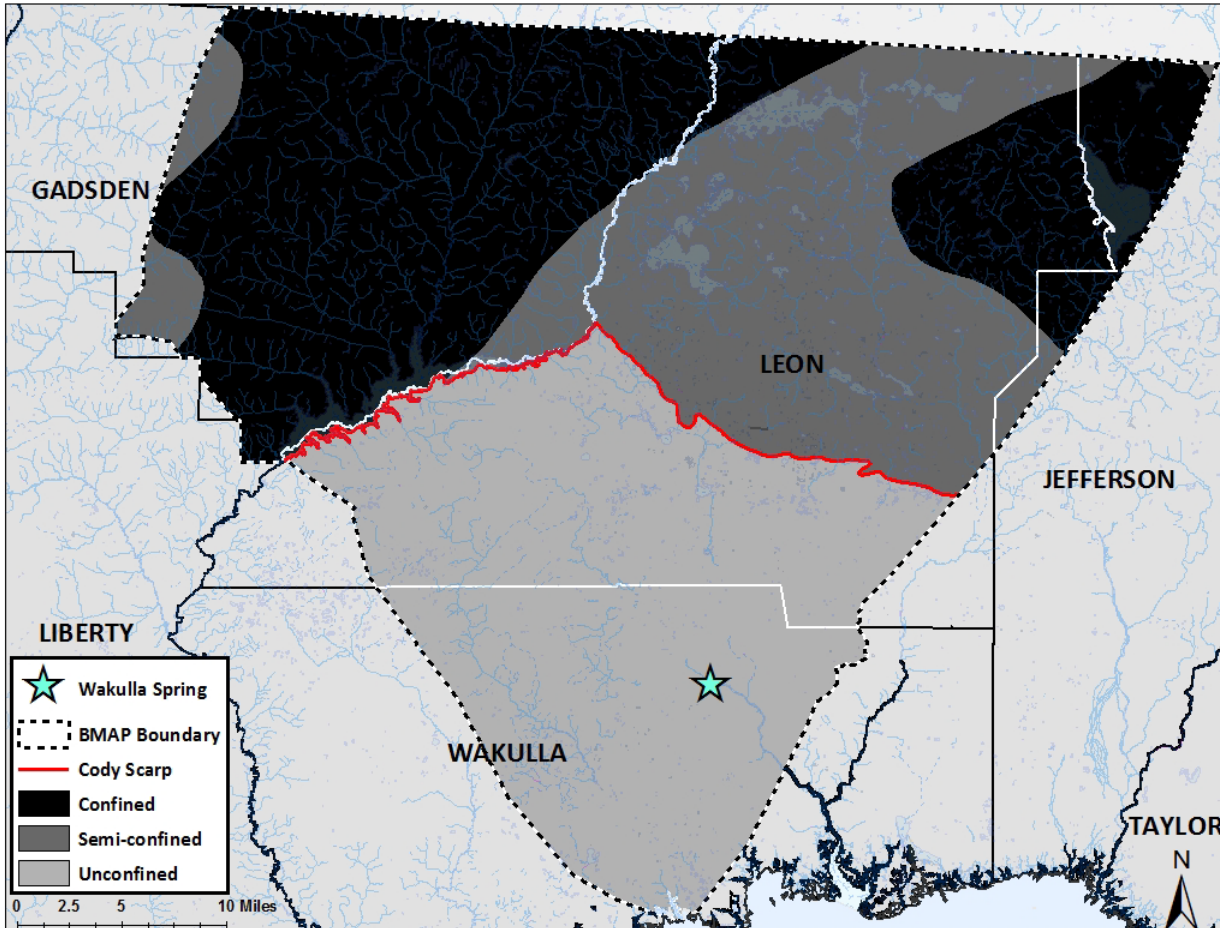

Nitrogen Cycle and Nitrogen Attenuation



Processes that control the transformation of N in soils and the subsurface.

The wide ranges reflect variable soil conditions, fertilizer material, livestock, crop types, etc.,
ALL AFFECT LEACHING OF N TO GROUNDWATER

Groundwater Recharge Areas



Inputs to land and loads to groundwater are calculated by recharge region within the springshed

Quantify the rate of recharge to groundwater relative to the UFA based on geological properties

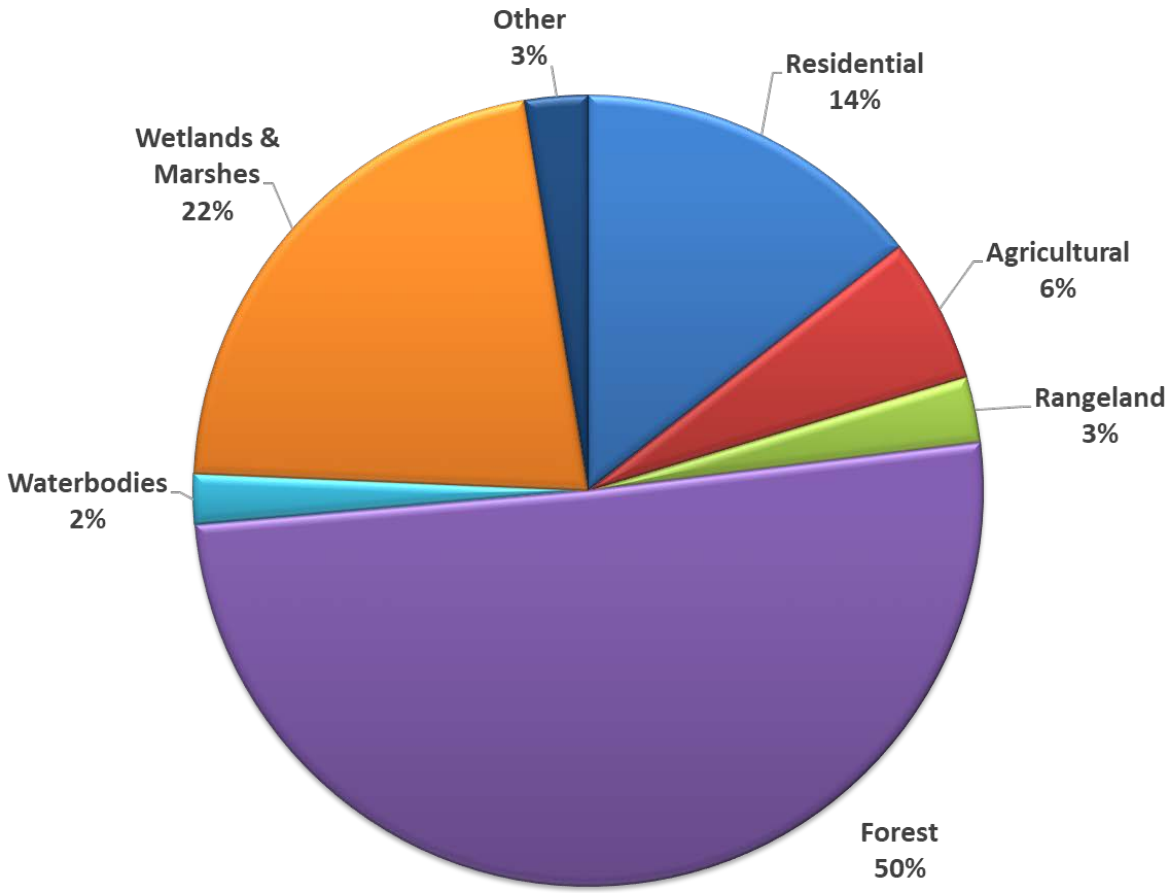
- Unconfined: 9-20 in/yr
- Semi-Confined: 3-8 in/yr
- Confined: 0-2 in/yr

