Final Report

Task 3: Assess Contributions of Onsite Wastewater Treatment Systems Relative to Other Sources

Wekiva Onsite Nitrogen Contribution Study

Linda J. Young
Department of Statistics
Institute of Food and Agricultural Sciences
University of Florida

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Background

The Florida Legislature tasked the Florida Department of Health (FDOH) to conduct the Wekiva Onsite Nitrogen Contribution Study. The appropriation language reads:

> "$250,000 in non-recurring tobacco settlement funds are provided to the Department of Health to conduct or contract for a study to further identify and quantify the nitrogen loading from onsite wastewater treatment systems (OWTS) within the Wekiva Study Area. The objectives of the study shall be determined by the Department's Research Review and Advisory Committee, which shall also have oversight of the study. The Department shall provide a report to the Executive Office of the Governor, President of the Senate, and the Speaker of the House of Representatives no later than June 30, 2007. The report shall assess whether OWTS are a significant source of nitrogen to the underlying groundwater relative to other sources and shall recommend a range of possible cost-effective OWTS nitrogen reduction strategies if contributions are significant."

The study was divided into the following tasks:

> Task 1: Field Study to identify and quantify nitrogen loading at a few sample onsite wastewater treatment systems (OWTS) in the Wekiva Study Area
>
> Task 2: Categorization and Quantification of Nitrogen Loading from Onsite Wastewater Treatment System Types
>
> Task 3 (subject of this report): Assessment if OWTS are a significant source of nitrogen to the underlying groundwater relative to other sources; in particular enumeration and aggregation of OWTS loading
>
> Task 4: Recommend a range of possible cost-effective OWTS nitrogen reduction strategies if significant

This is a report of the work conducted under Task 3. The task was divided into five components, plus deliverables:

1. Develop procedures for categorizing OWTS (septic systems) with regard to characteristics that are expected to influence their functioning and environmental impact.
2. Count the number of septic systems in each subcategory for each vulnerability zone in the Wekiva Study area, and the municipalities with area in the Wekiva Study Area.
3. Estimate the nitrogen loading from the different subcategories of septic systems to the environment and to the water table.
4. Coordinating with MACTEC, St. John's River Management District's consultant working on the Wekiva Basin nitrogen loading, estimate the nitrogen loading

from other sources of nitrogen, including atmospheric deposition, centralized wastewater facilities, fertilizer applications, and animals.

5. Determine the relative contribution of septic systems to the nitrogen load to the underlying groundwater and assess its significance.

Information for the first three components was obtained from Dr. Richard Otis. MACTEC supplied the data that were the foundation for completion of component 4. Results from the first four components were used to complete component five. During the Research Review and Advisory Committee for the Bureau of Onsite Sewage Programs (RRAC) meeting on June 12, 2007, at Sylvan Lake Park, Sanford, Florida, it was decided that only information on inputs should be included in this final report. Further, modifications to the methods employed by MACTEC (used in component 4) were requested. These were made and documented in the appropriate sections. Subsequent to the RRAC meeting, DOH personnel Dr. Ebhard Roeder and Ms. Elke Ursin requested that estimated loadings from OWTS be presented, using information provided by Dr. Richard Otis.

The Study Area

The Wekiva Study Area (WSA) is comprised of about 304,000 acres, covering portions of Lake, Orange, and Seminole Counties. A map of the land uses within the WSA, as identified by the 2004 Land Use Survey, is displayed in Figure 1. The proportions of land designated for categories of land uses are shown in Figure 2.

Figure 1: Map showing land uses within the Wekiva Study Area

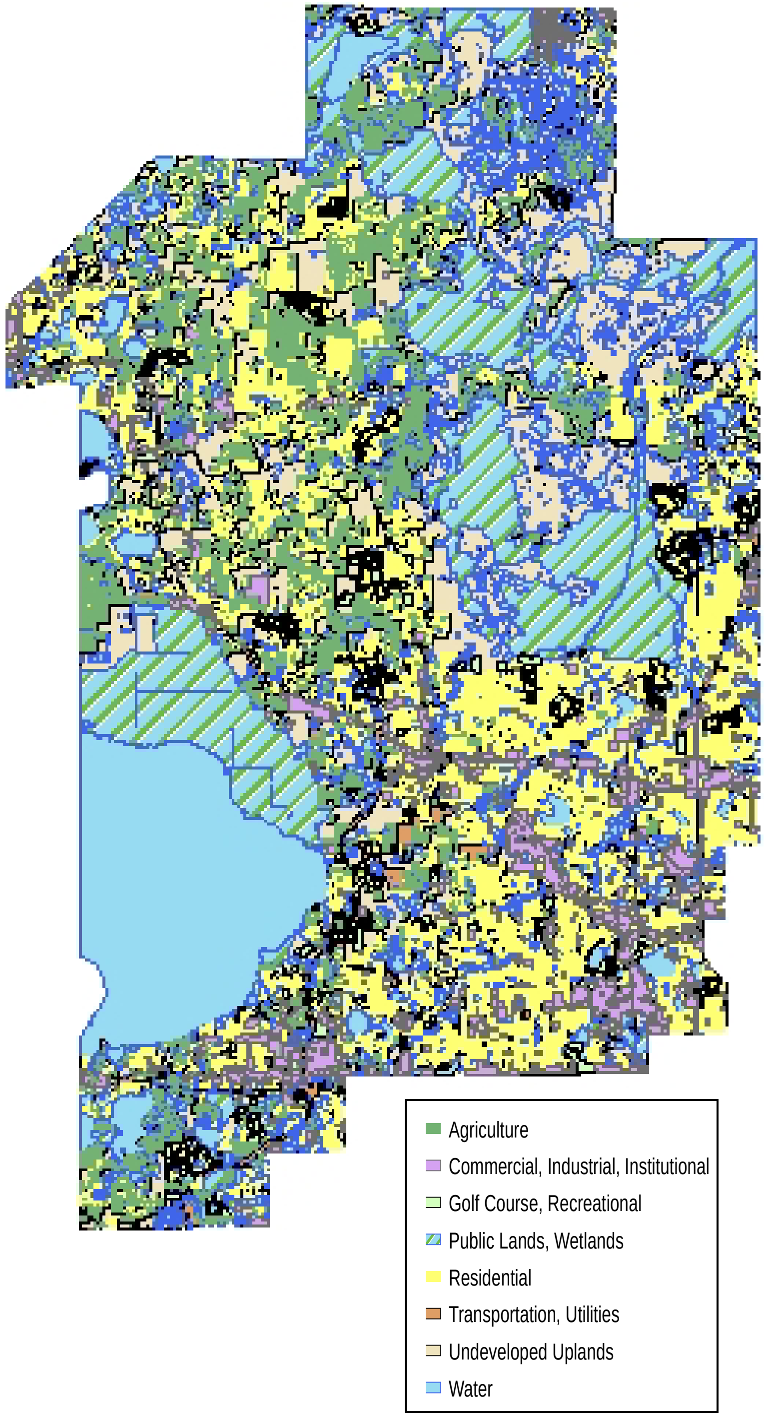
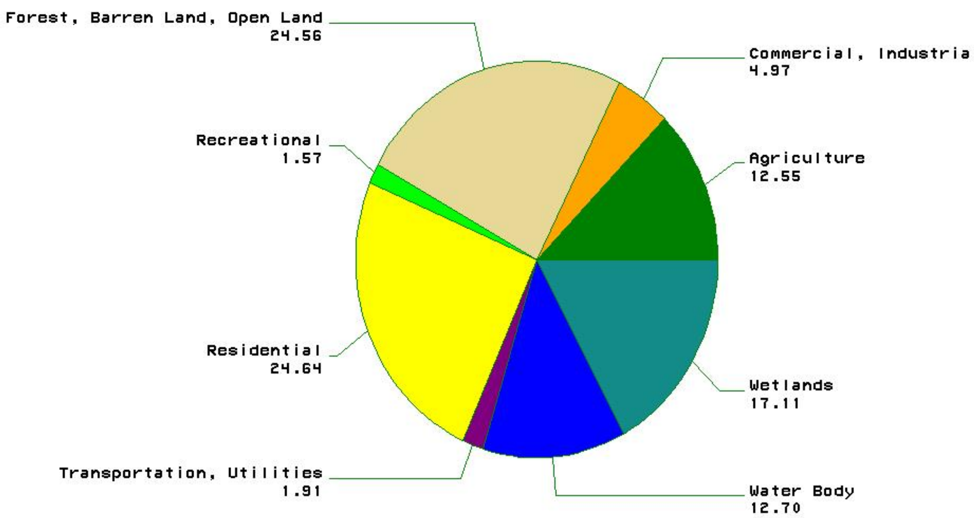


Figure 2. Land Uses in the Wekiva Study Area



Data Sources

GIS coverages with the location of septic systems in the WSA, 2004 Land Use, and Soils were provided by FDOH. Dr. Richard Otis developed the subcategories for the septic systems. He also provided factors for determining nitrogen inputs to the environment and loadings to the groundwater. MACTEC provided sections of its March 2007 report entitled "Phase 1 Report Wekiva River Basin Nitrate Sourcing Study" (referred to as FDEP 2007 Phase1 Report throughout this document) and supplementary materials used in their computations. The full report was obtained from the Florida Department of Environmental Protection (FDEP). The Wekiva Basin encompasses the WSA, but also includes other lands and waters. A major effort in this report went to adjusting the estimates for the Wekiva Basin to obtain those for the WSA.

