metroplan orlando

A REGIONAL TRANSPORTATION PARTNERSHIP

2008 Emissions Inventory for Orange, Seminole, and Osceola Counties

A Final Report (Corrected)

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Table of Contents

List of Figures and Tables

Executive Summary

An emissions inventory for the year 2008 has been completed for the Orlando Urban Area (OUA), composed of Orange, Seminole, and Osceola (OSO) Counties. The inventory focused on VOC and NO_x emissions, both of which are precursors to ozone, but also included CO_2 emissions. The inventory was developed using methods, data, and models endorsed by the U.S. Environmental Protection Agency. In agreement with the previous inventory (2002), the current results show the importance of on-road and non-road mobile sources for VOCs and NO_x, along with the significant contributions of area sources to total regional VOC emissions as well as the significant contributions of point sources to total NO_x emissions. In spite of overall population growth since the previous inventory, emissions of VOCs and NO_x declined during the past 6 years, especially from mobile sources. This decrease was due mostly to the improvements on both on-road and non-road vehicles that resulted from federally-mandated steps by manufacturers to reduce pollution from new vehicles and engines.

The overall picture of emissions in OSO is given in Table EX-1, and the percentages of VOCs and NO_x from each major source group are shown in Figure EX-1 and Figure EX-2. As can be seen from Table EX-1, total VOC emissions in the OSO region are about 71,000 tons/year, and NO_x emissions are about 59,000 tons/year. Of these totals, on-road vehicles (cars, SUVs, trucks, buses, etc.) emit about 33% of the VOCs and 64% of the NO_x. Non-road sources (construction equipment, lawn and garden equipment, boats, etc.) emit about 21% of the region's VOCs, and about 17% of its NO_x. Area sources (chemicals and paints, gasoline stations, printing and coating operations, open burning, etc.) emit a large portion of the VOCs – about 43%, while point sources (mostly power plants) emit about 19% of the NO_x.

Table EX-1 – Total OSO emissions by source category

Source	VOC, tons/yr	NO_x, tons/yr	CO_2, tons/yr
On-road	23,582	37,726	12,608,634
Non-road	15,190	10,172	1,348,158
Point	1,901	10,987	8,627,199
Area	30,648	158	147,158
TOTALS	**71,321**	**59,043**	**22,731,149**

