Orange Creek Basin
Onsite Wastewater Treatment System Loading Analysis
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Background

The Total Maximum Daily Load (TMDL) documents prepared for the four impaired lakes in the Orange Creek Basin (Newnans, Orange, Lochloosa, and Wauberg) [1] identified onsite wastewater systems (septic tanks and package plants) as sources of nutrient loading. However, loading values from onsite wastewater systems were calculated differently among the four lakes. The Newnans and Orange Lake TMDLs estimated loading from failing septic tanks only. The Lake Wauberg TMDL estimated loading from all septic tanks, with a reduction factor applied to account for nutrient retention in the soil. Septic tank loading was not quantified in the Lake Lochloosa TMDL.

This analysis provides a consistent method for estimating nutrient loading from properly functioning and failing onsite wastewater treatment systems that contribute loading to lakes in this Basin. This information is provided to the Orange Creek Basin Basin Management Plan (BMAP) Working Group for their use in developing and prioritizing management actions. Various sources contribute nutrients to the four impaired lakes, and knowledge of the relative magnitude of these sources will help the Working Group make informed decisions regarding the type of corrective actions to be implemented.

The results of this analysis are expressed in terms of the total nitrogen (TN) loading per year that reaches the four impaired lakes through direct surface runoff and/or near-shore groundwater flow.

Approach

The approach for this study is similar to the 2005 Marion County wastewater study[2]. Calculation of loading from onsite systems required determination of: 1) the total number and locations of septic tank and package plant systems in the basin; and 2) nutrient loads to lakes associated with each system.

Number and Location of Systems

Land parcels with activities that require onsite wastewater treatment were identified through a GIS analysis. These included residential, commercial, and public use facilities. For unincorporated Alachua County, map layers derived from the County Property Appraiser's GIS database were used to identify such parcels. Information provided by Gainesville Regional Utilities and Marion County was used to identify parcels with septic tanks within their service areas. Information from Gainesville Regional Utilities (GRU) was applicable to the Newnans Lake Subbasin, while the Marion County information was applicable to Orange Lake.

Consistent with the 1995 St. Johns River Water Management District (SJRWMD) Nutrient Budget Report[3], only those systems within 200 meters (m) of the lake shore or the lake's tributaries (e.g. connected wetland, stream, or canal system) were considered to contribute nutrients to the lake. Aerial photos (2005) were used to confirm the presence of structures associated with onsite wastewater systems in the 200m surface water drainage area.

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[1] Baniukiewicz, A. 2004. Total Maximum Daily Loads for Lake Lochloosa; Wu, T.S. 2003. Nutrient Total Maximum Daily Load for Lake Wauberg Outlet; Gao, X. 2003. Nutrient Total Maximum Daily Load for Orange Lake; Gao, X. 2003. Draft Nutrient Total Maximum Daily Load for Newnans Lake.

[2] Kuphal, T. 2005. Quantification of Domestic Wastewater Discharge and Associated Nitrate Loading in Marion County, Florida. Marion County, FL, Planning Department.

[3] Fulton, R. 1995. External Nutrient Budget and Trophic State Modeling for Lakes in the Upper Ocklawaha River Basin. St. Johns River Water Management District Technical Publication SJ95-6.

At any given time, a portion of these systems are "failing" septic tanks. Although there are multiple ways in which a septic system can physically fail, for the purposes of this study failed septic tanks were considered to contribute 100% of their loading directly to a surface water, without soil retention. The TMDL documents consistently estimate the rate of septic tank failure at 5%. As such, the total number of septic tanks was split into "functioning" and "failing" at the rate of 95% and 5%, respectively. All calculated loading values applied a soil retention factor for the 95% of functioning systems and did not apply the soil retention factor for the 5% of failing systems.

Two package plants were identified inside the 200m drainage area: Brittany Estates (Newnans Lake subbasin) and Sportsmans Cove (Orange Lake subbasin). Table 1 contains the estimated total number of onsite systems in each subbasin.