Inputs represent the nitrogen delivered to the environment. Inputs from direct application of fertilizer, livestock waste (which is assumed to be released to the environment), atmospheric deposition (wet and dry) of total nitrate (nitrate + nitric acid); domestic and industrial wastewater effluents, and septic system discharges are estimated for the WSA in this report. Not all nitrogen inputs reach the waters of the WSA. Loadings represent the portion of nitrogen inputs that do reach either the surface waters or ground water. Loadings from sources other than septic systems will not be considered further here because the RRAC committee decided it should wait for more definitive results from Phase 2 of FDEP's study.

An important difference exists between the septic system data and data from other sources. For all but septic systems, MACTEC indicated that ***only nitrates*** were considered. However, MACTEC considered ***total nitrogen*** for fertilizer, livestock waste, and septic systems in the FDEP 2007 Phase 1 Report but, for atmospheric deposition and centralized wastewater facilities, only nitrates were used. This distorts the relative inputs, inflating the inputs from fertilizer, livestock waste, and septic systems, and diminishing those from atmospheric deposition and centralized wastewater facilities. All input valus were adjusted to reflect total nitrogen. The methods used in making those adjustments will be discussed in the appropriate sections.

Inputs to the Wekiva Study Area

Inputs to the WSA include direct application of fertilizer, livestock waste (which is assumed to be released to the environment), atmospheric deposition (wet and dry) of total nitrate (nitrate + nitric acid); effluents from centralized wastewater facilities, and septic system discharges. Each source has been quantified. With the exception of septic systems, the methods from the FDEP 2007 Phase 1 Report have been followed here with adjustments so that the total nitrogen, and not just nitrates, are reported for each source. Although a summary of the methods used will be given, the report should be consulted for a fuller explanation. For septic systems, the information was supplied by Dr. Richard Otis. A more detailed explanation of the methods he used may be obtained from the final report for Task 2.

Fertilizer Use

Fertilizer was assumed to be applied at rates recommended by the University of Florida’s (UF) Institute of Food and Agricultural Sciences (IFAS) unless it was determined that actual practice deviated from that. These recommendations are based on total nitrogen, not just nitrates, so no adjustment to values in the MACTEC report was necessary. The following equation was used to estimate residential, commercial, institutional, and transportation land uses:

$$Fertilizer\ Use_{LU} = \frac{Pervious\ \ Fracton_{LU} \times Application\ \ Rate_{LU} \times Area_{LU}}{CF}$$

where $Fertilizer\ Use_{LU}$ = Nitrogen contained in fertilizer applied for a specific land use (LU), totaled for that land use over the entire Wekiva Basin (MT/year);

$Pervious\ Fraction_{LU}$ = Fraction of the land use area that is not paved or under roof;

$Application\ Rate_{LU}$ = Application rate of nitrates in fertilizer (kg/ha/yr);

$Area_{LU}$ = Area within a given land use classification totaled over the entire Wekiva Basin (ha); and

CF = Conversion factor to achieve desired units of measurement, 1000 (kg/MT)

The application rate and impervious fraction by land use are taken from the FDEP 2007 Phase 1 Report’s Appendix D, Table 2. These, as well as the total area within each land use and the fertilizer use in kg/year and MT/year, are displayed in Table 1. The estimated total input from fertilizer is estimated to be 5735.39 MT/year.

Livestock

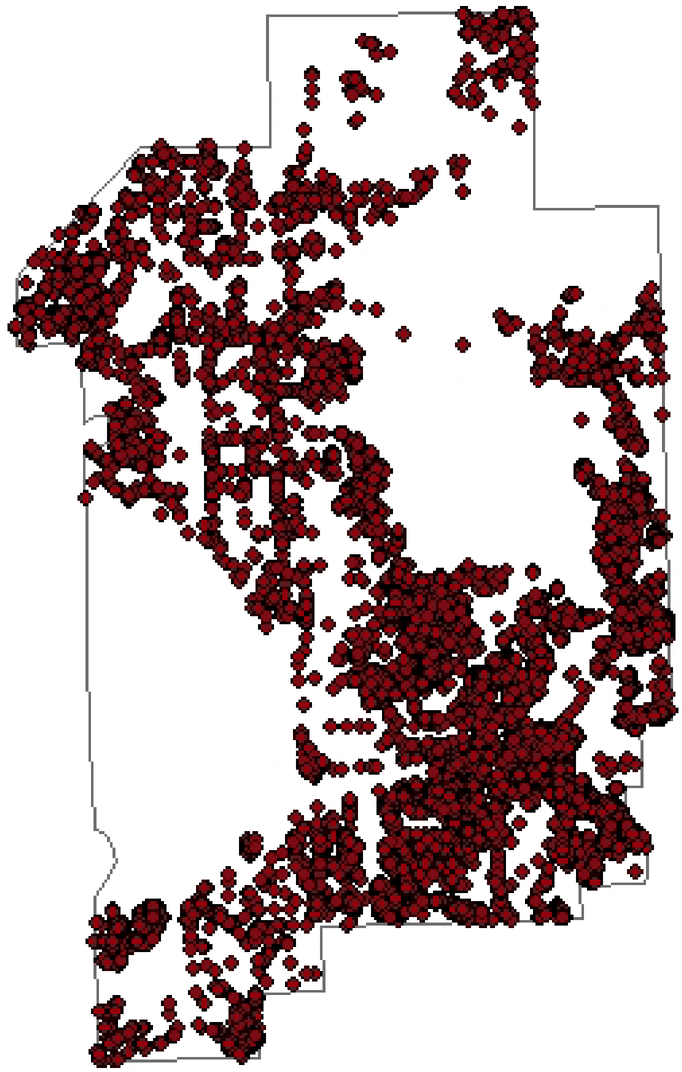
From the FDEP 2007 Phase 1 Report, total nitrogen contributions from livestock waste on pasture land is 41 kg/ha/year and that on feedlot land uses is taken to be 4100 kg/ha/year. Based on these values, the input of nitrogen from land use sources is estimated to be 652.55 MT/year (see Table 2).

Septic Systems

Over 55,000 septic systems are located in the WSA (see Figure 3). Each person living in the household is estimated to discharge 11.2 gms N/day to the septic system (Dr. Richard Otis, e-mail communication). Since an average of 2.6 people live in a household (2000 census), approximately 10.6 kg N/household enter the septic system each year. Assuming that 15% of the total nitrogen is removed in the septic tank, Dr. Richard Otis has estimated the contribution of total nitrogen from septic systems to be 9.0 kg/home/year. The distribution of the 55,417 septic systems in the Wekiva Study Area by Drainage Class, Depth to Estimated Seasonal High Water Table Class, Organic Matter Class and Soil Series is shown in Table 3. (Note: Other factors, such as system type and age, affect the nitrogen loadings from septic systems. Information on individual septic system characteristics is not available for the majority of the systems. Only available data were used when deciding on the categories.) The nitrogen discharged to the soil by the septic systems within each category as well as the overall totals are also displayed in that table. Thus, the total nitrogen input to the Wekiva Study Area is estimated to be 498.75 MT/year.