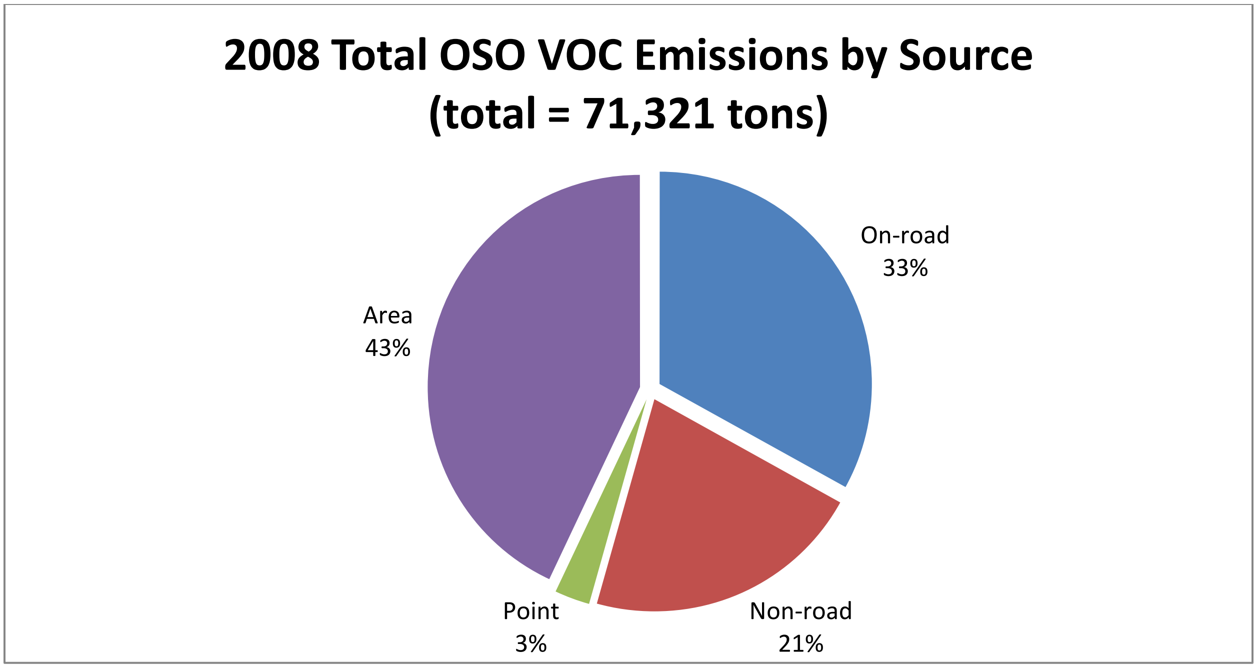

Figure EX-1 – Total VOC emissions for OSO by source category

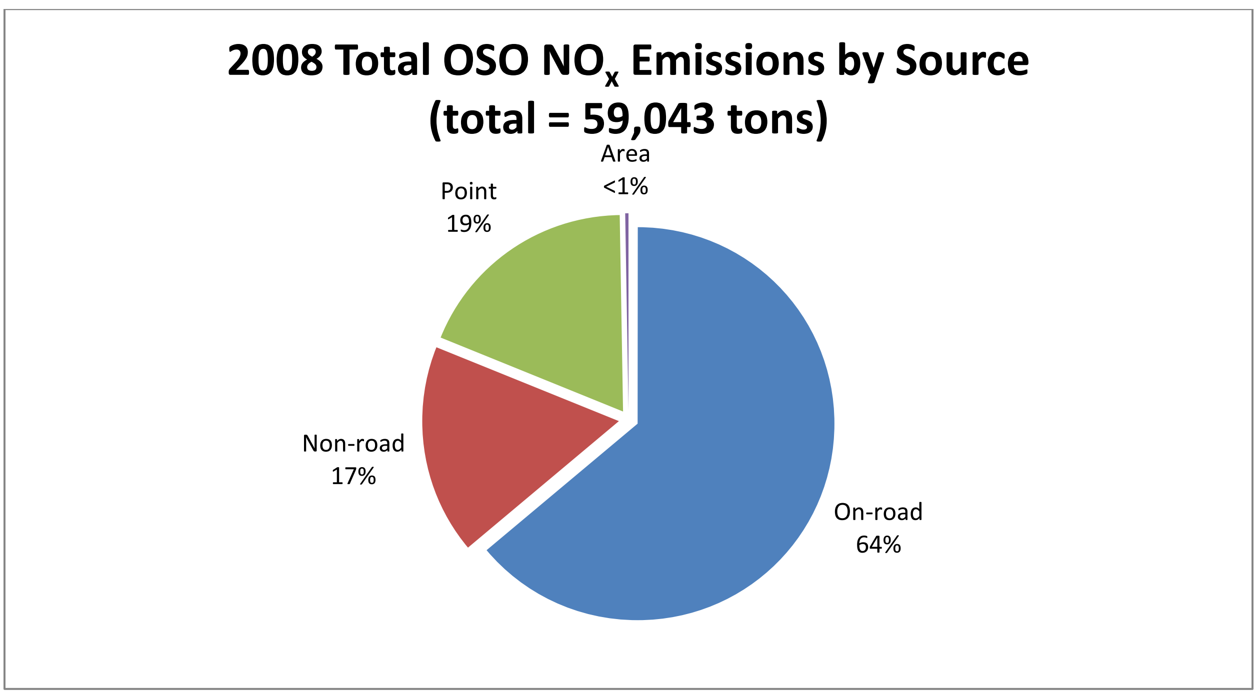

Figure EX-2 – Total NO_x emissions for OSO by source category

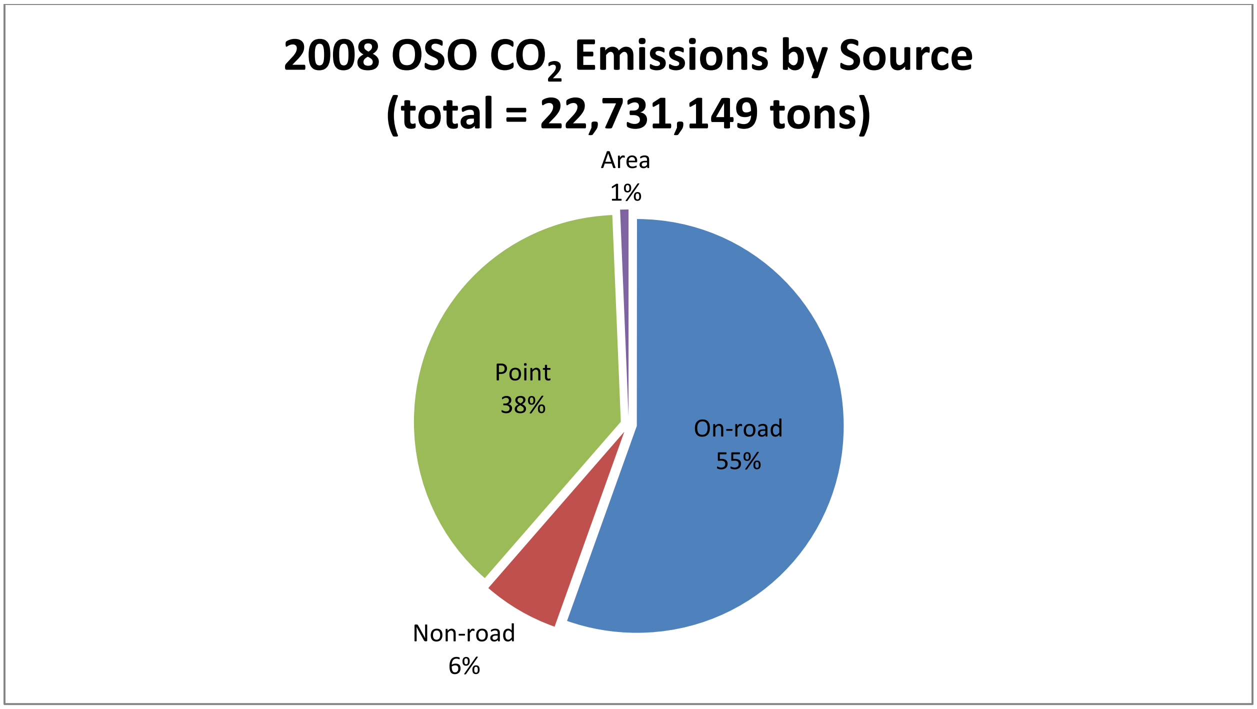

Figure EX-3 – Total CO_2 emissions for OSO by source category

In addition to VOCs and NO_x emissions, we also estimated CO_2 emissions as part of this project. That additional information (although not part of the original contracted work) was included because of the current interest in global climate change emissions throughout the region, the state and the nation. Total emissions of CO_2 in the region were estimated to be about 23 million tons per year, of which about 62% came from the mobile sources (mostly on-road) and about 38% from point sources.

Introduction

This report contains an emissions inventory for the Orange, Seminole, and Osceola (OSO) tri-county area, also called the Orlando Urban Area (OUA). Volatile organic compounds (VOC), nitrogen oxide (NO_x), and carbon dioxide (CO_2) pollutant emissions were tallied for the 2008 calendar year. An emission inventory is an important tool in managing air quality for any region because it gives managers and decision makers a good tool for focusing their efforts to reduce emissions of particular types (U.S. Environmental Protection Agency, 2004).

VOCs and NO_x are known as “ozone precursors” and in the presence of sunlight can react in the atmosphere to form ground-level ozone (O_3). VOCs are emitted as gases from solvents or fuels, have high vapor pressures, and low water solubility. They can exist in many forms, ranging from simple hydrocarbons such as butane or benzene, to oxygenates like formaldehyde or methyl ethyl ketone, to chlorinated solvents such as trichloroethylene. NO_x is emitted from sources where high temperature combustion occurs, including diesel engines in motor vehicles, large steam-electric power generation boilers, and industrial furnaces (U.S. Environmental Protection Agency, 1998). NO_x contributes to acid rain formation and react with VOCs to create ground-level ozone. Ground-level ozone is a criteria pollutant that can cause serious health problems. In addition to VOCs and NO_x emissions, we also estimated CO_2 emissions as part of this project. That additional information (although not part of the original contracted work) was included because of the current interest in global climate change emissions throughout the region, the state and the nation.

In this inventory, emissions are categorized into four main source types: on-road mobile, non-road mobile, point, and area. On-road mobile sources include vehicles such as cars, SUVs, trucks, buses, motorcycles, etc. Non-road mobile sources include lawn equipment, pleasure craft (e.g., boats and jet skis), construction and mining equipment, and others. The area source category is comprised of numerous small emission sources that do not individually emit enough to be considered point sources, but, as a group, are large contributors. Area sources consist of restaurants, dry cleaning facilities, printers, painting operations, wildfires, architectural coating, pesticides, auto body refinishing, gasoline stations, and others. Point sources are large facilities or industrial sites that require air permits for their emissions and must submit an annual report. The United States Environmental Protection Agency (EPA) set minimum emission requirements for point sources at 25 tons of VOCs and 10 tons of NO_x annually (Florida Department of Environmental Protection, January 2010). Point sources may include power plants, airports, boat manufacturers, hospitals, food production facilities, concrete plants, and large printing firms, among others.

Computer models developed by the EPA and Federal Aviation Authority (FAA) were used to estimate mobile (both on-road and non-road), and airport emissions, respectively. EPA guidelines and journal articles were reviewed and followed to prepare the emissions inventory and provide accurate results. Florida DEP permits were reviewed to obtain estimates of point source emissions in the OUA. For area source emissions, we obtained data from the 2008 National Emission Inventory (“2008 National emissions inventory data & documentation,” 2010).

The last inventory for Metroplan Orlando was prepared in 2002 (Arbrandt, 2003). In the six years between inventories, there have been significant changes in population, on-road and non-road vehicles (and their emission characteristics), construction and development activity in the region, and the opening and closing of manufacturing facilities. Current data were gathered, and newer EPA models were used (compared with 2002) to produce the 2008 Emission Inventory. In general, there was good agreement with the previous inventory; the details of the differences and similarities of this work with the previous emission inventory can be seen in the results presented herein.

Literature Review

The US EPA performs a national emissions inventory every three years. It is a comprehensive list that includes VOCs and NO_x, as well as other compounds such as ammonia, methane, sulfur oxides, and more. It is important to quantify these emissions in order to manage emissions to better protect the nation's air quality, and to assess the need for new regulations to preserve and/or improve air quality.

Emissions can be estimated in two ways. One way is by using computer models and inputting the required data so that the model can use standard algorithms to calculate emissions for the specific scenarios. The second way is by making use of emission factors and multiplying each factor by its appropriate unit of measure. For example, if the factor is given as pounds per capita, it will be multiplied by a county-wide population to give total emissions for that particular county.

The methods for the estimation of VOC, NO_x, and CO_2 emissions have been discussed in many articles in professional journals. Some of these articles used the same estimation methods that we used, and thus validate the methods used to produce this emissions inventory. The following review provides detailed support for the methods used to quantify the emissions reported for OSO in 2008.

A. Athens airport emissions using EDMS (Theophanides et al, 2009)
   Theophanides and Anastassopoulou (2009) examined airport emissions from the Athens International Airport (AIA). They used the program that the Environmental Protection Agency (EPA) requires for modeling emissions from airports – the Emissions and Dispersion Modeling System (EDMS) developed by Federal Aviation Authority (FAA). The program incorporates the EPA's NONROAD and MOBILE6 models for contributions from ground support equipment (GSE), buses, and cars. Those authors assumed a reduced number of taxipaths and gates that represented the majority of traffic flow. They found that 75 tonnes VOCs (a tonne is a metric ton or 1000 kg) and approximately 360 tonnes NO_x per year per 100,000 aircraft movements came from the airport activity. The NO_x results produced from EDMS were within 10% of the values published by AIA (~390 tonnes NO_x per year per 100,000 aircraft movements). These results correlated to those from other studies. There was less information on airport VOC emissions against which to compare the AIA results, so Dulles International Airport was used as a reference by Theophanides and Anastassopoulou.

B. Non-road Equipment Emissions in California (Strum et al, 2007)
   The inventory performed in 2002 for California non-road equipment compared temporal aspects in generating emissions data using two programs – the National Mobile

Inventory Model (NMIM) and NONROAD model. The EPA used the NMIM to generate an inventory for each state besides California. Instead, California submitted its own results. The NMIM accounts for variation in temperature, activity, and fuels. It also takes into account the engine mode when generating emissions data. For the California inventory, the largest source of VOCs was pleasure craft with 2-stroke engines. The second largest contributor was lawn and garden equipment (both 2- and 4-stroke engines). NO_x emissions were highest from construction and mining equipment. The results from the California inventory can be seen in Table 1. Our results in the 2008 OSO inventory demonstrate very similar patterns as those found by Strum et al (2007).

