

# Land Development, Water and Accounting for Greenhouse Gas Emissions in Florida

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**Calculations and References:** GHG emission estimates for lawn maintenance were calculated conservatively (see below for factors not included in the evaluation). These calculations represent a working draft that is still being refined. The estimates presented are based on the following assumptions and calculations:

Activity	Assumptions	Calculations	References
Irrigation	Follow UF/IFAS recommendations to water as-needed. Turfgrass irrigation requirement estimates based on historical precipitation, effective rainfall, low water-holding capacity of Florida's soils, 80% replacement, 60% irrigation system efficiency. 2008 Tampa Bay Water data on production of surface water, groundwater and desalinated water.	38.69 inches/yr irrigation required x 1000 sq.ft. x 0.6234= 24,114 gallons/1000 sq.ft./yr. Using eGRID, Foerste et al 2010 calculated water production emissions (lbs. CO <sub>2</sub> /million gallons produced): groundwater – 1416; surface water – 1972; desal – 24,007; mixed – 4,982 For TBW 2008 mix, 0.00498 lbs.CO <sub>2</sub> /gal x 24,114 gal/1000 ft <sup>2</sup> /yr = 120.13 lbs.CO <sub>2</sub> /1000 ft <sup>2</sup> /yr	Trenholm and Unruh 2008  Dukes et al 2009  Dukes 2008  Foerste et al 2010  U.S. EPA. 2009
Mowing	Follow UF/IFAS recommendations for average of 35 mowings per year. Use of new gasoline powered mower. Fuel use of 1.0 gal/acre for walk behind mowers and 0.75 gal/acre for riding mower, with 80% of mowing using walk behind mower (OPEI estimates).	CO <sub>2</sub> emissions/gallon of gasoline = 2,421 grams x 0.99 x (44/12) = 8,788 grams = 8.8 kg/gallon = 19.4 lbs. CO <sub>2</sub> /gallon = 0.00889 MT CO <sub>2</sub> /gallon / 43560 ft <sup>2</sup> /acre x 1000 = 0.000204 MT CO <sub>2</sub> /1000 ft <sup>2</sup> (80% x 0.000204 MT CO <sub>2</sub> e/1000 ft <sup>2</sup> ) + (20% x .000153 MT CO <sub>2</sub> e/1000 ft <sup>2</sup> )= 0.000194 MT CO <sub>2</sub> e/1000 ft <sup>2</sup> x 35 = 0.000679 MT CO <sub>2</sub> e/1000 ft <sup>2</sup> /yr x 0.00045359237 = 14.96 lbs.CO <sub>2</sub> e/1000 ft <sup>2</sup> /yr	Trenholm et al 2009  Busey and Evert 1979  Sahu N.D.  U.S. EPA. 2005
Fertilizers	Follow UF/IFAS recommended annual nitrogen fertilization rates, based on average recommendations for homeowners and for landscape maintenance professionals across the 3 FL regions for 4 turfgrasses recommended for home lawns in FL (bahagrass, centipedegrass, St. Augustinegrass and zoysiagrass). No phosphorus fertilizer. Potassium applied at same rate as nitrogen. 1.25% of applied N emitted as NO <sub>2</sub> .	Average recommended application rate of 3.33 lbs. N/1000 ft <sup>2</sup> /yr. Average carbon emissions from fertilizers from literature = 1.3 for N, 0.15 for K. 3.33 lbs. N/1000 ft <sup>2</sup> /yr x 0.4535 kg/lb. = 1.512 kg N applied/1000 ft <sup>2</sup> /yr x 1.3 kg CE/kg N applied = 1.97 kg CE/1000 ft <sup>2</sup> /yr.= 0.0065376 MT CO <sub>2</sub> /1000 ft <sup>2</sup> /yr. from N fertilizer production, transportation, storage and transfer. 1.512 kg N/1000 ft <sup>2</sup> /yr x 1.25% = 0.0189 kg NO <sub>2</sub> /1000 ft <sup>2</sup> /yr. = 0.00586 MT CO <sub>2</sub> e/1000sq.ft additional emissions from N fertilizer For potassium, 3.33 lbs. K/1000 ft <sup>2</sup> /yr x 0.4535 kg/lb. = 1.512 kg K applied/1000 ft <sup>2</sup> /yr x 0.15 kg CE/kg N applied = 0.2268 kg CE/1000 ft <sup>2</sup> /yr.= 0.00075 MT CO <sub>2</sub> /1000 ft <sup>2</sup> /yr.	Trenholm and Unruh 2009  Florida Dept.of Environmental Protection 2008  Lal 2005
Pesticides	Total annual home and garden pesticide usage for the U.S. - 96 million lbs. a.i./yr. Estimated total area of lawns in U.S. - 163,812 km <sup>2</sup> Equivalent C emissions for pesticides from average of literature values (Lal 2005).	96 million lbs.ai/yr / 163,812 km <sup>2</sup> = 586 lbs. a.i./km <sup>2</sup> X 9.290304 x 10 <sup>-5</sup> km <sup>2</sup> / ft <sup>2</sup> = 0.0544 lbs. a.i/1000 ft <sup>2</sup> /yr / 2.2046 kg/lb.= 0.0247 kg ai/1000 ft <sup>2</sup> /yr. X 5.00294 kg CE/kg a.i. = 0.12355 kg CE/1000 ft <sup>2</sup> /yr X 2.2046 kg/lb. = 0.2724 lbs. CE/ 1000 ft <sup>2</sup> /yr. X 44/12 = 0.9987 lbs. CO <sub>2</sub> e/ 1000 ft <sup>2</sup> /yr	Fishel 2007  Milesi et al 2005  Lal 2005

**Contributions to GHG emissions not included:** This estimate takes a conservative approach since it does not include all of the activities that contribute to carbon emissions from landscapes and their maintenance. Some of the GHG emissions that the analysis does not take into account include those resulting from:

- Pumping water from the utility to the irrigated area
- Producing, transporting and installing sod or other landscape plants.
- Using other gasoline-powered landscape equipment like weed wackers or leaf blowers (only lawn mowing was included).
- Using older mowers (fuel estimates are from manufacturers and therefore represent new engines, while many older model equipment produced before current air quality standards is still in use).
- Transporting landscape maintenance crews to work sites.
- Cleaning up impaired waters that have received nutrient and pesticide loads from runoff / leaching.

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