The soil type is often a factor in choosing which septic system (mounded, filled, sub-surface) to install, and the likely choice of system type for each soil series was considered by Dr. Richard Otis in determining the proportion of the inputs delivered to the ground water (see Appendix A). These loadings were found by multiplying the total nitrogen inputs to the environment by the proportion of that amount anticipated to reach groundwater. That proportion depended on soil drainage, water level class, organic matter class, and soil series as shown in Appendix A. For poorly drained soils, the percentages of TKN and NO_3 (nitrate) removed by the soil differed. Whether TKN or NO_3 is appropriate depends upon septic system type, and Dr. Richard Otis supplied that information as shown in Appendix A. Using this information, the low, medium, and high estimates of groundwater nitrogen loadings due to septic systems for each soil type are displayed in Table 4, and the estimated low, medium and high estimated groundwater loadings of total nitrogen from septic systems are 382.9, 410.2, and 445.8 MT/year, respectively.

Figure 3. Location of Septic Systems Within the Wekiva Studay Area



Atmospheric Deposition

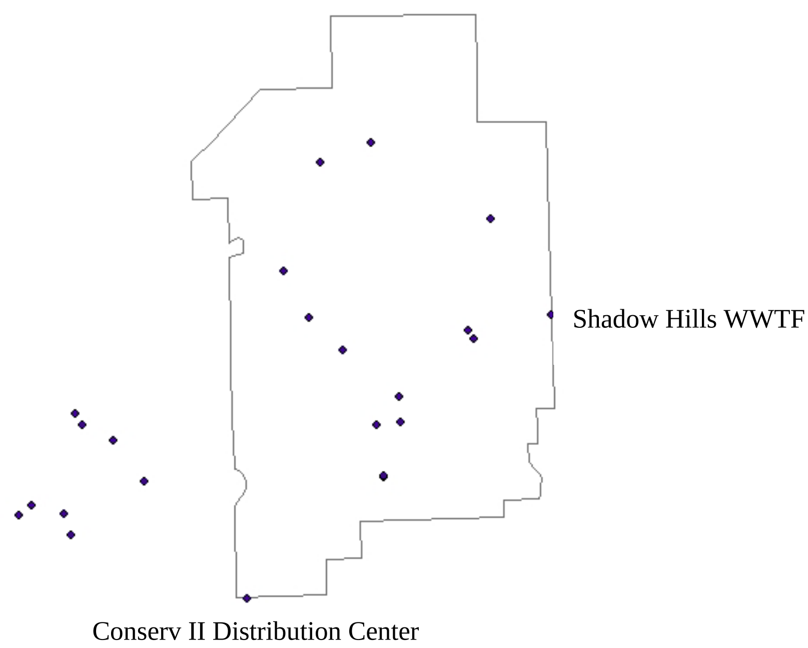
According to the FDEP 2007 Phase 1 Report, the nitrate input from acid deposition is estimated to be 2.57 and 4.18 kg/ha/year for rural and urban areas, respectively. In addition to these being nitrate, and not total nitrogen, values, it was believed that all of the Wekiva Study Area should be treated as urban for this computation. Based on the trend function estimated by Nickerson and Madsen (2005) for total nitrogen from wet deposition recorded in Orlando from 1978 to 1997, Dr. Eberhard Roeder obtained an estimate of 5.94 kg/hectare/year for the end of 2004. Dry deposition was taken to be 30% of the total, the average of the 15% recorded by the CASTNET Indian River Lagoon monitor and the 44% reported by Poor, *et al*. (2001) for Tampa Bay, or 2.55 kg/hectare/year. Thus, the total nitrogen from atmospheric deposition was estimated to be 8.5 kg/hectare/year, a value that is within the error bounds reported by Poor *et al*. (2001). The results by Land Use are shown in Table 4. Notice that, as in the FDEP 2007

Phase 1 Report, atmospheric deposition for water bodies is not considered. Thus the estimated nitrogen input to WSA from atmospheric deposition is 920.98 MT/year.

Discharge by Centralized Wastewater Facilities

The FDEP 2007 Phase 1 Report considered only nitrates from the permitted centralized wastewater discharge facilities within the Wekiva Basin. Because the emphasis here is on total nitrogen, Dr. Eberhard Roeder reviewed the FDEP permit records for most of the centralized wastewater facilities in the WSA and provided information on the total nitrogen discharged to surface water and to surface water and that which was reused. Information was available for 96.3% of the permitted discharge from the WSA centralized wastewater facilities. In addition two additional facilities were found to lie just outside the boundary of the WSA (see Figure 4). The facility with the largest input to the Wekiva Basin, the Conserv II Distribution Center, is one of the two lying just outside the boundary. Dr. Eberhard Roeder (e-mail communication) estimated that 10% of the discharge from that facility went to the WSA. All of the discharge from the other facility (Shadow Hills WWTF) was included in the computations. After consultation with FDOH, it was decided to include the two boundary facilities in the computations, but to also provide estimates for those only within the WSA.

Figure 4. Permitted Centralized Wastewater Facilities with the Two Facilities Lying Immediately Outside the Boundary Identified



Effluents were segregated by disposal type (e.g., sprayfield, percolation basins, rapid infiltration basins (RIBs), suface water discharge), and subsequently separated into two categories: discharge to surface water and discharge to groundwater. In addition, several facilities have a reclamation/reuse disposal system. Wastewater effluent inputs to surface water, groundwater, and reclaimed/reused were estimated as follows:

$$Input = \frac{Actual\ \ Discharge \times Concentration)}{CF}$$

where	*Input*	=	Wastewater facility effluent (MT/yr);
	Actual Discharge	=	Total Annual Discharge;
	Concentration	=	Average effluent concentration of total nitrogen during 2004 through 2006 (mg/L); and
	CF	=	Conversion factor to achieve desired units of measurement, 10^9 (mg/MT)

Based on the 28 facilities for which permit records were reviewed, total nitrogen discharged to surface water from permitted facilities within the WSA was estimated at 38.3 MT/year, and total nitrogen discharges to groundwater from these same facilities were estimated to be 135.8 MT/year (Table 4). The amount of nitrate-nitrogen that is reclaimed/reused was estimated to be 133.6 MT/year. In the FDEP 2007 Phase 1 Report, effluent reclaimed/reused was assumed to replace or reduce fertilizer and thus provided no additional inputs to the area. However, at the June 12, 2007, RRAC meeting it was determined that these should be considered as additional inputs.

According to the report, *A strategy for Water Quality Protection: Wastewater Treatment in the Wekiva Study Area* (FDEP 2004), within WSA, there are 16 centralized wastewater facilities with permits for discharges of 100,000 gallons per day (GPD) or more, and 32 facilities with permits for discharges of less than 1000,000 GPD. The total permitted capacity in millions of gallons per day is 41.42 for the centralized wastewater facilities for which the permit records were reviewed and 42.78 for all facilities. Because the total nitrogen concentrations released vary with facility and data on these concentrations are only available for the facilities for which the permit records were reviewed, the nitrate contributions by the remaining facilities cannot be accurately assessed. An estimate of the total nitrogen contributions from all facilities within the WSA may be obtained by assuming that the contribution is proportional to the permitted GPD discharge. Using this approach, the total nitrogen discharged to surface water and to groundwater from the WSA facilities, including contributions by the two facilities just outside the WSA, is estimated to be 39.52 MT/year and 101.18 MT/year, respectively. The amount of total nitrogen that is reclaimed/reused is estimated to be 175.30 MT/year. Thus, the total nitrogen discharged from the centralized wastewater facilities is 315.99 MT/year.

Total Inputs

The total nitrogen input to the WSA from all sources is estimated to be 8,123 MT/year. The relative contributions from all sources are displayed in Figure 5.