Table 1 – VOC and NOx emissions based on the NONROAD program for California 2002 (Strum et al, 2007)

SCC	Description	Calif . state total VOC from 2002 NEI, V3 (tons)
2282005000	Pleasure Craft;Gasoline 2-Stroke;Total	37,256
2260004000	Off-highway Vehicle Gasoline, 2-Stroke;Lawn and Garden Equipment;All	29,234
2265004000	Off-highway Vehicle Gasoline, 4-Stroke;Lawn and Garden Equipment;All	19,146
2265001020	Off-highway Vehicle Gasoline, 4-Stroke;Recreational Equipment;Snowmobiles	15,186
2270002000	Off-highway Vehicle Diesel;Construction and Mining Equipment;Total	12,089
2282010000	Pleasure Craft; Gasoline 4-Stroke;Total	6,838
SCC	**Description**	**Calif state total NOX from 2002 NEI, V3 tons)**
2270002000	Off-highway Vehicle Diesel;Construction and Mining Equipment;Total	117,031
2270005000	Off-highway Vehicle Diesel;Agricultural Equipment;Total	48,885

C. Denver on-road emissions inventory (Pokharel et al, 2002)

A dual method on-road emissions inventory was conducted for the Denver metropolitan area using fuel-based estimation and modeling using MOBILE6. The fuel-based method used fuel use data from tax records to develop emission factors. MOBILE6 produces emission factors based on vehicle miles traveled (VMT). VMT are estimated using a model based on the registered vehicle fleet. Figure 1 shows the comparison of VMT fraction to vehicle fleet age based on remote sensing data (RSD) that were used in the fuel-based approach and MOBILE6 defaults. These values were highly correlated.

MOBILE6 produced values that were 30-70% higher for CO, 40% lower for THC, and 40-80% higher for NO_x than the fuel-based approach. One of the reasons MOBILE6 produced a lower estimate for total hydrocarbons (THC) could be that it only modeled running exhaust emissions in order to be able to compare the results to the fuel-based results. In the Denver study, the model showed that 32% of THC emissions were from start emissions and 44% are from evaporative emissions. CO start emissions contributed 50% to the total and NO_x start emissions contributed 27%. Regarding mobile source emissions, VOCs are similar in magnitude to THCs, so the general trends from THC estimates can be applied to VOCs. The higher CO and NO_x estimates could indicate the worst case scenario. Under a certain set of assumptions, that is the highest that emissions are predicted to be, so that could be better for policy formation.

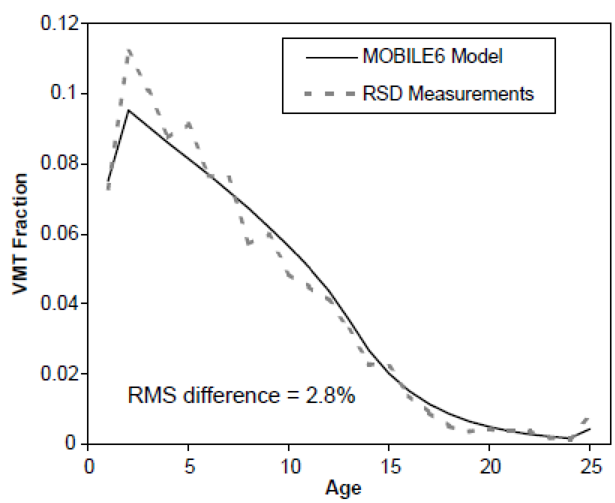

Figure 1 – Correlation of RSD measurements to MOBILE6 default values for the Denver metropolitan area (Pokharel et al, 2002)

Description of Inventory Source Types

On-road mobile sources

As the name suggests, on-road mobile sources are comprised of those vehicles which are operated on roadways. These vehicles include cars and light trucks, SUVs, heavy trucks, buses, and motorcycles, and contribute a very large portion of the area's VOC and NO_x emissions. For the past 10 years, MOBILE6 was EPA's official on-road emissions modeling program, and has been replaced very recently by MOVES. Use of MOBILE6 is still officially accepted until the end of 2010; MOBILE6 produces emission factors (grams per vehicle mile traveled) for volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxides (NO_x), carbon dioxide (CO_2), particulate matter (PM), toxics, and others (U.S. Environmental Protection Agency, May 2010). The user inputs conditions to simulate different environments and scenarios. Some of these conditions are calendar year, temperature, travel speeds, fuel volatility, and mileage accrual rates (U.S. Environmental Protection Agency, 2003). MOBILE6 is widely used by the air pollution control community to evaluate on-road mobile source emissions and develop control strategies (U.S. Environmental Protection Agency, 2003). To calculate total emissions, the emission factors produced from the program must be multiplied by vehicle miles traveled (VMT). In this study, VMT data were obtained from the Florida Department of Transportation (FDOT) website and includes rural, small and large urbanized roads, and limited access highways (Florida Department of Transportation, 2009).

Non-road mobile sources

Non-road mobile sources contribute a large portion of the area's VOC and NO_x emissions. Non-road sources include lawn equipment, construction equipment, pleasure craft, and more. NONROAD is the EPA model for non-road emission estimation. The program can produce national estimates at the broadest use and county level estimates at the most specific use (U.S. Environmental Protection Agency, 2005). The program was set up to specify Orange, Seminole, and Osceola counties and the results were tabulated in Microsoft Access and then imported to Excel. Inputs to the program include calendar year, temperatures, fuel properties, and others. NONROAD uses embedded algorithms to generate emissions estimates. The algorithms combine user inputs as well as default values contained in the program to provide these estimates.

Point Sources

Point sources are stationary sources that are large enough that they must file a permit with the Florida Department of Environmental Protection (FDEP) documenting their emission levels. The type and size of facility determines which type of permit is required. These permits specify emission testing and monitoring methods for each facility, and that each must report to DEP annually (Florida Department of Environmental Protection, March 2010). Point sources vary by location, but they typically include fossil-fuel fired power plants, manufacturing facilities, hospitals, large printing companies, and airports. The FDEP requires facilities that have the potential to emit more than 10 tons of VOCs or 25 tons of NO_x per year and are located in an ozone nonattainment area or ozone air quality maintenance area to have permits on file with the agency (Florida Department of Environmental Protection, January 2010). To calculate point source contributions, emission reports were obtained from FDEP and EPA. Furthermore, the EDMS model was used for the region's airports. Inputs to EDMS include aircraft and engine types and quantities (of take-offs and landings), runway, gate, and taxiway locations, taxipath configurations for arrival and departures between each gate and runway, and parking facility information.

Area Sources

Area sources are made up of many small sources, none of which individually releases enough emissions to be considered a point source, but collectively, can emit considerable amounts. They consist of dry cleaners, gasoline stations, restaurants, surface coating and painting operations, paving operations, traffic road striping, auto body shops, degreasing facilities, and even wildfires. The data for area source estimation in this report were obtained from the EPA's 2008 National Emission Inventory (2008 National emissions inventory data & documentation, 2010).

The Orlando Urban Area Inventory Results

Mobile Sources

On-road

Of the eight (8) vehicle types used in the fleet in MOBILE6, light duty gas vehicles (LDGV – cars) and light duty gas trucks and SUVs (LDGT) accounted for about 90% of VOC emissions and about 45% of NO_x emissions. The distinctions for light duty truck types within MOBILE6 are based on weight, and range from micro-pick-up trucks and small SUVs to large pick-ups and large SUVs. These light duty vehicle types make up about 90% of the vehicle miles traveled (VMT) in the region, so it was expected that they would be responsible for the largest portion of VOCs. Vehicles using gasoline (instead of diesel) are more numerous than diesel vehicles. However, diesel fuel burns at a higher temperature and therefore diesel vehicles emit considerably more NO_x but less VOCs per VMT than gasoline vehicles. Because of this, heavy duty diesel vehicles (HDDV) contributed a very large portion of NO_x (47.2%) despite accounting for less than 10% of the VMT.

To calculate emissions, the emission factor produced by MOBILE6 was multiplied by VMT for each category. These results were then converted from grams to tons per year. The formula for this calculation is:

$$Emission\ Factor\left(\frac{grams}{mile}\right) \times VMT\left(\frac{miles}{year}\right) \times \frac{1\ kg}{1000\ g} \times \frac{2.2\ lb}{1\ kg} \times \frac{1\ ton}{2000\ lb} = tons\ of\ pollutant/year$$

Diesel fuel has a higher carbon content than gasoline, and thus diesel vehicles contributed more than 20% of the CO_2. Table 2 shows the emissions of each vehicle type in both tons per year and its percentage of the total. Figure 2, Figure 3, and Figure 4 show the same results graphically for VOCs, NO_x, and CO_2 respectively.