Table 1
Number of Septic Systems within 200m Drainage Area of Each Lake

Lake	Total # Septic Systems	*Estimated # Failing Systems (5%)*	Package Plants
Lake Lochloosa	127	*6*	0
Newnans Lake	397	*20*	Brittany Estates
Orange Lake	204	*10*	Sportsmans Cove
Lake Wauberg	26	*1*	0
TOTAL	**754**	***37***	**2**

Nitrogen Loading to Lakes
The total nitrogen load from septic tanks was calculated with the following formula:

A x 0.065 x N x 8.337 x (1-S)

- A = Number of septic tank systems (including Homestead reduction as noted above)
- 0.065 = Average annual discharge in million gallons (65,000 gallons per system per year/1,000,000 gallons)
- N = Total nitrogen (TN) concentration of septic tank effluent in milligrams per liter
- 8.337 = Conversion factor (milligrams per liter to pounds per million gallons)
- S = percentage of TN loading from the septic tank effluent retained in the soil

This calculation is similar to that used in the 2005 Marion County wastewater study, with two exceptions. First, TN loading was calculated using 30 milligrams per liter (mg/L) and 50 mg/L. The 30 mg/L value is consistent with the TMDL documents. 50 mg/L is consistent with upper-end estimates of TN concentrations in septic effluent, similar to values used in the Marion County study and best professional judgment of FL Department of Environmental Protection Watershed Assessment Staff (W. Magley). Second, because the Marion County study focused on loading to groundwater and not surface water, retention of nitrogen in the soil was not incorporated into the loading calculations. To estimate the fraction of TN that reaches the surface water from septic tank effluent, a soil retention rate (S) was applied. Because the actual value for soil retention is unknown, TN loading was calculated with two soil retention values for comparison: 45% (1995 SJRWMD nutrient study) and 30% (P. Myers, Alachua Co. Health Dept.). These modifications allow for direct comparison with loading values from both the TMDLs and the Marion County wastewater study.

Total nitrogen loading from the two package plants was also calculated. Table 17 of the Newnans Lake TMDL provides daily discharge and average TN concentrations for the Brittany Estates outfall from

1996-2000. The daily average discharge and TN concentrations from the TMDL were used to calculate total annual TN loading for Brittany Estates. Loading from Sportsmans Cove was calculated in a similar manner, but with average monthly discharge and TN concentrations reported by the facility as stored in the DEP Wastewater Facility Regulation database. The retention factor (S) was applied to the load from Sportsmans Cove only, as Brittany Estates discharges directly into Little Hatchett Creek.

Results

Estimated septic tank TN loadings for each lake are shown in Tables 2A-D. Table 3 shows the estimated TN loading from the two package plants.

Table 2A
TN Loading from Septic Systems (lbs/year) – Lake Lochloosa

Estimated Soil TN Retention	Status	Total TN Loading (lbs/year)	
		30 mg/L Effluent TN Concentration	50 mg/L Effluent TN Concentration
30%	Functioning	1373	2288
	Failing	103	172
	TOTAL	**1476**	**2460**
45%	Functioning	1079	1798
	Failing	103	172
	TOTAL	**1182**	**1970**

Table 2B
TN Loading from Septic Systems (lbs/year) – Newnans Lake

Estimated Soil TN Retention	Status	Total TN Loading (lbs/year)	
		30 mg/L Effluent TN Concentration	50 mg/L Effluent TN Concentration
30%	Functioning	4292	7153
	Failing	323	538
	TOTAL	**4615**	**7691**
45%	Functioning	3372	5620
	Failing	323	538
	TOTAL	**3695**	**6158**

Table 2C
TN Loading from Septic Systems (lbs/year) – Orange Lake

Estimated Soil TN Retention	Status	Total TN Loading (lbs/year)	
		30 mg/L Effluent TN Concentration	50 mg/L Effluent TN Concentration
30%	Functioning	2205	3676
	Failing	166	276
	TOTAL	**2371**	**3952**
45%	Functioning	1733	2888
	Failing	166	276
	TOTAL	**1899**	**3164**