Table 1. Total Nitrogen Inputs to the Wekiva Study Area by Source

Source of Total Nitrogen	Total Nitrogen Input (MT/Year)
Fertilizer from Agriculture	2002.7
Fertilizer from Gof Courses	224.69
Fertilizer from Residences	3229.36
Fertilizer from Other Land Uses	278.64
Livestock Waste	652.55
Atmospheric Deposition	920.98
Centralized Wastewater Facilities	278.69
Septic Systems	498.75
Totals	**8123.39**

Figure 5. Total Nitrogen Inputs to Wekiva Study Area by Source

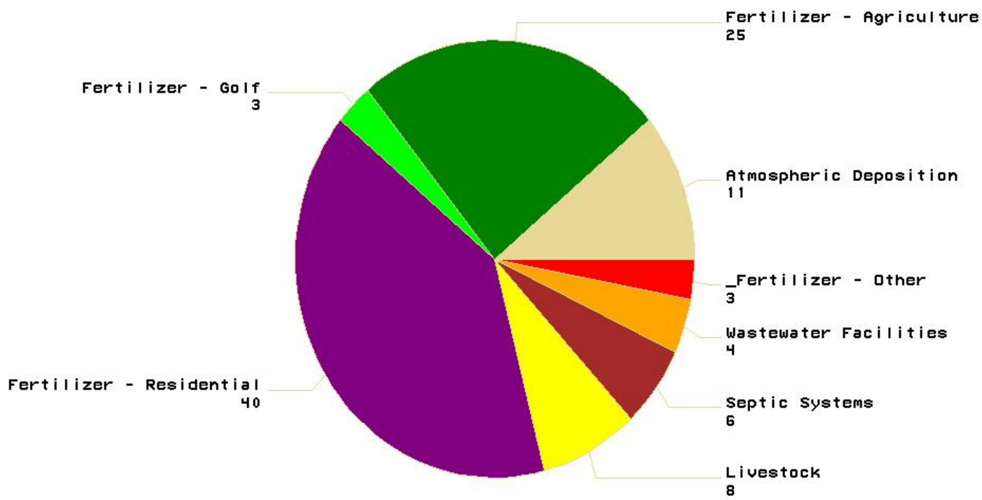


Table 2. Total Nitrogen Input to the Wekiva Study Area From Fertilizer Application by Land Use

LU Code	Land Use	Acres	Hectares	Fertilizer (kg/ha/year)	Impervious (%)	Fertilizer Subtotal (kg/year)/	Fertilizer (MT/year)
1100	Low Density Residential	22645.01	9164.44	148	14.70	1156955.18	1156.96
1200	Medium Density Residential	44361.16	17952.96	148	27.80	1918381.69	1918.38
1300	High Density Residential	7792.26	3153.53	148	67.00	154018.34	154.02
1400	Commercial	8266.56	3345.48	200	94.25	38472.97	38.47
1480	Airports	203.70	82.44	200	94.25	948.02	0.95
1700	Institutional	3311.45	1340.14	200	91.00	24122.57	24.12
1800	Recreational	1807.25	731.39	200	1.50	144084.76	144.08
1820	Golf Courses	3174.04	1284.53	175	0.00	224793.61	224.79
2100	Agriculture-Field Crops	59.31	24.00	150	0.00	3600.15	3.60
2110	Agriculture-Improved Pasture	13267.69	5369.44	63	0.00	338274.46	338.27
2120	Agriculture-Unimproved Pasture	7505.32	3037.40	63	0.00	191356.30	191.36
2140	Agriculture-Row Crops	692.6399311 8590	280.31	630	0.00	176596.17	176.60
2150	Agriculture-Field Crops	2568.65	1039.53	150	0.00	155930.05	155.93
2200	Agriculture-Tree Crops	6016.14	2434.73	227	0.00	552684.54	552.68
2400	Agriculture-Nurseries	128.83	52.14	227	0.00	11835.07	11.84
2410	Agriculture-Nurseries	82.90	33.55	227	0.00	7615.71	7.62
2420	Agriculture-Sod Farms	120.32	48.69	200	0.00	9738.40	9.74

LU Code	Land Use	Acres	Hectares	Fertilizer (kg/ha/year)	Impervious (%)	Fertilizer Subtotal (kg/year)/	Fertilizer (MT/year)
2430	Agriculture-Nurseries	5353.17	2166.43	227	0.00	491779.09	491.78
2450	Agriculture-Floriculture	21.05	8.52	200	0.00	1703.73	1.70
2500	Agriculture-Specialty Farms	86.60	35.05	200	0.00	7009.11	7.01
2510	Agriculture-Horse Farms	2151.10	870.55	63	0.00	54844.55	54.84
8100	Transportation	3491.93	1413.18	200	85.00	42395.50	42.40
8300	Utilities	2326.84	941.67	200	85.00	28250.17	28.25
	Totals	**135,433.91**	**54,810.10**			**5,735,390.12**	**5,735.39**

Table 3. Total Nitrogen Input to the Wekiva Study Area From Livestock Waste by Land Use

LU Code	Land Use	Acres	Hectares	Livestock Waste (kg/ha/year)	Livestock Waste Subtotal (kg/year)	Livestock Waste (MT/year)
2110	Agriculture-Improved Pasture	13267.69	5369.44	41	220146.87	220.147
2120	Agriculture-Unimproved Pasture	7505.32	3037.40	41	124533.46	124.533
2300	Agriculture-Feeding Operations	162.06	65.59	4150	272180.09	272.180
2510	Agriculture-Horse Farms	2151.10	870.55	41	35692.48	35.692
	Totals	**23,086.17**	**9,342.97**		**652,552.91**	**652.55**

Table 4. Total Nitrogen Input to the Wekiva Study Area from Septic Systems

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
	<=3.5 Feet	<= 1%		434	3.906
	<=3.5 Feet	<= 1%	**URBAN LAND**	8070	72.630
	> 3.5 Feet	<= 1%	**PITS**	17	0.153
Excessively Well/ Somewhat Excessively Well	> 3.5 Feet	<= 1%	**LAKE FINE SAND** Hyperthermic, coated Typic Quartzipsamments	1126	10.134
			PAOLA FINE SAND Hyperthermic, uncoated Spodic Quartzipsamments	412	3.708
			ST. LUCIE SAND Hyperthermic, uncoated Typic Quartzipsamments	542	4.878
		> 1%	**ASTATULA FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	2585	23.265
			CANDLER SAND Hyperthermic, uncoated Lamellic Quartzipsamments	22146	199.314
Well	> 3.5 Feet	<= 1%	**APOPKA SAND** Loamy, siliceous, hyperthermic Grossarenic Paleudults	52	0.468
		> 1%	**ORLANDO FINE SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	194	1.746
Moderately Well	<=3.5 Feet	<= 1%	**POMELLO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	934	8.406
	> 3.5 Feet	<= 1%	**ARCHBOLD SAND** Hyperthermic, uncoated Typic Quartzipsamments	133	1.197
			ORSINO FINE SAND Hyperthermic, uncoated Spodic Quartzipsamments	63	0.567
			UDORTHENTS	2	0.018
		> 1%	**FLORAHOME SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	185	1.665
			MILLHOPPER SAND Loamy, siliceous, semiactive, hyperthermic Grossarenic Paleudults	8	0.072
			TAVARES FINE SAND Hyperthermic, uncoated Typic Quartzipsamments	10120	91.080

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
Somewhat Poorly/ Poorly/Very Poorly	<=3.5 Feet	<= 1%	**ADAMSVILLE FINE SAND** Hyperthermic, uncoated Aquic Quartzipsamments	158	1.422
			ARENTS	316	2.844
			CASSIA FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	117	1.053
			ZOLFO FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	702	6.318
		>1%	**ANCLOTE SAND** Sandy, siliceous, hyperthermic Typic Endoaquolls	19	0.171
			BASINGER FINE SAND Siliceous, hyperthermic Spodic Psammaquents	959	8.631
			BRIGHTON MUCK Dysic, hyperthermic Typic Haplohemists	64	0.576
			CANOVA MUCK Fine-loamy, siliceous, superactive, hyperthermic Histic Glossaqualts	2	0.018
			CHOBEE FINE SANDY LOAM Fine-loamy, siliceaous, superactive, hyperthermic Typic Argiaquolls	4	0.036
Somewhat Poorly/ Poorly/Very Poorly	<=3.5 Feet	>1%	**EAUGALLIE FINE SAND** Sandy, siliceous, hyperthermic Alfic Alaquods	49	0.441
			EMERALDA FINE SAND Fine, mixed, superactive, hyperthermic Mollic Albaqualfs	17	0.153
			FELDA FINE SAND Loamy, siliceous, superactive, hyperthermic Arenic Endoaqualfs	27	0.243
			GATOR MUCK Loamy, siliceous, euic, hyperthermic Terric Haplosaprists	1	0.009
			IMMOKALEE FINE SAND Sandy, siliceous, hyperthermic Arenic Alaquods	433	3.897