Table 2 – 2008 On-road mobile source emission totals for OSO by vehicle type

Vehicle Type	Annual VMT	VOCs		NO_x		CO_2	
		tons/year	percent	tons/year	percent	tons/year	percent
LDGV	7,934,111,592	8,186	34.7%	6,096	16.2%	3,221,975	25.6%
LDGT12	7,639,946,529	8,228	34.9%	7,310	19.4%	4,015,419	31.8%
LDGT34	2,605,760,026	4,774	20.2%	3,708	9.8%	1,779,426	14.1%
HDGV	744,800,904	1,144	4.9%	2,613	6.9%	755,322	6.0%
LDDV	8,345,108	3	0.0%	7	0.0%	2,911	0.02%
LDDT	39,639,264	25	0.1%	43	0.1%	25,902	0.21%
HDDV	1,777,508,040	903	3.8%	17,791	47.2%	2,785,240	22.1%
MC	114,745,237	319	1.4%	158	0.4%	22,438	0.2%
TOTALS	**20,864,856,699**	**23,582**	**100%**	**37,726**	**100%**	**12,608,634**	**100%**

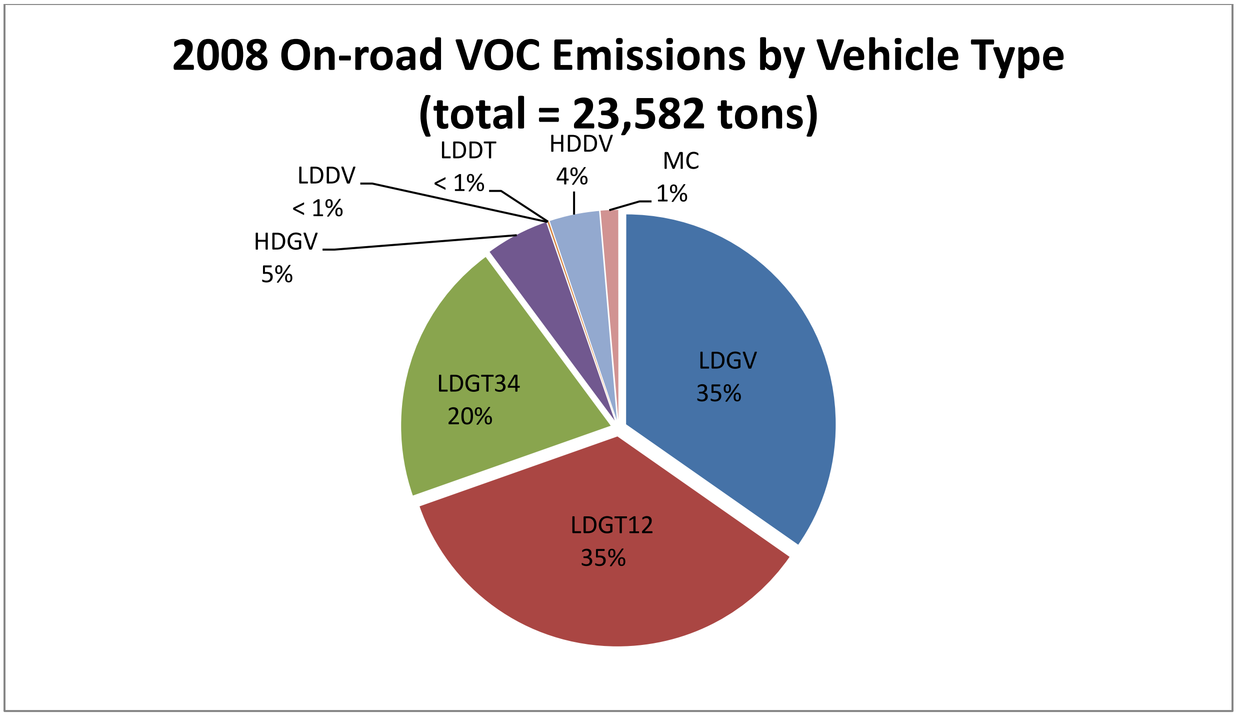

Figure 2 – 2008 On-road VOC contributions by vehicle type for the OSO area

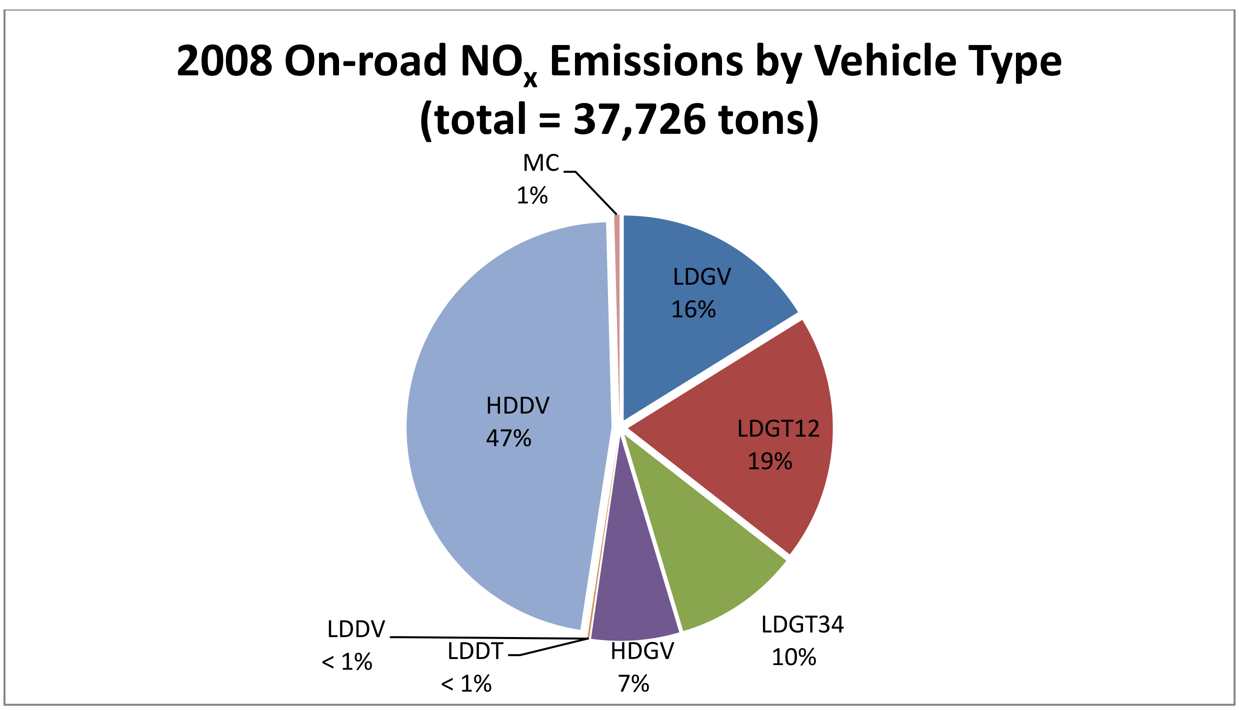

Figure 3 – 2008 On-road NO_x contributions by vehicle type for the OSO area

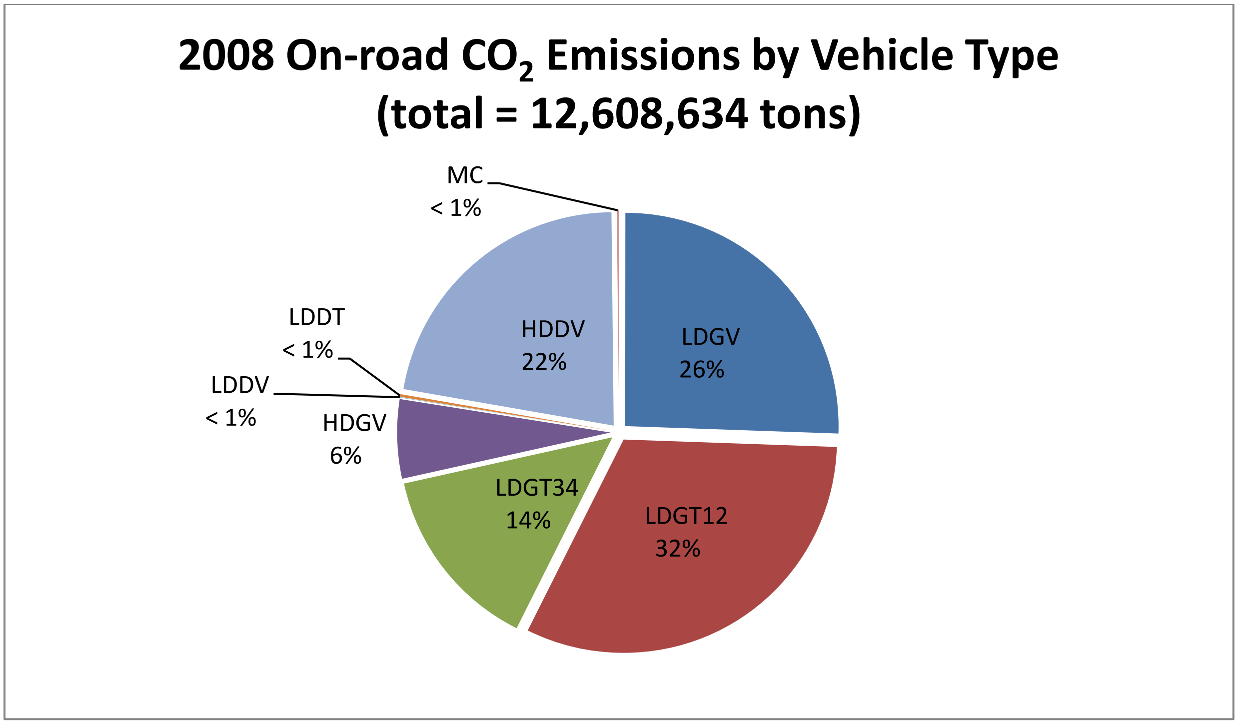

Figure 4 – 2008 On-road CO_2 contributions by vehicle type for the OSO area

Non-road

According to the NONROAD model, pleasure craft (motor boats and jet skis) are the largest source of VOC emissions comprising 42% of the total, followed closely by lawn and garden equipment (mowers, edgers, trimmers, chain saws, blowers, etc) with 35% of the total. Construction and mining equipment is the largest source of NO_x emissions. This accounts for 67% of the total. This type of equipment is also responsible for the largest portion of CO_2 emissions, making up 56% of the total. Total VOC, NO_x, and CO_2 emissions from the NONROAD program are tabulated in Table 3. Figures 5, 6, and 7 show the break-down of VOC, NOx, and CO2 emissions in the OSO area by source.