A weighting factor is assigned to recharge category to account for additional attenuation:

- Unconfined, 0.9
- Semi-Confined, 0.5
- Confined, 0.1

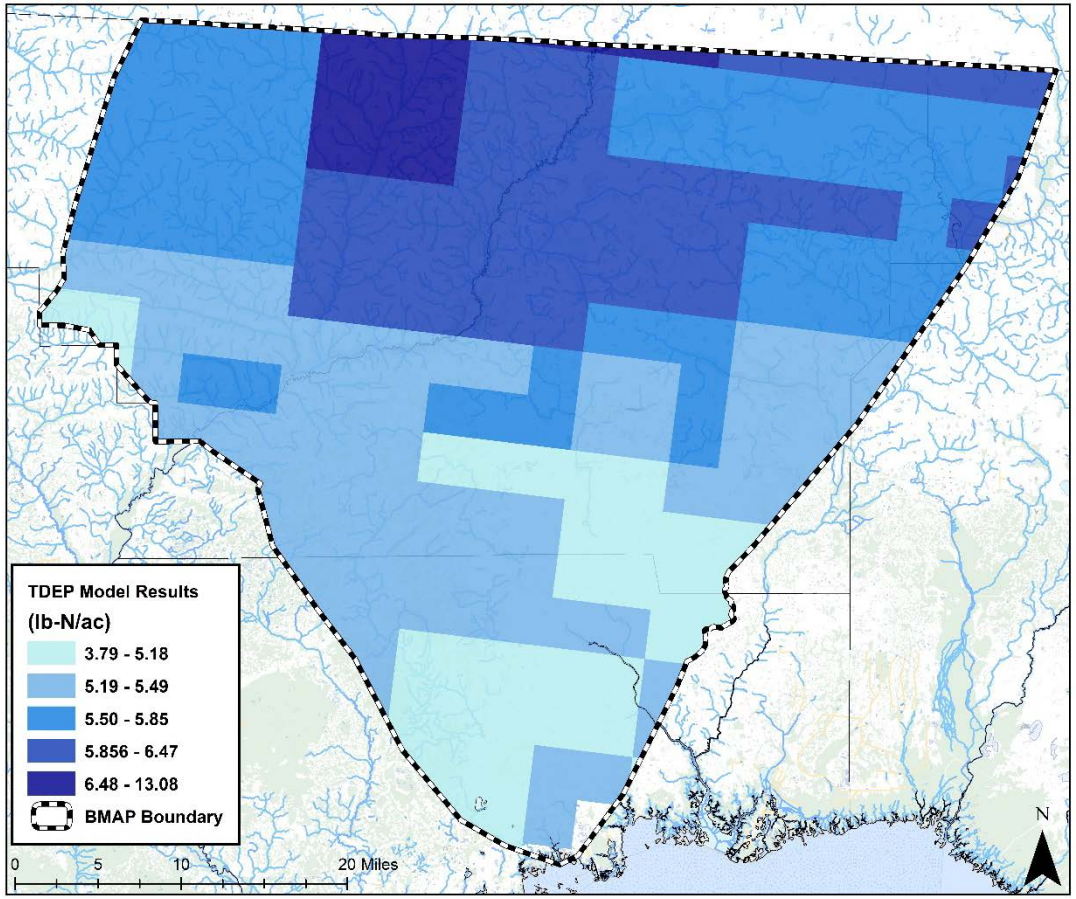
The amount of nitrate that is transported to the UFA in a given year is related to the rate of recharge to the aquifer

Land Use in the Springshed



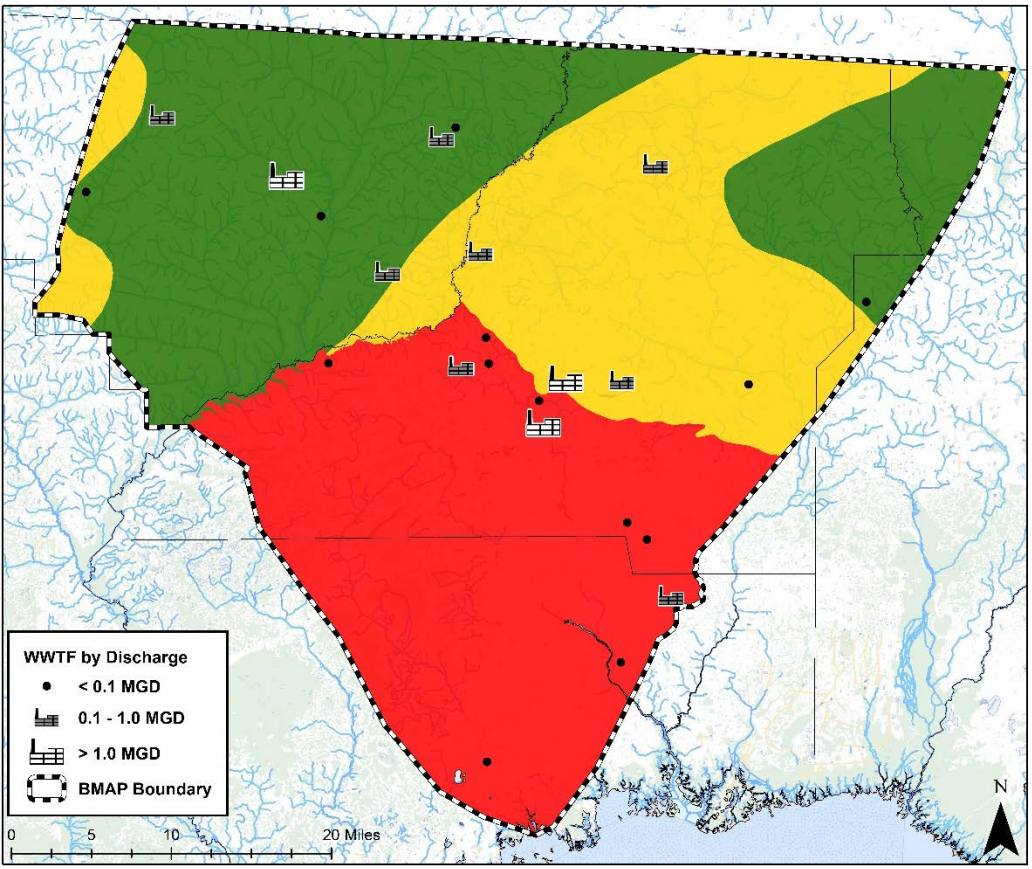
- Majority of N inputs occur within agricultural and urban land areas
- These categories represent 6% and 14%, respectively, of the land use within the BMAP