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
			MALABAR FINE SAND Loamy, siliceous, active, hyperthermic Grossarenic Endoaqualfs	6	0.054
			MYAKKA FINE SAND Sandy, siliceous, hyperthermic Aeric Alaquods	645	5.805
			NITTAW SANDY CLAY Fine, smectitic, hyperthermic Typic Argiaquolls	128	1.152
			OCOEE MUCK Sandy or sandy skeletal, siliceous, dysic, hyperthermic Terric Haplohemists	1	0.009
			OKEELANTA MUCK Sandy or sandy skeletal, siliceous, euic, hyperthermic Terric Haplosaprists	3	0.027
			ONA FINE SAND Sandy, siliceous, hyperthermic Typic Alaquods	851	7.659
			PLACID FINE SAND Sandy, siliceious, hyperthermic Typic Humaquepts	45	0.405
			POMPANO FINE SAND Siliceous, hyperthermic Typic Psammaquents	202	1.818
			SAMSULA MUCK Sandy or sandy skeletal, siliceous, dysic, hperthermic Terric Haplosaprists	88	0.792
			SANIBEL	68	0.612
			SEFFNER FINE SAND Sandy, siliceous, hyperthermic Aquic Humic Dystrudepts	152	1.368
			SMYRNA SAND Sandy, siliceous, hyperthermic Aeric Alaquods	2657	23.913
			SPARR FINE SAND Loamy, siliceous, subactive, hyperthermic Grossarenic Paleudults	22	0.198

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
			ST. JOHNS FINE SAND Sandy, siliceous, hyperhtermic TypicAlaquods	287	2.583
			WABASSO FINE SAND Sandy over loamy, siliceous, active, hyperthermic Alfic Alaquods	339	3.051
			WAUBERG FINE SAND Loamy, siliceous, active, hyperthermic Arenic Albaqualfs	2	0.018
			WAUCHULA FINE SAND Sandy over loamy, siliceous, active hyperthermic Ultic Alaquods	1	0.009
	> 3.5 Feet	> 1%	**LOCHLOOSA FINE SAND** Loamy, siliceous, semiactive, hyperthermic Aquic Arenic Paleudults	29	0.261
Totals				**55,417**	**498.75**

Table 5. Total Nitrogen Groundwater Loading Due to Septic Systems

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Medium Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
	<=3.5 Feet	<= 1%		434	3.212	2.643	2.503
			URBAN LAND	8070	59.731	49.141	46.534
			PITS	17	0.153	0.145	0.138
Excessively Well/ Somewhat Excessively Well	>3.5 Feet	<= 1%	**LAKE FINE SAND** Hyperthermic, coated Typic Quartzipsamments	1126	10.134	9.627	9.121
			PAOLA FINE SAND Hyperthermic, uncoated Spodic Quartzipsamments	412	3.708	3.523	3.337
			ST. LUCIE SAND Hyperthermic, uncoated Typic Quartzipsamments	542	4.878	4.634	4.390
		>1%	**ASTATULA FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	2585	23.265	22.102	20.939
			CANDLER SAND Hyperthermic, uncoated Lamellic Quartzipsamments	22146	199.314	189.348	179.383
Well	>3.5 Feet	<= 1%	**APOPKA SAND** Loamy, siliceous, hyperthermic Grossarenic Paleudults	52	0.468	0.445	0.421
		>1%	**ORLANDO FINE SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	194	1.746	1.659	1.571
	<=3.5 Feet	<= 1%	**POMELLO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	934	7.565	5.884	4.203

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Medium Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
Moderately Well	>3.5 Feet	<= 1%	**ARCHBOLD SAND** Hyperthermic, uncoated Typic Quartzipsamments	133	1.137	1.077	1.017
			ORSINO FINE SAND Hyperthermic, uncoated Spodic Quartzipsamments	63	0.539	0.510	0.482
			UDORTHENTS	2	0.016	0.014	0.011
		>1%	**FLORAHOME SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	185	1.499	1.415	1.332
			MILLHOPPER SAND Loamy, siliceous, semiactive, hyperthermic Grossarenic Paleudults	8	0.065	0.061	0.058
			TAVARES FINE SAND Hyperthermic, uncoated Typic Quartzipsamments	10120	86.526	81.972	77.418
Somewhat Poorly/ Poorly/Very Poorly	<=3.5 Feet	<= 1%	**ADAMSVILLE FINE SAND** Hyperthermic, uncoated Aquic Quartzipsamments	158	1.351	1.280	1.209
			ARENTS	316	1.991	1.564	1.138
			CASSIA FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	117	0.948	0.895	0.842
			ZOLFO FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	702	6.002	5.370	4.739
		>1%	**ANCLOTE SAND** Sandy, siliceous, hyperthermic Typic Endoaquolls	19	0.043	0.021	0.000

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Medium Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
			BASINGER FINE SAND Siliceous, hyperthermic Spodic Psammaquents	959	8.199	7.552	6.905
			BRIGHTON MUCK Dysic, hyperthermic Typic Haplohemists	64	0.058	0.029	0.000
			CANOVA MUCK Fine-loamy, siliceous, superactive, hyperthermic Histic Glossaqualts	2	0.002	0.001	0.000
			CHOBEE FINE SANDY LOAM Fine-loamy, siliceaous, superactive, hyperthermic Typic Argiaquolls	4	0.032	0.029	0.025
			EAUGALLIE FINE SAND Sandy, siliceous, hyperthermic Alfic Alaquods	49	0.353	0.309	0.265
			EMERALDA FINE SAND Fine, mixed, superactive, hyperthermic Mollic Albaqualfs	17	0.015	0.008	0.000
			FELDA FINE SAND Loamy, siliceous, superactive, hyperthermic Arenic Endoaqualfs	27	0.146	0.122	0.097
			GATOR MUCK Loamy, siliceous, euic, hyperthermic Terric Haplosaprists	1	0.008	0.007	0.006
			IMMOKALEE FINE SAND Sandy, siliceous, hyperthermic Arenic Alaquods	433	3.118	2.728	2.338

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Medium Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
			MALABAR FINE SAND Loamy, siliceous, active, hyperthermic Grossarenic Endoaqualfs	6	0.049	0.043	0.038
			MYAKKA FINE SAND Sandy, siliceous, hyperthermic Aeric Alaquods	645	3.483	2.903	2.322
			NITTAW SANDY CLAY Fine, smectitic, hyperthermic Typic Argiaquolls	128	0.115	0.058	0.000
			OCOEE MUCK Sandy or sandy skeletal, siliceous, dysic, hyperthermic Terric Haplohemists	1	0.009	0.008	0.007
			OKEELANTA MUCK Sandy or sandy skeletal, siliceous, euic, hyperthermic Terric Haplosaprists	3	0.026	0.024	0.022
			ONA FINE SAND Sandy, siliceous, hyperthermic Typic Alaquods	851	6.893	6.127	5.361
			PLACID FINE SAND Sandy, siliceious, hyperthermic Typic Humaquepts	45	0.041	0.020	0.000
			POMPANO FINE SAND Siliceous, hyperthermic Typic Psammaquents	202	1.091	0.909	0.727

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Medium Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
			SAMSULA MUCK Sandy or sandy skeletal, siliceous, dysic, hperthermic Terric Haplosaprists	88	0.079	0.040	0.000
			SANIBEL	68	0.581	0.551	0.520
			SEFFNER FINE SAND Sandy, siliceous, hyperthermic Aquic Humic Dystrudepts	152	0.137	0.068	0.000
			SMYRNA SAND Sandy, siliceous, hyperthermic Aeric Alaquods	2657	2.391	1.196	0.000
			SPARR FINE SAND Loamy, siliceous, subactive, hyperthermic Grossarenic Paleudults	22	0.020	0.010	0.000
			ST. JOHNS FINE SAND Sandy, siliceous, hyperhtermic TypicAlaquods	287	2.066	1.808	1.550
			WABASSO FINE SAND Sandy over loamy, siliceous, active, hyperthermic Alfic Alaquods	339	2.441	2.136	1.831
			WAUBERG FINE SAND Loamy, siliceous, active, hyperthermic Arenic Albaqualfs	2	0.011	0.009	0.007

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Medium Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
			WAUCHULA FINE SAND Sandy over loamy, siliceous, active hyperthermic Ultic Alaquods	1	0.009	0.008	0.008
	>3.5 Feet	> 1%	**LOCHLOOSA FINE SAND** Loamy, siliceous, semiactive, hyperthermic Aquic Arenic Paleudults	29	0.157	0.131	0.104
Totals				**55,417**	**445.8**	**410.2**	**382.9**