In the years from 2005-2008, prior to the extreme slow-down in economic activity that occurred in the latter half of 2008, there had been enormous land development activity in the OSO area. This equated to a huge number of a wide variety of construction equipment being used (graders, pavers, dozers, excavators, off-highway trucks, scrapers, backhoes, etc). All this equipment is diesel engine driven (higher NO_x emissions), and typically moves under high load for short distances or sits idling, waiting to be used numerous times throughout the day. The stop-and-go movements are an inefficient use of fuel and according to the modeling results, construction vehicles produce a majority of the NO_x emissions in this region.

Table 3 – 2008 NONROAD Emission totals for OSO

Classification	VOC, tons/yr	NO_x, tons/yr	CO_2, tons/yr
Agricultural Equipment	9	73	6,907
Airport Equipment	17	183	20,407
Commercial Equipment	1,195	771	117,770
Construction and Mining Equipment	1,013	6,796	755,940
Industrial Equipment	193	934	98,915
Lawn and Garden Equipment (Com)	3,575	762	191,294
Lawn and Garden Equipment (Res)	1,714	113	42,037
Logging Equipment	2	4	526
Pleasure Craft	6,339	500	98,312
Railroad Equipment	0	1	59
Recreational Equipment	1,133	35	15,993
TOTALS	**15,190**	**10,172**	**1,348,158**

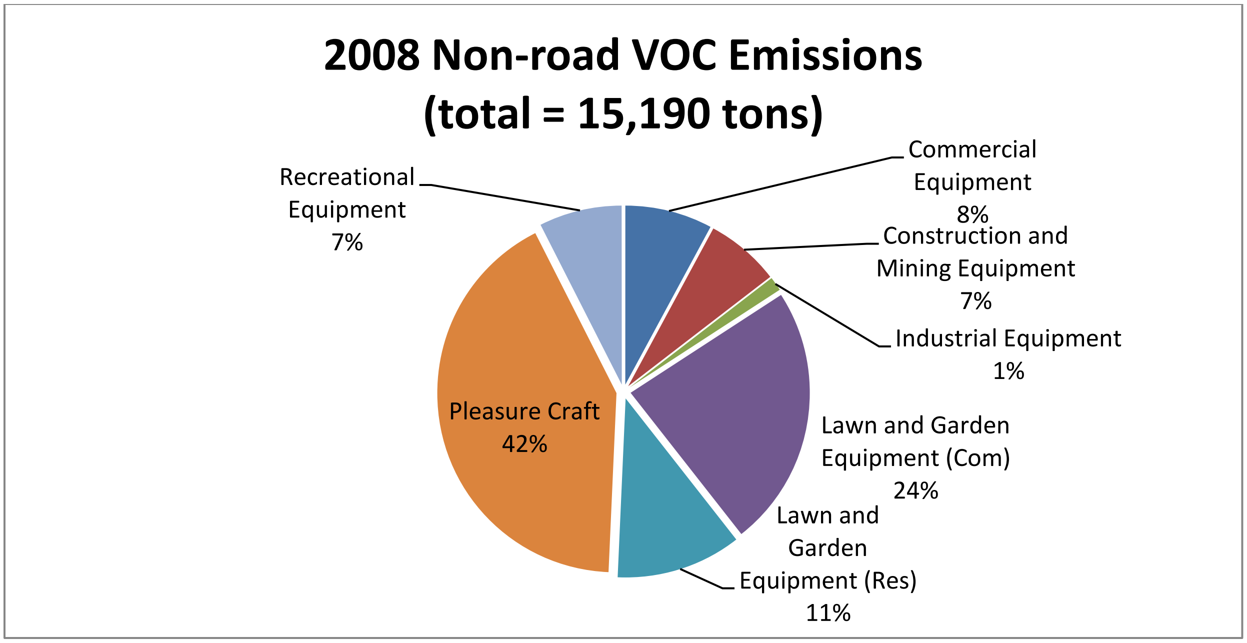

Figure 5 – 2008 Non-road VOC contributions by source for the OSO area*

* Does not include agricultural equipment, airport equipment, logging equipment, and railroad equipment. The total from these sources combined was less than 0.25%.

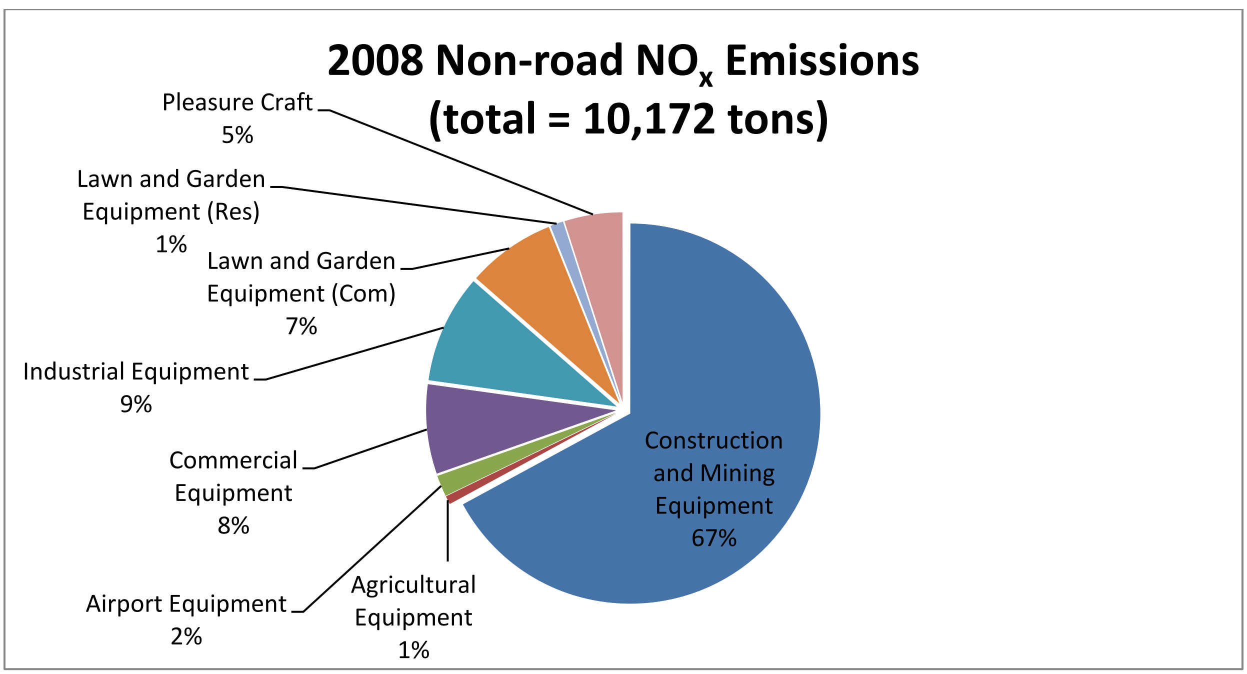

Figure 6 – 2008 Non-road NO_x contributions by source for the OSO area*

* Does not include logging equipment, railroad equipment, and recreational equipment. The total from these sources combined was less than 0.50%.