Table 2D
TN Loading from Septic Systems (lbs/year) – Lake Wauberg

Estimated Soil TN Retention	Status	Total TN Loading (lbs/year)	
		30 mg/L Effluent TN Concentration	50 mg/L Effluent TN Concentration
30%	Functioning	281	468
	Failing	21	35
	TOTAL	**302**	**504**
45%	Functioning	221	368
	Failing	21	35
	TOTAL	**242**	**403**

Table 3
TN Loading from Package Plants (lbs/year)

Lake	Package Plants in 200m Drainage Area	30% Soil Retention	45% Soil Retention
Lochloosa	-	-	-
Newnans	Brittany Estates *	736	736
Orange	Sportsman's Cove	5	4
Wauberg	-	-	-

* Brittany Estates discharges directly into Little Hatchett Creek. As such, the soil retention factor was not applied.

Figure 1 shows the relative TN loading from onsite wastewater systems for each lake using the most conservative estimates (30% retention rate and 50 mg/L TN concentration). Figures 2A through 2D show TN loading from onsite wastewater systems relative to loading from other sources. In these figures, the onsite wastewater loading was calculated assuming a 30% retention rate and 50 mg/L average TN concentration to provide a maximum loading estimate. Loading from non-wastewater sources and the total baseline loading values were taken directly from the TMDL documents for comparison purposes.

Given the variety of assumptions and data used in TMDL development among the lakes, these estimates of onsite wastewater system loading are rough estimates. Additional loading from onsite systems beyond the 200m drainage area may be occurring. However, without accurate data regarding groundwater baseflow into basin lakes, this additional contribution cannot be accurately quantified even within an order of magnitude.

Figure 1
Estimated TN Loading from Functioning Septic Systems, Failing Septic Systems, and Package Plants
(Calculated with 30% retention rate and 50 mg/L average TN concentration)