Table 6. Total Nitrogen Input to the Wekiva Study Area From Atmospheric Deposition by Land Use

LU Code	Land Use	Acres	Hectares	Atmospheric Deposition (kg/year)	Atmospheric Deposition (MT/hyear)
1100	Agriculture-Aquaculture	22645.01	9164.44	66446.75	66.447
1200	Agriculture-Feeding Operations	44361.16	17952.96	110177.33	110.177
1300	Agriculture-Field Crops	7792.26	3153.53	8845.65	8.846
1400	Agriculture-Floriculture	8266.56	3345.48	1635.10	1.635
1480	Agriculture-Horse Farms	203.70	82.44	40.29	0.040
1500	Agriculture-Improved Pasture	2714.17	1098.42	9336.60	9.337
1600	Agriculture-Nurseries	634.46	256.77	2182.51	2.183
1700	Agriculture-Row Crops	3311.45	1340.14	1025.21	1.025
1800	Agriculture-Sod Farms	28.89	11.69	99.36	0.099
1800	Agriculture-Specialty Farms	1807.25	731.39	6123.60	6.124
1800	Agriculture-Tree Crops	2.38	0.96	8.18	0.008
1820	Agriculture-Unimproved Pasture	3174.04	1284.53	10918.55	10.919
1900	Airports	2841.58	1149.99	9774.89	9.775
2100	Barren Land	59.31	24.00	204.01	0.204
2110	Cemetaries	13267.69	5369.44	45640.20	45.640
2120	Commercial	7505.32	3037.40	25817.91	25.818
2140	Communications	692.64	280.31	2382.65	2.383
2150	Extractive	2568.65	1039.53	8836.04	8.836

LU Code	Land Use	Acres	Hectares	Atmospheric Deposition (kg/year)	Atmospheric Deposition (MT/hyear)
2200	Low Density Residential	6016.14	2434.73	20695.24	20.695
2300	Medium Density Residential	162.06	65.59	557.48	0.557
2400	High Density Residential	128.83	52.14	443.16	0.443
2410	Commercial	82.90	33.55	285.17	0.285
2420	Airports	120.32	48.69	413.88	0.414
2430	Industrial	5353.17	2166.43	18414.64	18.415
2450	Extractive	21.05	8.52	72.41	0.072
2500	Institutional	15.23	6.16	52.40	0.052
2500	Marinas and Fish Camps	86.60	35.05	297.89	0.298
2510	Recreational	2151.10	870.55	7399.66	7.400
3000	Swimming Beaches	17361.24	7026.09	59721.81	59.722
4000	Golf Courses	45169.45	18280.08	155380.66	155.381
5000	Open Land	38687.88	15656.99	133084.38	133.084
6000	Agriculture-Field Crops	52103.30	21086.21	179232.75	179.233
7000	Agriculture-Improved Pasture	9427.61	3815.35	32430.49	32.430
8100	Agriculture-Unimproved Pasture	3491.93	1413.18	1801.81	1.802
8300	Agriculture-Row Crops	2326.84	941.67	1200.63	1.201
	Totals	**304,582.15**	**123,364.40**	**920,979.27**	**920.98**

Table 7. Surface Water, Groundwater, and Reuse Total Nitrogen Discharge from Wekiva Study Area's Centralized Wastewater Facilities

Facility ID	Name	Surface Water (MT/Yr)	Ground Water (MT/Yr)	Reused (MT/Yr)
FLA010795	Conserv II Distribution Center	0.0000	24.8675	37.3012
FL0033251	Altamonte Springs/Swofford	15.6458	0.0000	61.9573
FLA010798	OCUD/Northwest Water Reclamation Facility	14.9205	38.2033	0.0000
FLA010818	Apopka WRF – Project Arrow	0.0000	1.3263	4.3988
FLA010815	Ocoee, City of	0.0000	1.1981	6.1892
FL0036251	Sanlando Utilities; 'Wekiva Hunt Club	7.6961	5.4348	16.6769
FL0042625	Seminole County NW regional	0.0000	0.0000	7.0872
FLA010865	Zellwood Station MHP	0.0000	1.3249	0.0000
FLA295965	Eustis – Eastern	0.0000	0.6991	0.0000
FLA010541	Wekiva Falls Resort	0.0000	0.2735	0.0000
FLA010851	Clarcona Resort Condo	0.0000	0.4973	0.0000
FLA010498	Seminole Springs Elementary School WWTF	0.0000	0.0166	0.0000
FLA010855	Coca-Cola/Apopka Facility	0.0000	0.0154	0.0000
FLA010833	Monterey Mushroom Farm (Terry Farms)	0.0000	0.0253	0.0000
Totals of above (facilities in WSA)		**38.26**	**73.88**	**133.61**

Limitations

The FDEP 2007 Phase 1 Report identified a number of limitations, both from procedural issues and uncertainties in input parameters. These apply here as well. Only a few of these will be identified here, and the interested reader should refer to the report for a more detailed discussion.

The parameters used in all of the computations are subject to uncertainty. As an example, the estimated amount of fertilizer applied to each land use was based on the technical literature and surely varies over the WSA. The atmospheric deposition was assumed to be the same for all lands. Because these uncertainties have not been quantified, it is not know how much uncertainty is associated with any of these estimates.

The nitrogen effluent concentrations were available for only a portion of the centralized wastewater facilities. The permitted, and not the actual, discharge rates from the wastewater facilities were used in the computations for any facility for which permit records were not available. Ten percent of the nitrogen discharged by the boundary facility with the largest discharge (302.7 MT/year) and all of the discharge from the other boundary facility were included in the computations; these are the best available estimates and are not exact.

The limitations of the septic system parameters are discussed by Dr. Richard Otis in his final report for Task 2. In addition, error is undoubtedly present in the location of at least some of the septic systems. For each septic system, the soil series associated with the corresponding map unit in the soils maps was assigned to the system, and any error in this assignment would affect the estimates of nitrogen inputs. The proportion of inputs contributing to the loadings to the waters of the WSA is not the same for all sources. Although loading from septic systems was estimated here, their relative contribution to the loadings is likely different from their relative contributions to the inputs.

Conclusions

Fertilizer is the major source of nitrate inputs to the WSA, accounting for 71 percent of all inputs. Among the sources of fertilizer, residential use is the primary factor (40 percent) followed closely be agricultural use (33 percent).