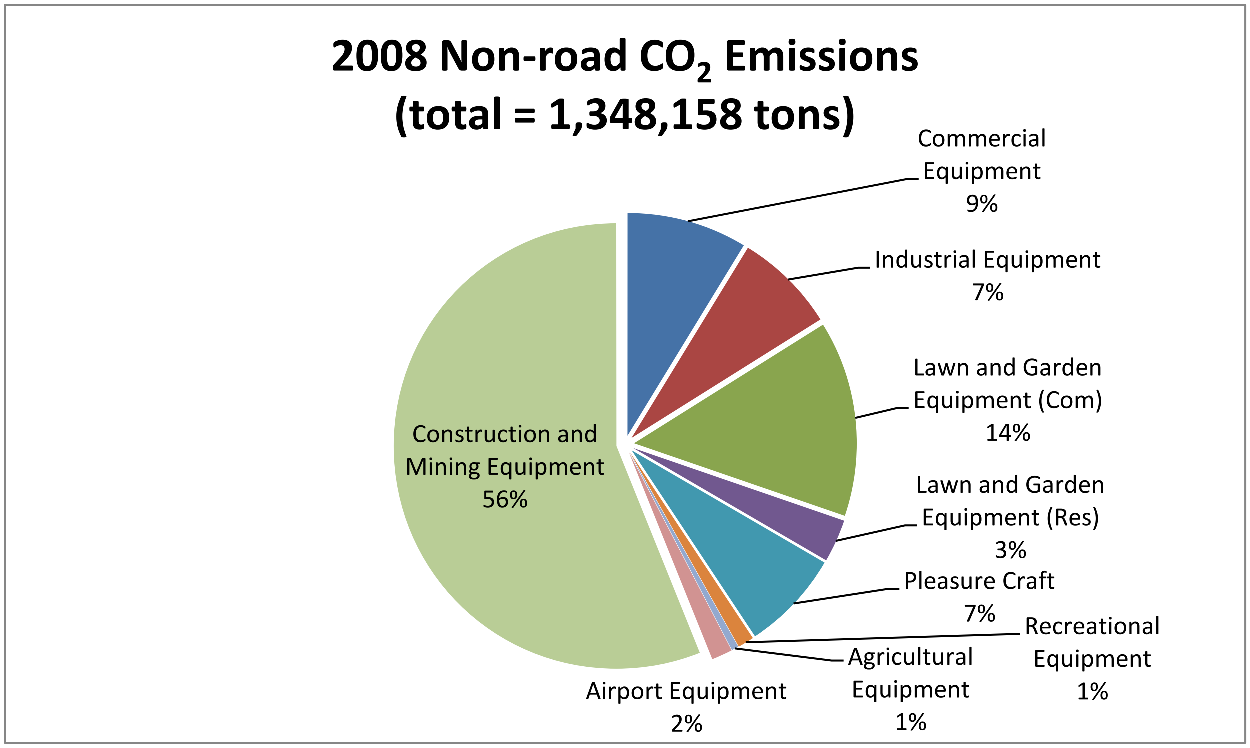

Figure 7 – 2008 Non-road CO_2 contributions by source for the OSO area

* Does not include logging equipment and railroad equipment. The total from these sources combined was less than 0.05%.

Point Sources

Point sources were identified from the US EPA Facility Emissions List and the central Florida office of the FDEP (U.S. Environmental Protection Agency, Clean Air Markets Division, 2010 and Michael Young, personal communication, December 4, 2009). Point source facilities included large power plants (such as the OUC Stanton Plant), large facilities (such as Disney World, Lockheed Martin, large graphic arts shops, and large asphalt plants), and major airports (such as Orlando International). Each individual facility must submit annual emission records to the FDEP to show they are operating within their permitted limits. Table 4 shows the categories in which facilities may be classified. The "Airports" and "Other" categories had the highest level of VOC emissions. The "Airport" category includes aircraft emissions, but does not include ground service equipment (GSE) emissions. GSE was included in the Non-road source section. Some of the companies included in the "Other" category were Cellofoam North America Inc., Sonoco Products Company, Walt Disney World Co., and Lockheed Martin Missiles & Fire Control. The airports in OSO are Orlando International Airport (OIA), Orlando Sanford International Airport, Orlando Executive Airport, and Kissimmee Gateway. Orlando International handled approximately 360,000 flights during the 2008 calendar year. The OIA emissions were estimated based on a detailed model of flight activity (data gathered directly from OIA) and using the EDMS model. The other three airports have drastically less air traffic, and their emissions were taken as given in the 2008 EPA inventory (2008 National emissions inventory data & documentation, 2010).

Power plants emitted significant amounts of NO_x in OSO, accounting for three fourths of all the point source emissions, and about 14% of the total regional emissions of NO_x from all sources. Most of that came from the two (2) coal fired units at the Orlando Utilities Commission (OUC) Stanton Energy Center. OUC, Kissimmee Utility Authority (KUA), and the Southern Company have ownership in one or more of the power plants in OSO. The NO_x and CO_2 emissions from each power plant can be seen in Table 5. The aircraft emissions from the region's four airports are shown in Table 6. It was assumed that CO_2 emissions from point sources other than airports and power plants are insignificant in comparison and so only these two groups were included in this inventory.

Table 4 – 2008 Point source emission totals for OSO

Category	Total		
	VOC, tons/yr	NO_x, tons/yr	CO_2, tons/yr
Airports (aircraft)*	**473**	**1,469**	**492,645**
Asphalt Plant	**31**	**66**	**-**
Chemical Plant	**2**	**0**	**-**
Electric Production	**0**	**36**	**-**
Fiberglass Products Mfg.	**103**	**0**	**-**
Food Production	**297**	**31**	**-**
Graphic Arts/Printing	**146**	**1**	**-**
Hospitals/Health Care	**5**	**77**	**-**
Misc Wood Products Mfg.	**2**	**0**	**-**
MSW Landfill	**37**	**24**	**-**
Other	**364**	**708**	**-**
Other Incineration	**1**	**32**	**-**
Petroleum Storage/Transfer	**80**	**9**	**-**
Power Plants	**111**	**8,525**	**8,134,554**
Secondary Metal Production	**0**	**1**	**-**
Surface Coating Operations	**249**	**8**	**-**
TOTALS	**1,901**	**10,987**	**8,627,199**

*Airports in this table represent aircraft emissions (landings and take-offs and taxiing) but do not include ground service equipment (GSE). Those emissions are included in the non-road inventory.

Table 5 – 2008 Annual NO_x and CO_2 emissions of OSO power plants

Facility Name	NO_x, tons/yr	CO_2, tons/yr
Curtis H. Stanton Energy Center	8,137	5,953,729
Orlando CoGen	144	328,439
RRI Energy Osceola	35	142,176
Reedy Creek	1	1,910
Stanton A	126	1,099,367
Cane Island	82	608,933
TOTALS	**8,525**	**8,134,554**

Table 6 – 2008 EDMS airport (aircraft) emission results

Airport	VOC, tons/yr	NO_x, tons/yr	CO_2, tons/yr
Orlando International	322	1,353	453,743
Orlando Executive	40	3	1,006
Orlando-Sanford International	66	110	36,890
Kissimmee Gateway	45	3	1,006
TOTALS	**473**	**1,469**	**492,645**

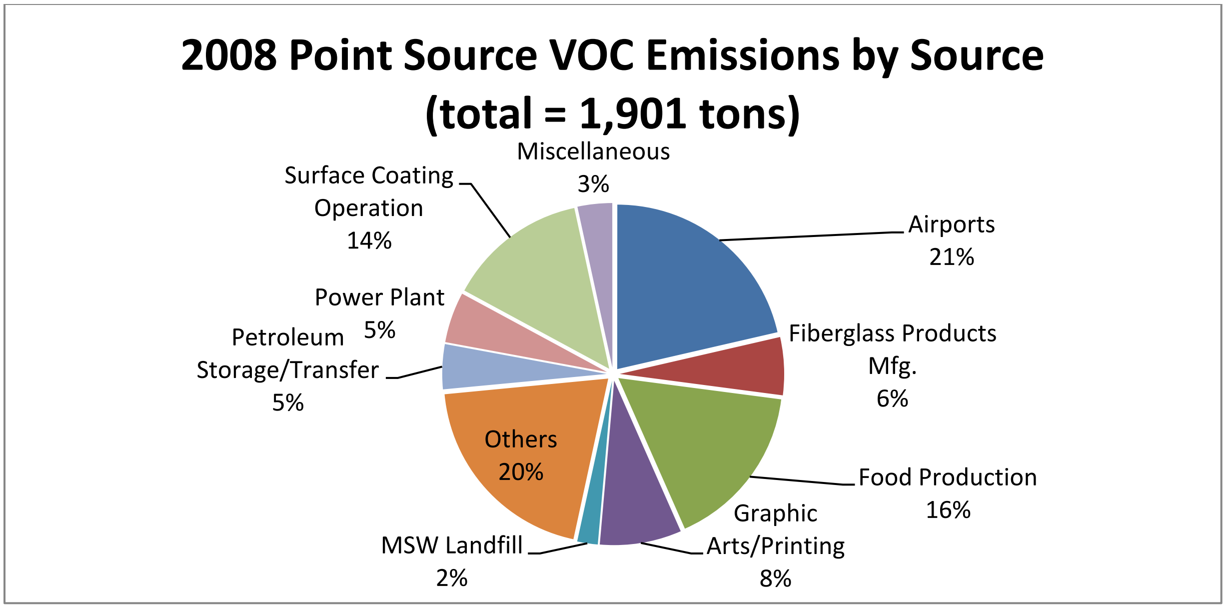

Figure 8 – 2008 Point source VOC contributions by source for the OSO area*

* The “Miscellaneous” source category includes chemical plants, hospitals/healthcare facilities, miscellaneous wood products manufacturing, other incineration, and asphalt plants