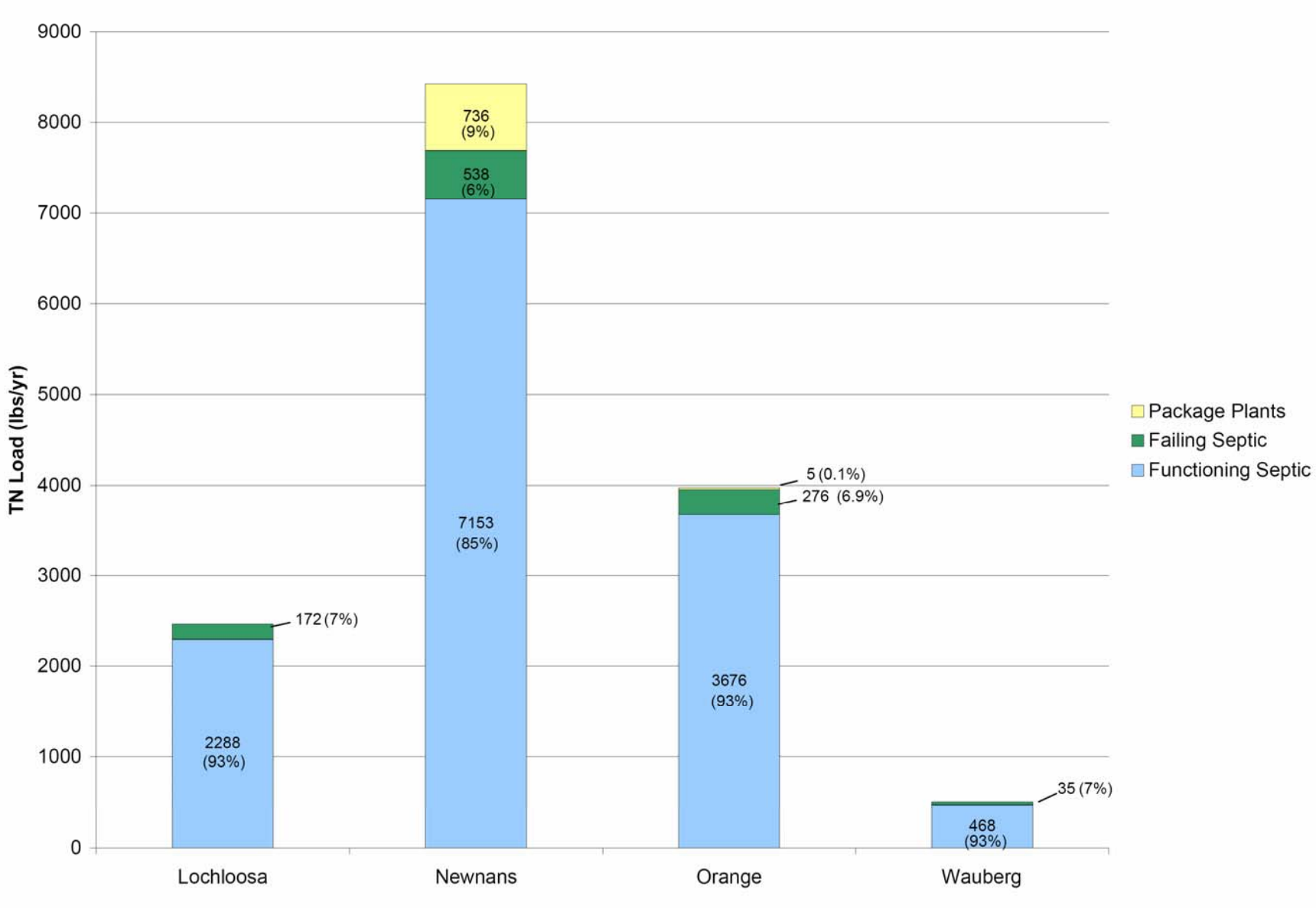
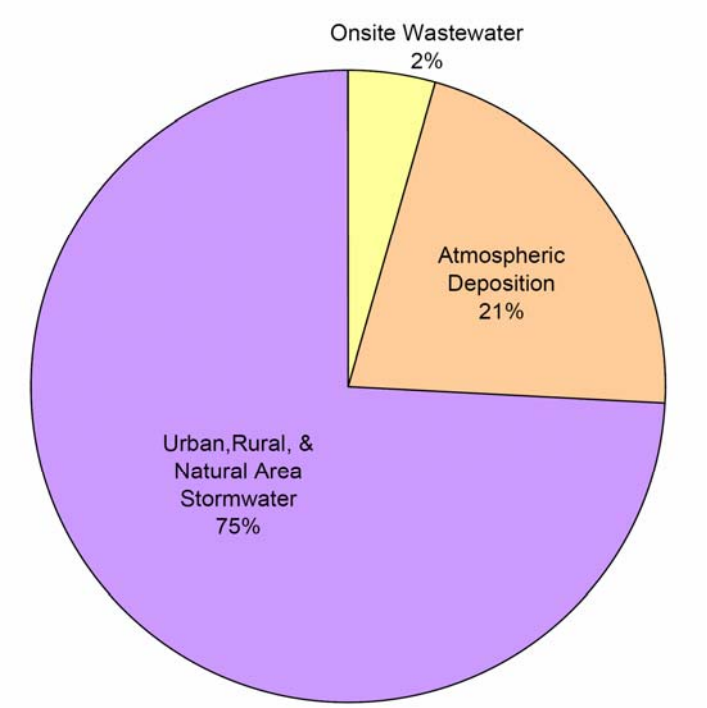