Nitrogen Input: Atmospheric Deposition



- TDEP model
  - U.S. EPA method to estimate spatially continuous atmospheric deposition
  - Nationwide total deposition model for N and S
- Estimated deposition based on monitoring stations and modeled atmospheric concentrations
- Model year is an average from 2011 to 2013
- Average TN deposition
  - Range 3.79-13.08 lb-N/ac/yr

Nitrogen Input: Domestic Wastewater



- Inventory includes domestic WWTF application sites in each springshed
- TN effluent concentrations as reported to DEP
- NO_3 used to project TN data, if necessary
- 24 permitted facilities apply wastewater in the BMAP
- Effluent disposal types:
  - RIBS
  - Sprayfields
  - Reuse

Septic Systems (OSTDS)- Updates

Previous Data Sources

- Septic count derived from the Hall and Clancy Model (2009). This model relied on tax parcel data with known septic tanks and known sewer areas.
- The estimated tanks were associated with land parcels located in areas where it was assumed that no sewer service existed

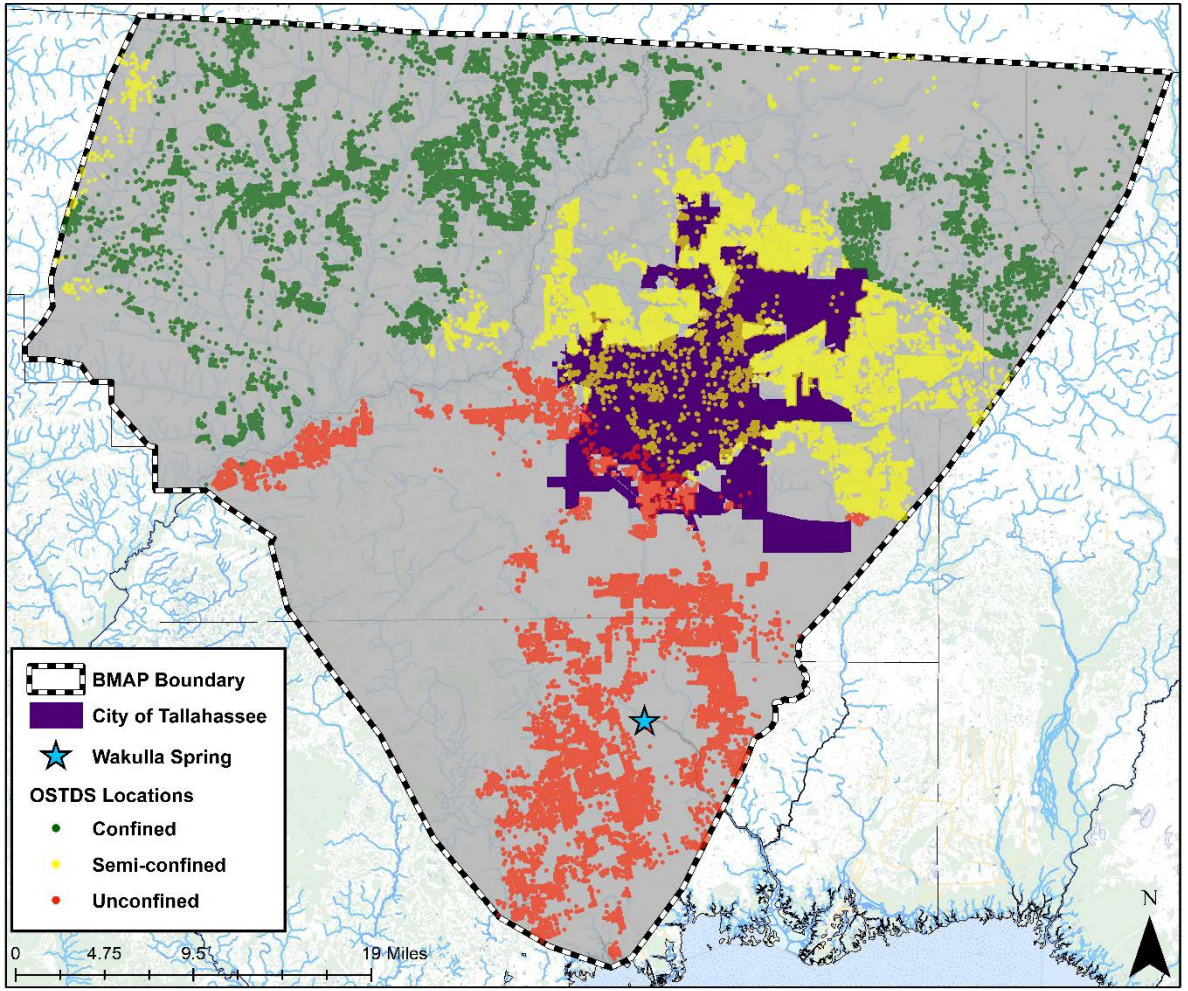
Updated Data Sources

- Florida Water Management Inventory (FLWMI)
  - Septic tank data provided by FDOH and cross referenced with Leon County's data.
- Several datasets were compared to obtain the most representative OSTDS count based on currently available data