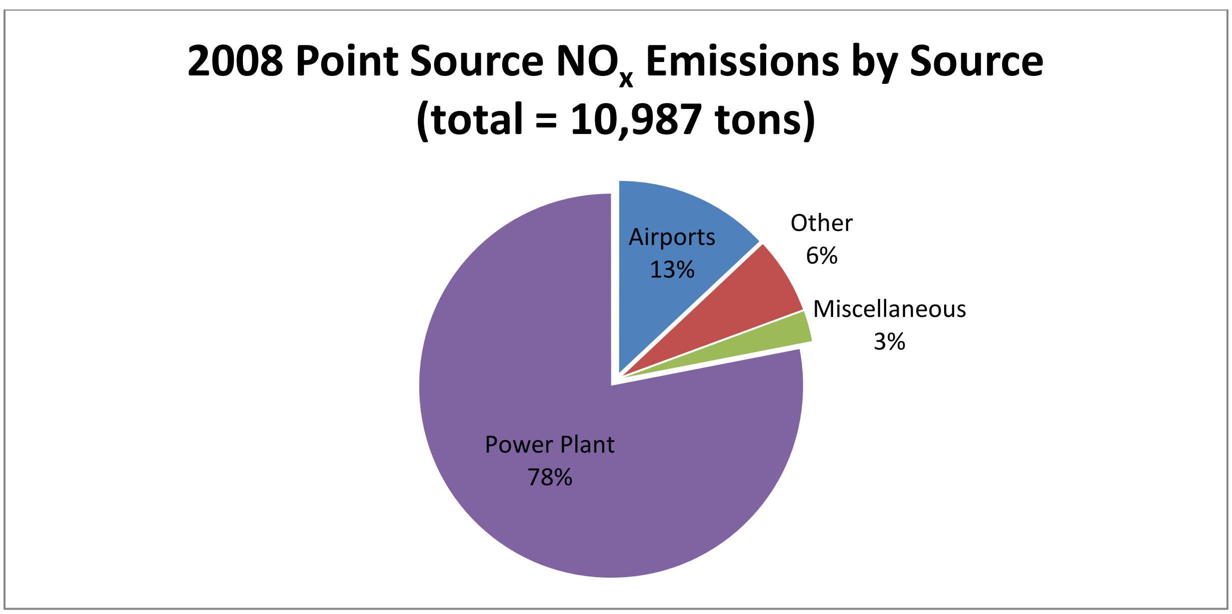

Figure 9 – 2008 Point source NO_x contributions by source for the OSO area*

* The "Miscellaneous" source category includes graphic arts/printing, petroleum storage/transfer, secondary metal production, surface coating operation, MSW landfill, asphalt plant, electric production, food production, hospitals/healthcare facilities, and other incineration

Area Sources

Area source emissions data came from the US EPA 2008 National Emissions Inventory ("2008 National emissions inventory data & documentation," 2010). The EPA has county-level data for the sub-categories listed in Table 7. The totals for the area source emissions in the OSO region can be seen in Table 8. It was assumed that source categories which did not show appreciable NO_x emissions would have negligible contributions to CO_2 emissions. Therefore, burning, land clearing, and residential heating categories were the only ones for which CO_2 emissions were significant, but for two of those sub-categories, the CO_2 emissions are typically assumed to be part of the natural cycle. Table 9 shows CO_2 emissions by fuel type for residential heating in the region. The largest contributor of VOCs amongst the area sources was the chemicals and paint category, which comprised 47% of the area source total. The consumer solvents sub-category accounted for approximately half of that source with VOC emissions of 7,365 tons per year. The majority of area-source NO_x emissions came from the burning of gas and oil for residential heating. Open burning of yard waste and land clearing debris can contribute both VOCs and NO_x, but both Orange and Seminole counties had open burning bans in 2008, so emissions of both pollutants were low in 2008. Emission totals for area sources (by category) can be seen graphically in Figure 10 and Figure 11.

Table 7 – List of categories included in area sources

Area Source Category	Sub-categories
Coatings	Architectural coatings Industrial maintenance coatings Other special purpose coatings Surface coatings
Chemicals and Paints	Consumer solvents Degreasing Dry cleaning Graphic arts (smaller print shops) Pesticide application Traffic paints
Gasoline and Fuels	Aviation gasoline distribution stages 1 and 2 Gasoline distribution – stage 1 Portable fuel containers Residential heating Stage 2 gasoline refueling
Cooking	Commercial cooking
Asphalt	Cutback asphalt (small operations) Emulsified asphalt (small operations)
Land Clearing	Land clearing
Burning	Household waste burning Open burning – yard waste

Table 8 – 2008 Area Source Emission Totals for OSO

Sub-category	VOC, tons/yr	NO_x, tons/yr	CO_2, tons/yr
Asphalt	67	0	**-**
Burning	51	33	**Assumed to be part of the natural carbon cycle**
Chemicals and Paints	14,519	0	-
Coatings	5,229	0	-
Cooking	63	0	-
Gasoline and Fuels	10,719	125	147,158*
Land Clearing	1	1	**Assumed to be part of the natural carbon cycle**
TOTALS	**30,648**	**158**	**147,158**

* The CO_2 data for "Gasoline and Fuels" comes from residential heating and not the entire list of sub-categories

Table 9 – 2008 CO_2 emissions from residential heating by fuel type

Fuel Type	CO_2, tons/yr
Anthracite Coal	1.3
Bituminous Coal (assumed 70% carbon content)	5.2
Distillate Fuel	4,789
Kerosene	2,963
LPG	55,799
Natural Gas	83,601
TOTAL	**147,158**