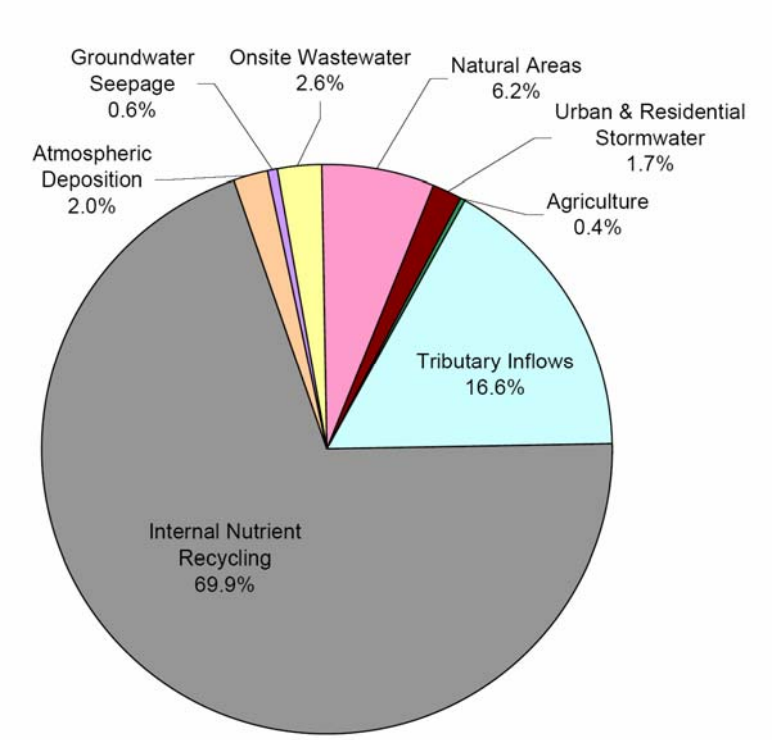
Figure 2A
Estimated TN Loading (lbs/year) and Percentage of Baseline Loading from Various Sources – Lake Lochloosa



Notes:

- Stormwater runoff was not separated by land use types in the original TMDL.
- The refined wastewater loading estimate shown in this figure was calculated with a 30% retention rate & 50 mg/L average TN concentration
- See Table 6 and Section 5.8 in the Lake Lochloosa TMDL for more information about non-wastewater sources.

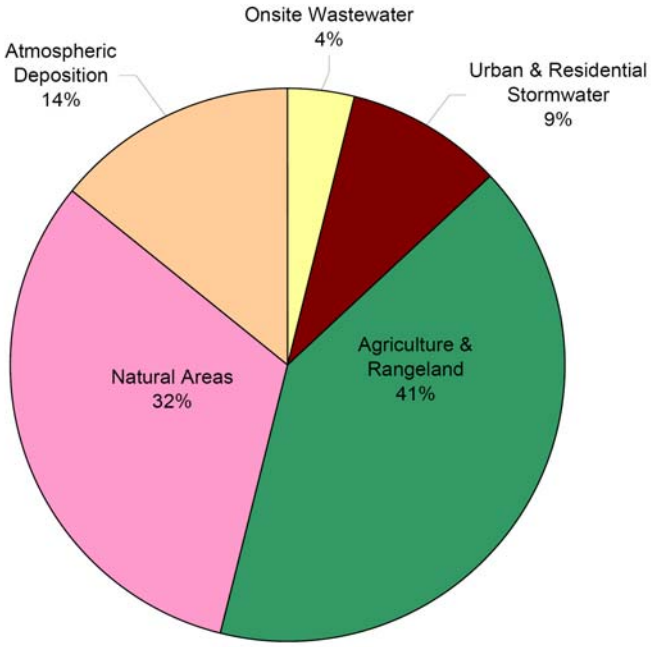
Figure 2B
Estimated TN Loading (lbs/year) and Percentage of Baseline Loading from Various Sources – Newnans Lake



Notes:

- The original onsite wastewater loading estimate calculated for the TMDL was 800 lbs/year (0.3% of total TN loading).
- The refined wastewater loading estimate shown in this figure was calculated with a 30% retention rate & 50 mg/L average TN concentration
- See Tables 23 & 26 in the Newnans Lake TMDL for more information about non-wastewater sources.