Data Source	Leon OSTDS	Tallahassee OSTDS	Wakulla OSTDS	Gadsden OSTDS	Jefferson OSTDS	Total
Original Hall and Clancy	31,546	403	7,595	12,373	529	**52,446**
FDOH FLWMI	30,019	1,587	7,904	10,116	381	**50,007**
Leon County	30,209	1,548	-	-	-	-

Nitrogen Input: Septic Systems (OSTDS)

- Septic count taken from Florida Department of Health
  - Leon County provided best available septic tank data for comparison
- Accuracy of this data was verified using an aerial analysis
- Calculate # of people relying on septic tanks
  - Leon County = 2.08 people per household
  - Wakulla County = 2.43 people per household
  - Gadsden County = 2.30 people per household
  - Jefferson County = 2.25people per household
- Average annual input to septic tank = 9.012 lb-N/person (US EPA)



Nitrogen Input: Livestock Waste

Literature review provided information on common livestock animals in Florida

- Animal waste factors

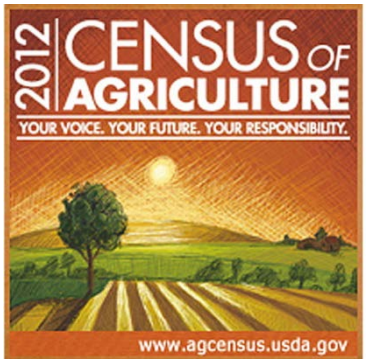
2012 Census of Agriculture (CoA)

- # of livestock (categorized by animal)
- Full county data ONLY

Use County-level land use information to estimate livestock population within the springshed

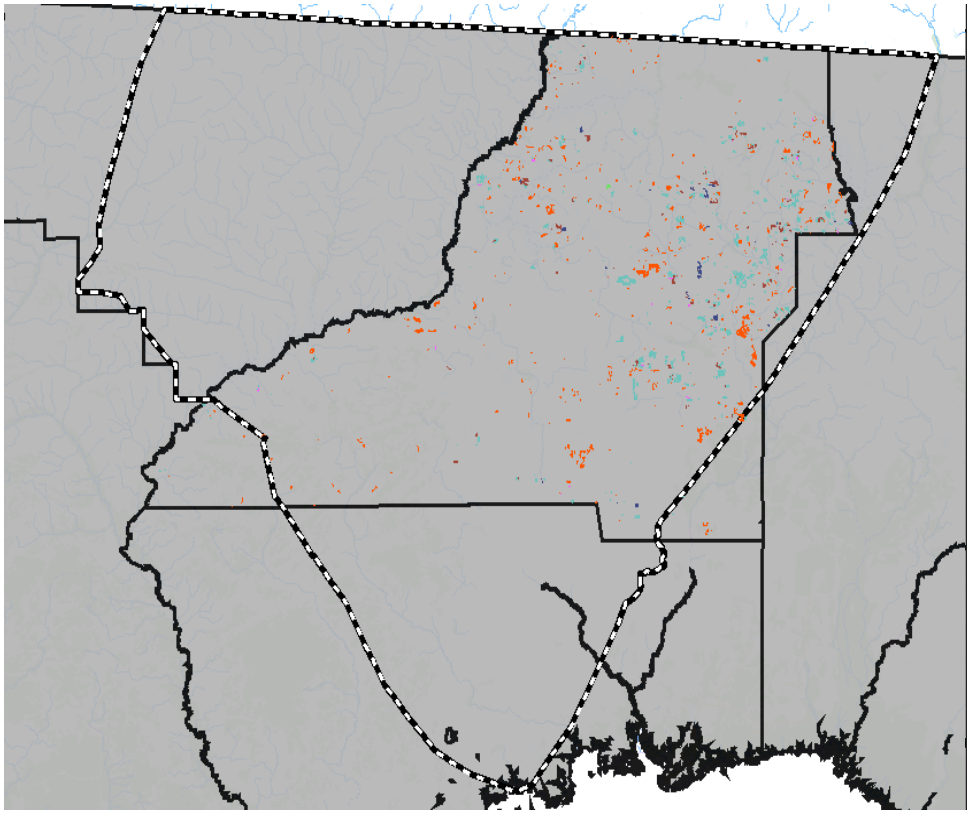
Livestock	Waste Factor (lb-N/day)
Beef Cows	0.337
Other Beef Cattle	0.31
Chicken, broilers	0.002
Chicken, layers	0.003
Calves	0.068
Equine	0.273
Goats	0.035
Hogs	0.19
Sheep	0.198
Turkeys	0.006

Land Use Description
Cattle Feeding Operations*
Feeding Operations*
Horse Farms
Improved Pastures*
Poultry Feeding Operations
Range Land, Herbaceous (Dry Prairie)*
Specialty Farms
Unimproved Pastures*



USDA

Land use Percentages: Livestock



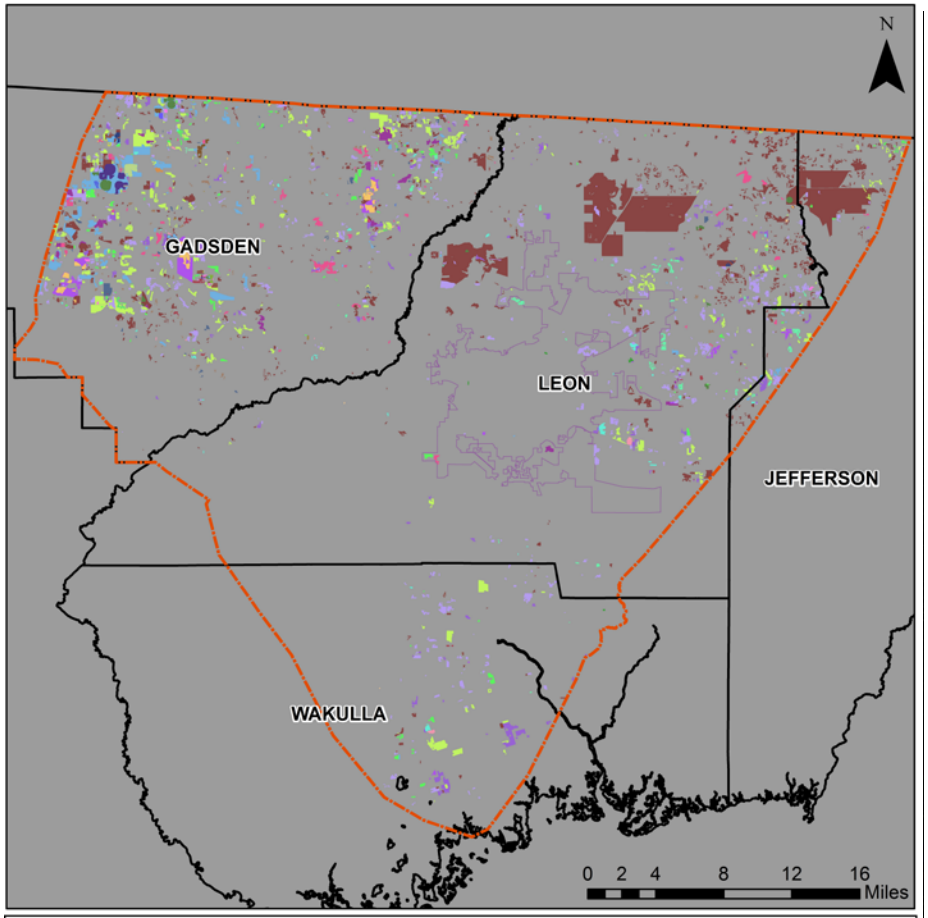
98% of all Livestock lands in Leon Co fall within the BMAP