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Appendix A

Information from Dr. Richard Otis

ESTIMATED DENITRIFICATION POTENTIAL OF SOILS IN THE WEKIVA STUDY AREA

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Execessively / Somewhat Excessively	2	1	**LAKE FINE SAND** Hyperthermic, coated Typic Quartzipsamments	Excessively drained, rapidly to very rapidly permeable soils formed in thick beds of sand. Water table is >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	1	**PAOLA FINE SAND** Hyperthermic, uncoated Spodic Quartzipsamments	Very deep, excessively drained, very rapidly permeable upland soils that formed in sandy marine deposits. Water table is >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	1	**ST. LUCIE SAND** Hyperthermic, uncoated Typic Quartzipsamments	Very deep, excessively darined, very rapidly permeable soils formed in marine eolian sand. Water table >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	2	**ASTATULA FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	Very deep, excessively drained, rapidly permeable soils formed in eolian and marine sands. Water table >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	2	**CANDLER SAND** Hyperthermic, uncoated Lamellic Quartzipsamments	Very deep, excessively drained, rapidly permeable soils that formed in thick beds of eolian or marine deposits of coarse textured materials. Short, thin loamy lamella exist below 70". Water table >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
Well	2	1	**APOPKA SAND** Loamy, siliceous, hyperthermic Grossarenic Paleudults	Very deep, well drained, moderately permeable soils that formed in thick beds of sandy and loamy marine or eolian deposits. Water table >60" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	2	**ORLANDO FINE SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	Very deep, well drained, rapidly permeable soils that formed in thick deposits of sandy marine or fluvial sediments. Water table >72".	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Moderately Well	2	1	**ARCHBOLD SAND** Hyperthermic, uncoated Typic Quartzipsamments	Deep, well drained, very rapidly permeable sandy soils that formed in marine or eolian deposits. Seasonally high water table (June-November) at 42-60" but 60-80" the remainder of the year.	Moderate: wetness	TKN/NO_3	5-15%	Very low organic content Low moisture content (aerobic)	
	2	1	**ORSINO FINE SAND** Hyperthermic, uncoated Spodic Quartzipsamments	Very deep, moderately well drained, very rapidly permeable soils that formed in thick beds of sandy marine or eolian deposits. Water table at 50-60" deep. Spodic horizon at 25".	Severe: wetness	TKN/NO_3	5-15%	Very low organic content Low moisture content (aerobic)	
	2	2	**FLORAHOME SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	Deep, moderately well drained, dark sufaced, rapidly permeable soils that formed in sandy marine and eolian deposits. Water table depth at 48-72" for 4-6 months each year receeding to >72 in dry periods.	Moderate: wetness	TKN/NO_3	10-20%	Low organic content Low moisture content (aerobic) Fluctuating water table	
	2	2	**MILLHOPPER SAND** Loamy, siliceous, semiactive, hyperthermic Grossarenic Paleudults	Very deep, moderately well drained, moderately permeable soils that formed in thick beds of sandy and loamy marine sediments. Water table depth is 48-60" for 1-4 months and 60-72" for 2-4 months most years.	Moderate: wetness	TKN/NO_3	10-20%	Low organic content Low moisture content (aerobic) Fluctuating water table	
	2	2	**TAVARES FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	Very deep, moderately well drained, rapidly permeable soils that formed in sand marine or eolian deposits. Zones of saturation at depths of 40-80".	Moderate: wetness	TKN/NO_3	5-15%	Low organic content Low moisture content (aerobic)	
Somewhat Poorly / Poorly /Very Poorly	1	1	**ADAMSVILLE FINE SAND** Hyperthermic, uncoated Aquic Quartzipsamments	Very deep, somewhat poorly drained, rapidly permeable soils that formed in thick sandy marine sediments. Water table is at 20-40" for 2-6 months of most years and 10-20" for up two weeks in some years. It is within 60" for more than 9 months in most years.	Severe: wetness poor filter	TKN	5-15%	Very low organic content below 4" Rapid permeability Fluctuating water table with aquic regime (anoxic)	
						NO3	15-30%		
	1	1	**CASSIA FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	Very deep, somewhat poorly drained, moderately rapid permeable soils formed in sandy materials. Water table is at 18-42" for about 6 months during most years and will drop to >42" during the driest season.	Severe: wetness	TKN	10-20%	Fine sand with shallow water table High organic content in spodic horizon at 2-3 ft. Fluctuating water table	
						NO3	5-25%		
	1	1	**POMELLO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	Very deep, moderately well to somewhat poorly drained soils, which are sandy to depths of >80" that formed in sandy marine sediments. Seasonally high water table is at depths of about 24-42" for 1-4 months during most years.	Severe: ponding poor filter	TKN	10-40%	Freely draining Shallow, fluctuating water table at 2-3 ft Spodic horizon high in organic content at 3.5 ft	
						NO3	10-50%		

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	1	**ZOLFO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	Very deep, somewhat poorly drained soils that forme in thick beds of sandy marine deposits. Water table is at depths of 24-40" for 2-6 months of the year and up to 1024" deep for short periods. It is within 60" for more than 9 months most years.	Severe: wetness poor filter	TKN	5-25%	Fine sand with shallow water table (2-3.5ft) Spodic horizon at 5-8 ft Fluctuating water table	
						NO3	15-35%		
	1	2	**ANCLOTE SAND** Sandy, siliceous, hyperthermic Typic Endoaquolls	Very deep, very poorly drained, rapidly permeable fine sandy soils in depressions, drainage way and floodplains. Water table is within 10" of the surface for 6 or more months during most years and rededes to >20" during the driest season.	Severe: ponding wetness poor filter	TKN	5-20%	Very shallow water table (<1ft) High organic content in surface horizon	
						NO3	>75%		
	1	2	**BASINGER FINE SAND** Siliceous, hyperthermic Spodic Psammaquents	Very deep, poorly drained and very poorly drained, rapidly permeable soils fromed in sandy marine sediments. Found in sloughs, depressions, and low flats. Water table at depths of <12" 2-6 months annually and 12-30" for periods >6 months. Surface ponding is common.	Severe: wetness ponding poor filter	TKN	5-20%	Very shallow fluctuating water table Very high organic content	
						NO3	>75%		
	1	2	**BRIGHTON MUCK** Dysic, hyperthermic Typic Haplohemists	Very deep, very poorly drained, moderately rapid to rapidly permeable organic soils in depressions, freshwater marshes and swamps. Organic layer is >54" thick. Water table is above ground surface for 4-6 months.	Severe: subsides flooding wetness	TKN	20-40%	Deep organic surface horizon Very shallow, fluctuating water table	
						NO3	>90%		
	1	2	**CANOVA MUCK** Fine-loamy, siliceous, superactive, hyperthermic Histic Glossaqualfs	Very deep, very poorly drained, moderately slowly permeable fine sandy and loamy soils in depressions and fresh water swamps and marshes. They are formed in loamy marine sediments. Water table is at the surface or within 10" of the surface for more than 9 month during most years. The soil may be flooded for 36 months.	Severe: ponding	TKN	20-40%	Very shallow water table (<1ft) High organic content in surface horizon and the Btg horizon at 32-43"	
						NO3	>90%		
	1	2	**CHOBEE FINE SANDY LOAM** Fine-loamy, siliceaous, superactive, hyperthermic Typic Argiaquolls	Very deep, very poorly drained, slowly to vry slowly permeable soils in depressions, flats, and river flood plains that formed in thick beds of loamy marine sediments. Water table within 6" for 1-4 months of the year.	Severe: flooding wetness percs slowly	TKN	10-30%	Very shallow water table High organic content in the surface horizon	
						NO3	>90%		
	1	2	**EAUGALLIE FINE SAND** Sandy, siliceous, hyperthermic Alfic Alaquods	Deep or very deep, poorl or very poorly drained, slowly permeable soils in flats, sloughs, and depressionsthat were formed in sandy and loamy marine sediments. The water table rises to within 6-18"of the surface for periods of 1-4 months annually and within 40" for more than 6 months.	Severe: wetness	TKN	20-40%	Shallow, fluctuating water table Moderately high organic content near surface in within a spodic horizon at depths >22"	
						NO3	>90%		
	1	2	**EMERALDA FINE SAND** Fine, mixed, superactive, hyperthermic Mollic Albaqualfs	Very deep, poorly drained, slowly or very slowly permeable fine sand to sandy clay soils in low areas near lakes and streams that were formed in clayey marine sediments. The water table is at depths of <10" for 6-9 months and saturated most of the year	Severe: flooding wetness percs slowly	TKN	10-30%	Very shallow water table High organic content in the surface horizon	
						NO3	>90%		