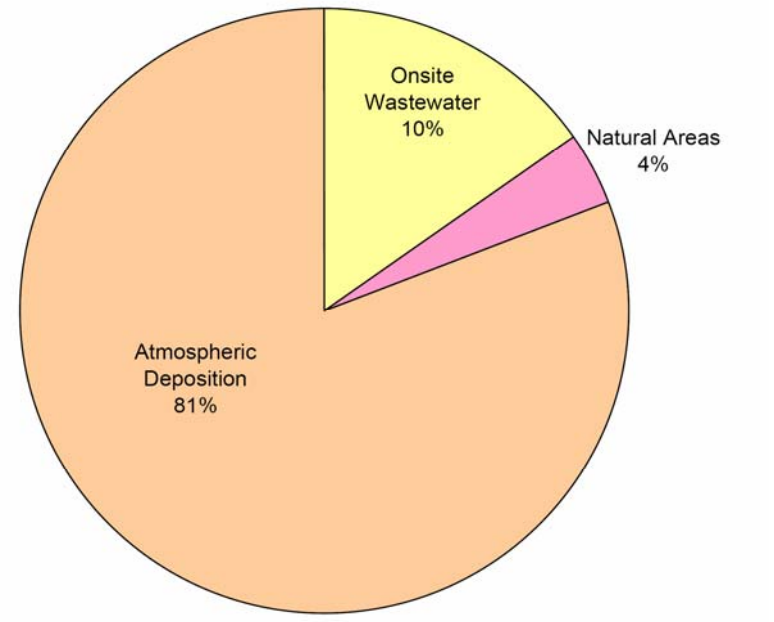
Figure 2C
Estimated TN Loading (lbs/year) and Percentage of Baseline Loading from Various Sources – Orange Lake



Notes:

- The original onsite wastewater loading estimate calculated for the TMDL was 4630 lbs/year (5% of total TN loading).
- The refined wastewater loading estimate shown in this figure was calculated with a 30% retention rate & 50 mg/L average TN concentration
- See Tables 18 & 21 of the Orange Lake TMDL for more information about non-wastewater loading.

Figure 2D
Estimated TN Loading (lbs/year) and Percentage of Baseline Loading from Various Sources – Lake Wauberg



Notes:

- The original onsite wastewater loading estimate calculated for the TMDL was 1299 lbs/year (32% of total TN loading).
- The refined wastewater loading estimate shown in this figure was calculated with a 30% retention rate & 50 mg/L average TN concentration
- See Section 5 of the Lake Wauberg TMDL for more information about non-wastewater loading.

Conclusions

Onsite wastewater systems are frequently identified as a significant source of nitrogen loading to surface waters. However, loading values from onsite systems are often based upon the total number of systems in the watershed, and not on the loading from those systems that actually reaches an impaired surface water. The purpose of this analysis was to estimate the fraction of total loading from onsite wastewater system effluent that reaches the four impaired lakes in the Orange Creek Basin. To identify this fraction, only systems within 200m of the lake and its associated surface water drainage features were included.

Based on the information provided above, TN loading from onsite systems in the 200m drainage area ranged from 8427 lbs/year (maximum estimate for Newnans Lake) to 242 lbs/year (minimum estimate for Lake Wauberg). The maximum estimates of loading from septic tanks alone were as follows: Lochloosa-2460 lbs/year, Newnans-7691 lbs/year, Orange-3952 lbs/year, and Wauberg-504 lbs/year.

In the four subbasins, functioning septic systems are estimated to contribute significantly more TN than failing systems and package plants combined (see Figure 1). TN loading from failing septic systems was limited. Loadings from the two package plants in the 200m surface water drainage area (Brittany Estates and Sportsman's Cove) were also minimal relative to loading from functioning septic tanks in their respective subbasins.

Relative to other sources, loading from onsite wastewater systems was a small fraction of the total TN loading to Lochloosa, Newnans, and Orange Lakes. For these three lakes, loadings from onsite systems were 2-4.5% of the total baseline loading. In Lake Wauberg, loading from onsite systems primarily located on the west-southwest side of the Lake represented 10% of the baseline loading. Further, the maximum estimate of TN load from onsite systems in Lake Wauberg (504 lbs/year) represents approximately 25% of the TMDL (2062.4 lbs/year).

Onsite wastewater disposal appears to provide only a small fraction of nitrogen loading to Lake Lochloosa, Newnans Lake, and Orange Lake. Addressing nitrogen loads from onsite wastewater systems would have the greatest benefit for Lake Wauberg, as onsite systems contribute a larger portion of the overall loading for this lake than in the other three impaired lakes. In addition to onsite wastewater systems, all sources need to be considered when developing a plan that will successfully improve water quality in lakes of the Orange Creek Basin.