- Pastures
  - Improved
  - Unimproved
  - Woodland
- Feeding Operations
  - Cattle
  - Poultry
  - Dairies
- Separate Category
  - Horse Farms

Livestock Waste

- Land use percentages utilized to estimate number of animals within the BMAP boundary
- Daily waste factors applied

Land Use Coverages to Estimate Crop Type and Acreage



Irrigated lands and crop type based on FSAID irrigated lands geodatabase (ILG).

Outside of ILG, agriculture areas based on WMD land use and Property Appraiser Data.

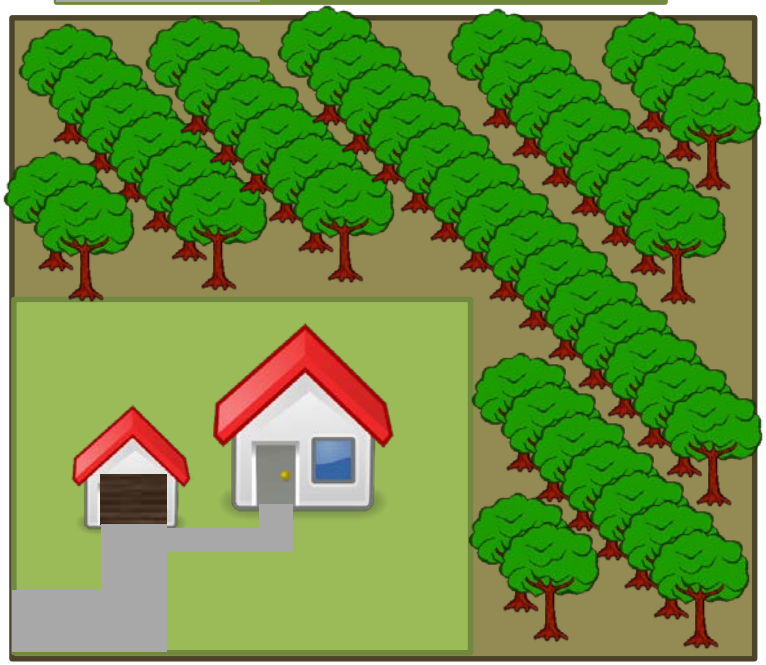
Crop fertilizer application rates were applied to the acreages identified within springsheds based on crop type.

Application rates based on UF-IFAS recommended rates as well as producer feedback.**

3 large plantations in the NE section of the BMAP were assessed at 20% of total acreage

Nitrogen Input: Urban Turfgrass Fertilizers

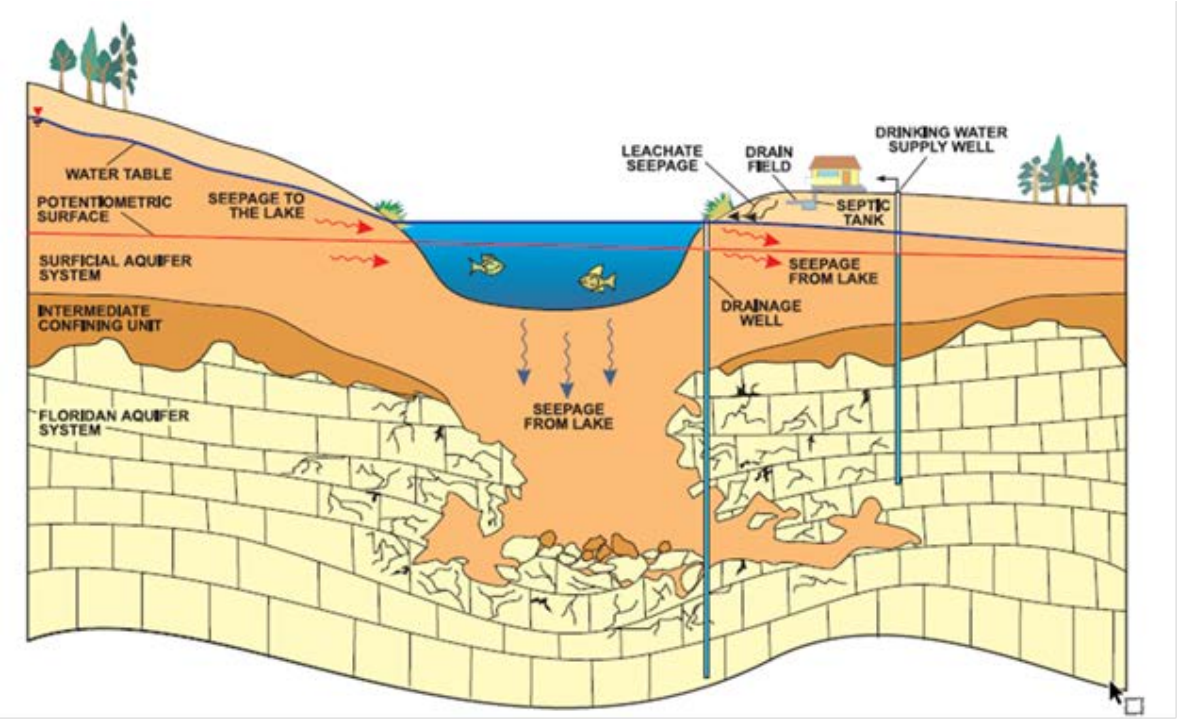
- Acreage likely to receive fertilizer estimated from PA data and property values
  - Residential
  - Non-residential
- Used zoning information to determine impervious, and therefore not fertilized, land area
- Maximum fertilizable acreage was capped at 1 acre
- Property values used to assess probability of fertilization
- Annual Application Rates and Frequencies based on 2016 TAPP survey for the City of Tallahassee and a 2009 study by UCF
  - 17% fertilized by owners
    - 2.98 times year
  - 15% fertilized by lawn service
    - 4.27 times a year
  - 68% non-fertilized