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	2	**FELDA FINE SAND** Loamy, siliceous, superactive, hyperthermic Arenic Endoaqualfs	Very deep, poorly drained and very poorly drained, moderately permeable fine sandy soils in drainageways and depressions that formed in stratefied, unconsolidated marine sands and clays. The water table is within 12" of the surface for 2-6 months each year.	Severe: ponding wetness poor filter	TKN	10-30%	Very shallow water table Moderate to high organic content in the surface horizon	
						NO3	40-60%		
	1	2	**GATOR MUCK** Loamy, siliceous, euic, hyperthermic Terric Haplosaprists	Very poolry drained organic soils that formed in moderately thick beds of hydrophytic plant remains overlying beds of loamy and sandy marine sediments. These soils are always saturated at or above the surface except during extended droughts.	Severe: ponding percs slowly poor filter	TKN	10-30%	Very shallow water table Low organic content below 34"	
						NO3	>90%		
	1	2	**IMMOKALEE FINE SAND** Sandy, siliceous, hyperthermic Arenic Alaquods	Deep and very deep, poorly drained and very poorly drained soils that formed in sandy marine sediments that occur in flantwoods and depressions. The water table is at depths of 6-18" for 1-4 months, 18-36" for 2-10 months and below 60" during dry periods.	Severe: wetness	TKN	20-40%	Shallow, fluctuating water table Moderately high organic content near surface	
						NO3	>90%		
	1	2	**MALABAR FINE SAND** Loamy, siliceous, active, hyperthermic Grossarenic Endoaqualfs	Very deep, poorly to very poorly drained soils in sloughs, shallow depressions and along flood plains in sandy and loamy marine sediments. The water table is within depths of 10" for 2-6 months during most years.	Severe: wetness poor filter	TKN	10-30%	Very shallow water table Low organic content	
						NO3	40-60%		
	1	2	**MYAKKA FINE SAND** Sandy, siliceous, hyperthermic Aeric Alaquods	Deep and very deep, poorly to very poorly drained soils formed in sandy marine deposit, which occur on flatwoods, flood plains, and depressions. The water table is at depths <18" for 1-4 month duration in most years and recedes to depths >40" during very dry seasons.	Severe: ponding wetness poor filter	TKN	40-60%	Shallow, fluctuating water table Moderate organic content	
						NO3	>90%		
	1	2	**NITTAW SANDY CLAY** Fine, smectitic, hyperthermic Typic Argiaquolls	Very poorly drained, slowly pwermeable soils that formed in thick deposits of clayey sediments of marine origin, which occur in drainageways, swamps and marshes. They are subjext to standing water above the soil surface for >6 months during late spring, summer and fall.	Severe: ponding percs slowly	TKN	10-30%	Very shallow water table High organic content in O and A horizons but diminishing quickly with depth Soil permeability slow in the sandy clay below A horizon	
						NO3	>90%		
	1	2	**OCOEE MUCK** Sandy or sandy skeletal, siliceous, dysic, hyperthermic Terric Haplohemists	Deep, very poorly drained soils that fromed in herbaceous organic material and sandy minera material, which occur on flood plains, fresh water marshes, and depressions.	Severe: subsides flooding wetness	TKN	5-20%	Very wet Deep O horizon from 0-38"	
						NO3	>90%		
	1	2	**OKEELANTA MUCK** Sandy or sandy skeletal, siliceous, euic, hyperthermic Terric Haplosaprists	Very deep, very poorly drained, rapidly permeable soils in large fresh water marshes and small depressional areas, which formed in decomposed hydrophytic non-woody organic material overlying sand. The water table is at depths of <10" below surface or ponded above surface.	Severe: flooding poor filter wetness	TKN	5-20%	Very wet Deep O horizon from 0-31"	
						NO3	>90%		

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	2	**ONA FINE SAND** Sandy, siliceous, hyperthermic Typic Alaquods	Poorly drained, moderately permeable soils that formed in thick sand marine sediments, which occur in flatwood areas. The water table is at depths of 10-40" for periods of 4-6 months. It rises to depths of <10" for periods of 12 months and may recede to >40" during very dry seasons.	Severe: wetness poor filter	TKN	10-30%	Shallow, fluctuating water table Moderate organic content above 20"	
						NO3	>90%		
	1	2	**PLACID FINE SAND** Sandy, siliceious, hyperthermic Typic Humaquepts	Very deep, very poorly drained, rapidly permeable soils on low flats, depressions, drainageways, and flood plains. The soils formed in sandy marine sediments. The water table ranges in depths from 0-6" for >2 months in most years.	Severe: ponding wetness poor filter	TKN	5-15%	Very shallow water table Moderatly high organic content above 18"	
						NO3	>90%		
	1	2	**POMPANO FINE SAND** Siliceous, hyperthermic Typic Psammaquents	Very deep, very poorlly drained, rapidly permieable soils occuring in depressions, drainageways and broad flats. The soils were formed in thick beds of marine sands. The water table is at depthso f >10" for 2-6 months each year and within depths of 30" for mor than 9 months.	Severe: ponding poor filter	TKN	5-15%	Very shallow, fluctuating water table Low organic content	
						NO3	40-60%		
	1	2	**SAMSULA MUCK** Sandy or sandy skeletal, siliceous, dysic, hperthermic Terric Haplosaprists	Very deep, very poorly drained, rapidly permeable soils that formed in moderately thick beds of hydrophytic plant remains underlain by sandy marine sediments. They occur in swamps and flood plains. The water table is at or above the surface except during extended dry periods.	Severe: ponding poor filter	TKN	5-15%	Very shallow water table Sapric soil materials from surface to 36"	
						NO3	>90%		
	1	2	**SANIBEL FINE SAND** Sandy, siliceous, hperthermic Histic Humaquepts	Very poorly drained sandy soils with organic surfaces, that formed in rapidly permeable marine sediments, which occur on nearly level and depressional areas. The water table is <10" deep for 6-12 months and is above ground surface 2-6 months during wet seasons.	Severe: ponding poor filter	TKN	5-15%	Very shallow water table High organic content in the O and A horizons to a depth of 10"	
						NO3	>90%		
	1	2	**SEFFNER FINE SAND** Sandy, siliceous, hyperthermic Aquic Humic Dystrudepts	Very deep, somewhat poorly drained, rapidly permeable soils on rims of depressions and on lower lying flats, which formed in sandy marine sediments. The water table is within depths of 18-42" for 2-4 months and within 60" for >9 months in most years.	Severe: wetness poor filter	TKN	5-15%	Very shallow water table Moderate organic content to 20"	
						NO3	>90%		
	1	2	**SMYRNA SAND** Sandy, siliceous, hyperthermic Aeric Alaquods	Very deep, poorly to very poorly drained soils fomremed in thick depsolits of sandy marine materials. The water table is at depths of >18" for 1-4 months and 1240" for more than 6 months	Severe: ponding poor filter	TKN	20-40%	Shallow, fluctuating water table Moderate organic content to 35"	
						NO3	>90%		
	1	2	**SPARR FINE SAND** Loamy, siliceous, subactive, hyperthermic Grossarenic Paleudults	Very deep, somewhat poorly drained, moderate slowly to slowly permeable fine sandy soils on uplands. They formed in thick beds of sand and loamy marine sediments. The water table is at depths of 20-40" for 1-4 months. The water table is usually perch on the loamy layers.	Severe: ponding poor filter	TKN	20-40%	Moderately shallow water table Low to moderate organic content	
						NO3	>90%		

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	2	**ST. JOHNS FINE SAND** Sandy, siliceous, hyperhtermic TypicAlaquods	Very deep, very poorly or poorly drained, moderately permeable soils on broad flats and depressional areas. These soils formed in sandy marine sediments. The water table is 0-15" below surface for 20-50% of the year but is at 15-30" during periods of low rainfall.	Severe: wetness	TKN	20-40%	Shallow, fluctuating water table Spodic horizon with moderate organic content at 22-66"	
						NO3	>90%		
	1	2	**WABASSO FINE SAND** Sandy over loamy, siliceous, active, hyperthermic Alfic Alaquods	Deep or very deep, very poorly and poorly drained, very slowly and slowly permeable soils on flatwoods, flood plains, and depressions. They formed in sandy and loam marine sediments. The water table is at depths of 12-40" for more than 6 month and >40" during very dry seasons.	Severe: wetness poor filter	TKN	20-40%	Moderately shallow, fluctuating water table Low to moderate organic content	
						NO3	>90%		
	1	2	**WAUBERG FINE SAND** Loamy, siliceous, active, hyperthermic Arenic Albaqualfs	Poorly drained, very slowly permeable sandy soils that formed in thick beds of loamy marine sediments within large prairie areas and low areas within flatwoods. The water table is at depths of <10" for 3-5 months during most years.	Severe: wetness percs slowly	TKN	5-15%	Very shallow water table Sandy clay loam restrictive horizon at 24" Low to moderate organic content to 24"	
						NO3	40-60%		
	1	2	**WAUCHULA FINE SAND** Sandy over loamy, siliceous, active hyperthermic Ultic Alaquods	Very deep, very poorly or poorly drained, moderately slow or slowly permeable soils formed in sandy and loamy marine sediments. The water table is at depths of 6-18" for 1-4 month and 10-40" for as long as 6 months but receding to depths of 40" during the driest season.	Severe: wetness poor filter	TKN	5-15%	Shallow, fluctuating water table Low organic content	
						NO3	40-60%		
	2	2	**LOCHLOOSA FINE SAND** Loamy, siliceous, semiactive, hyperthermic Aquic Arenic Paleudults	Somewhat poorly drained, slowly permeable soils formed in thick beds fo sandy and loamy marine sediments. The water table is at depths of 30-60" for 1-4 months and recedes to >60" during the drier seasons.	Severe: wetness	TKN	20-40%	Moderatly deep, fluctuating water table Low to moderate organic content	
						NO3	40-60%		