Sports Turfgrass Fertilizers

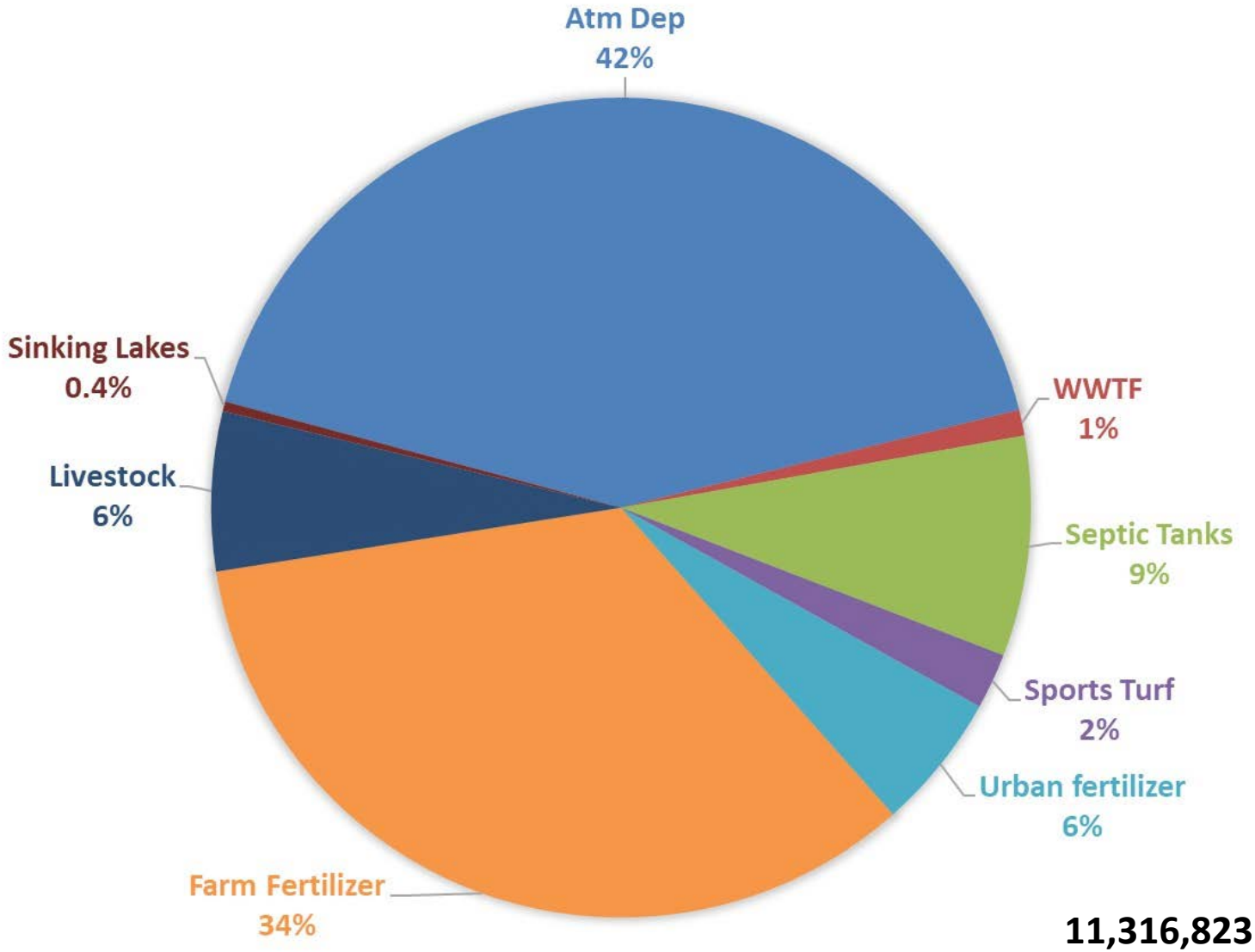
- Sports fields
  - Acreage estimates from aerial analysis of PA landuse data
  - Application rates based on commercial turf maintenance estimates
- Golf Courses
  - Acreage estimated through PA landuse data
  - Application rates based on data provided by golf courses
  - Annual application rate = 4.5 lb-N/1,000 sq ft

Sinking Waterbodies



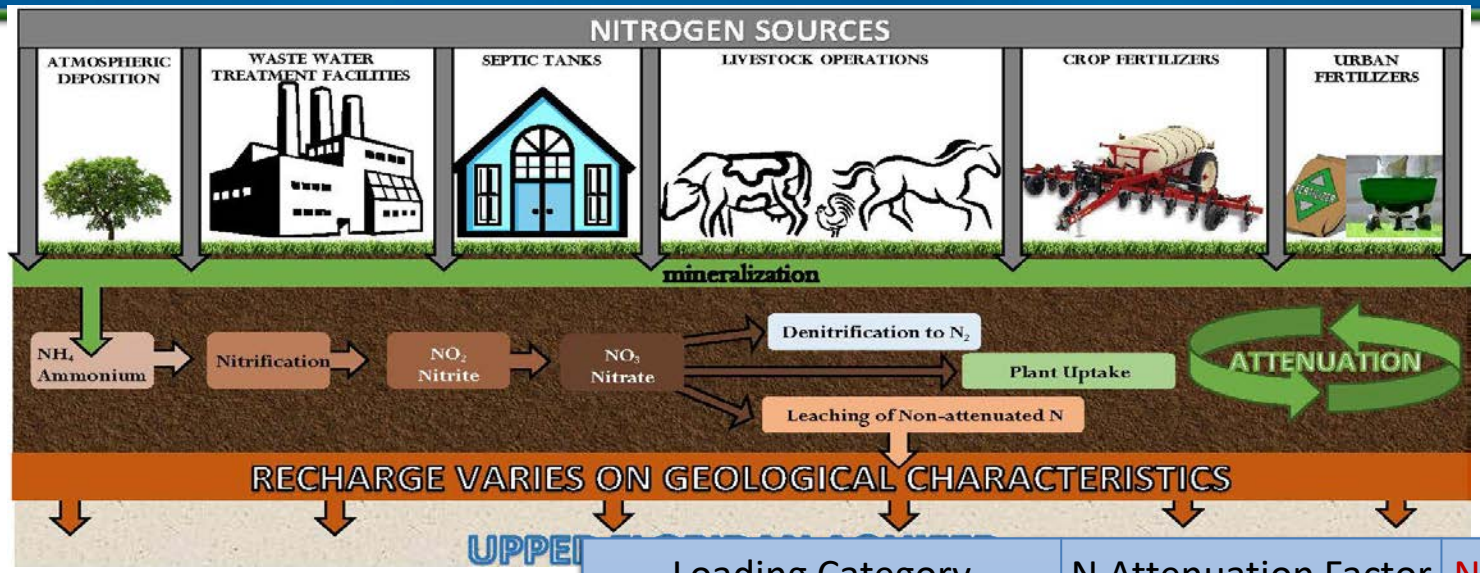
- Lake Munson
- Lake Lafayette
- Lake Jackson

Nitrogen Input to Surface



11,316,823 lb-N/yr

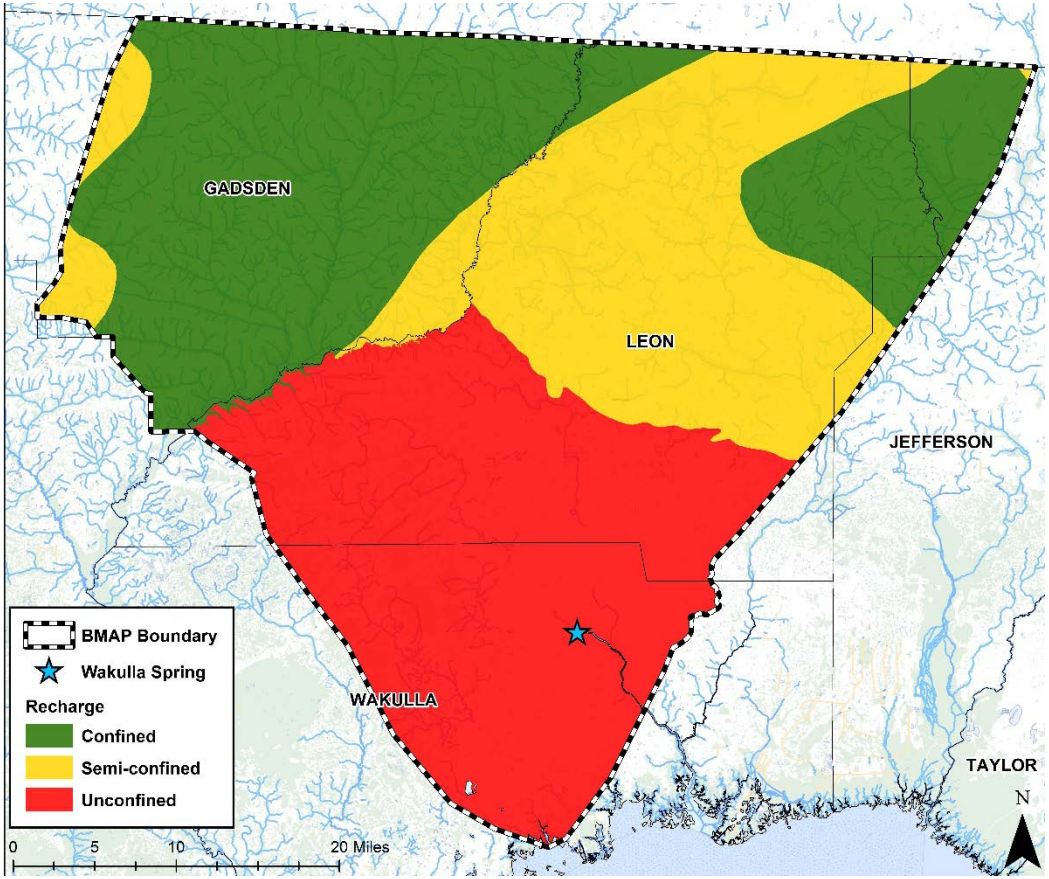
Biochemical Attenuation Factors- Updates



- Represent the percentage of N removed and therefore not available for leaching to groundwater
- There is a range for all these factors however, these values represent an average attenuation expected given Florida's environmental conditions
- These factors are the result of an extensive literature and peer review

Loading Category	N Attenuation Factor	N Leaching
Atmospheric Deposition	90%	10%
Septic Systems	**50%**	**50%**
WWTF- RIB	**25%**	**75%**
WWTF-Reuse	**75%**	**25%**
WWTF- Sprayfield	**60%**	**40%**
Urban Turfgrass Fertilizers	**70%**	**30%**
Sports Turfgrass Fertilizers	**70%**	**30%**
Farm Fertilizers	**80%**	**20%**
Livestock	**90%**	**10%**
Sinking Lakes	20%	80%

Hydrogeological Attenuation Factors Based on Recharge to UFA



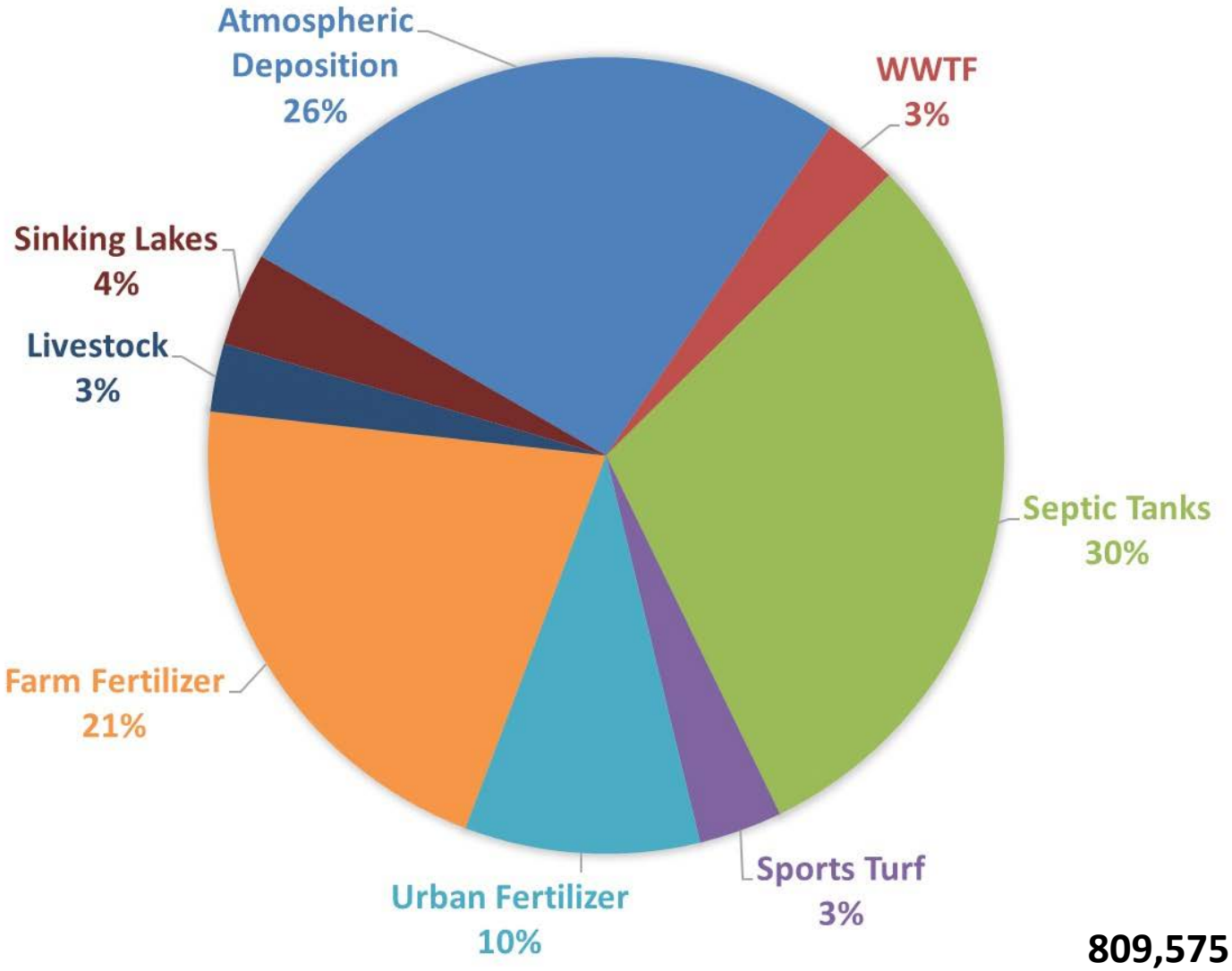
- Recharge factors are used to estimate the percentage of the non-attenuated nitrogen expected to reach the aquifer in a year

10%

50%

90%

Nitrogen Load to Groundwater



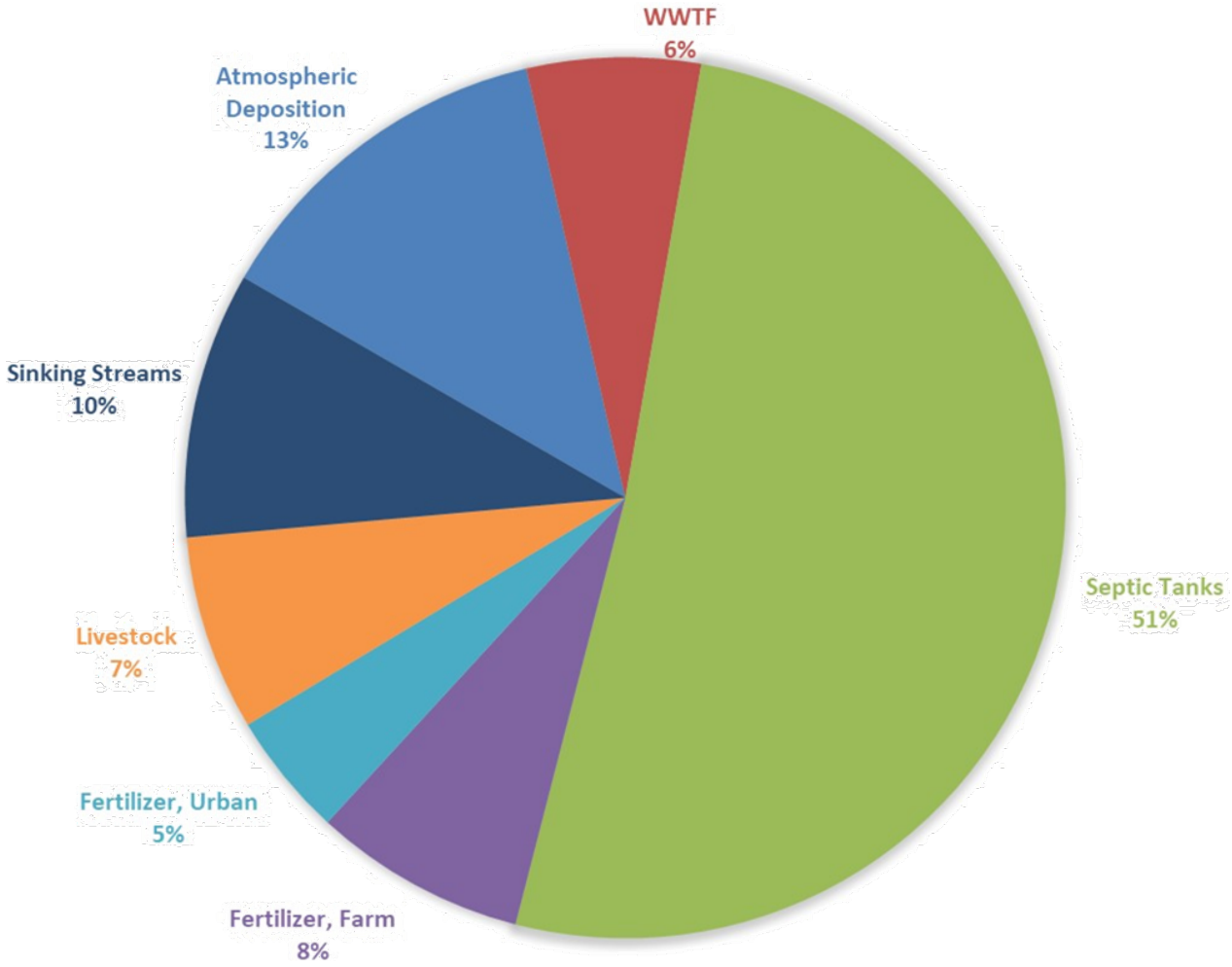
809,575 lb-N/yr

QUESTIONS??

Division of Environmental Assessment and Restoration
Groundwater Management Section

Celeste.Lyon@dep.state.fl.us

Original NSILT Loading



754,086 lb-N/yr