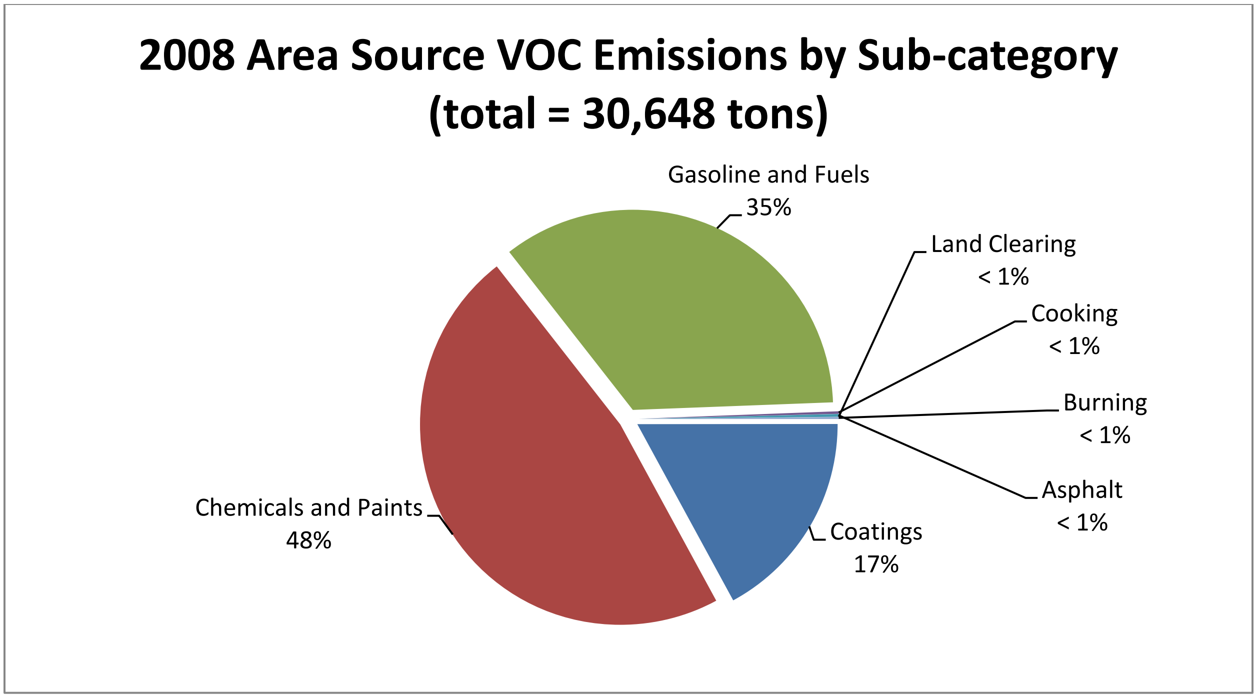

Figure 10 – 2008 Area source VOC contributions by source for the OSO area

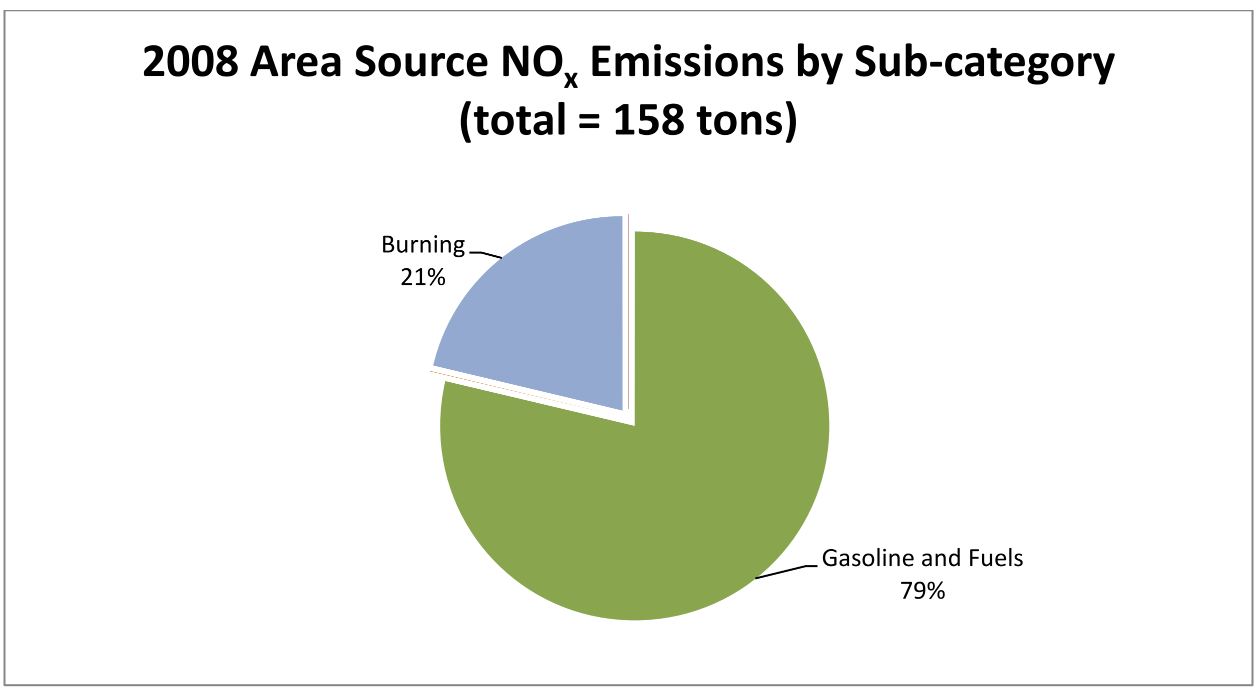

Figure 11 – 2008 Area source NO_x contributions by source for the OSO area

2008 Inventory compared with 2002 Results

Table 10 shows a summary of the results from the 2002 inventory and the most recent, 2008, inventory. The largest decrease in emissions was from on-road mobile sources (37%). This decrease can be attributed to improvements in vehicle pollution control technology and the turnover of the vehicle fleet over six (6) years. Older, higher-emitting vehicles were removed and replaced with newer, lower-emitting ones. Non-road VOCs increased slightly from 2002 (due to increased boating and lawn & garden activity), while non-road NO_x showed a decrease of 36% (likely due to improvements in the larger, diesel-engine non-road vehicles). Point sources remained relatively consistent with a slight drop in NO_x emissions. Area source VOCs decreased slightly, but owing to the large decreases posted by on-road vehicles, became a larger percentage of the region's total emissions. NO_x emissions from area sources remain very low as a percentage of the total. The sub-categories that were listed in the 2002 inventory differ from those in the 2008 inventory, so the details cannot be compared directly. Overall, total emissions in the region decreased from 2002 to 2008: VOCs by 15% and NO_x by 25%.

Table 10 – 2002 and 2008 OSO emission totals for VOC and NOx

Source	2002		2008	
	VOC, tons/yr	NO_x, tons/yr	VOC, tons/yr	NO_x, tons/yr
On-road	37,511	49,872	23,582	37,726
Non-road	13,389	15,889	15,190	10,172
Point	1,711	12,596	1,901	10,987
Area	31,198	103	30,648	158
TOTALS	**83,809**	**78,460**	**71,321**	**59,043**

Summary

Emissions in the OSO area are on the decline. Improvements to emissions control systems in the on-road vehicle fleet and improvements in the design of new non-road engines are the two main reasons for this reduction. The largest contributors to VOCs are area sources, on-road vehicles, and non-road engines; the largest NO_x emitters are on-road vehicles, construction equipment and point sources (mainly power plants). This can be seen in Figure 12 and Figure 13. The totals for each pollutant by source category are shown in Table 11. On-road mobile sources produce the most carbon dioxide emissions, but point sources also make up a large portion of the total. Despite population growth in the three counties, emissions decreased over the six (6) years between inventories. This indicates that policies in place and advances in technology are still achieving lower emissions.

Table 11 – 2008 OSO Emission totals

Source	VOC, tons/yr	NO_x, tons/yr	CO_2, tons/yr
On-road	23,582	37,726	12,608,634
Non-road	15,190	10,172	1,348,158
Point	1,901	10,987	8,627,199
Area	30,648	158	147,158
TOTALS	**71,321**	**59,043**	**22,731,149**

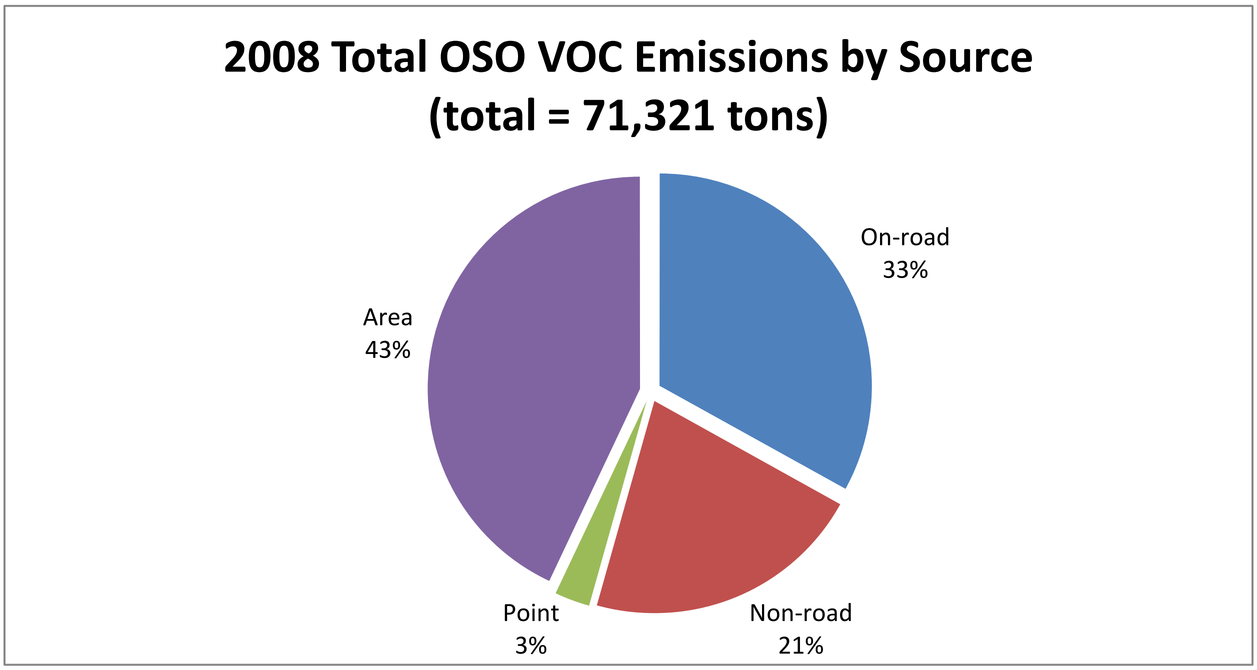

Figure 12 – 2008 Total VOC emissions for the OSO area

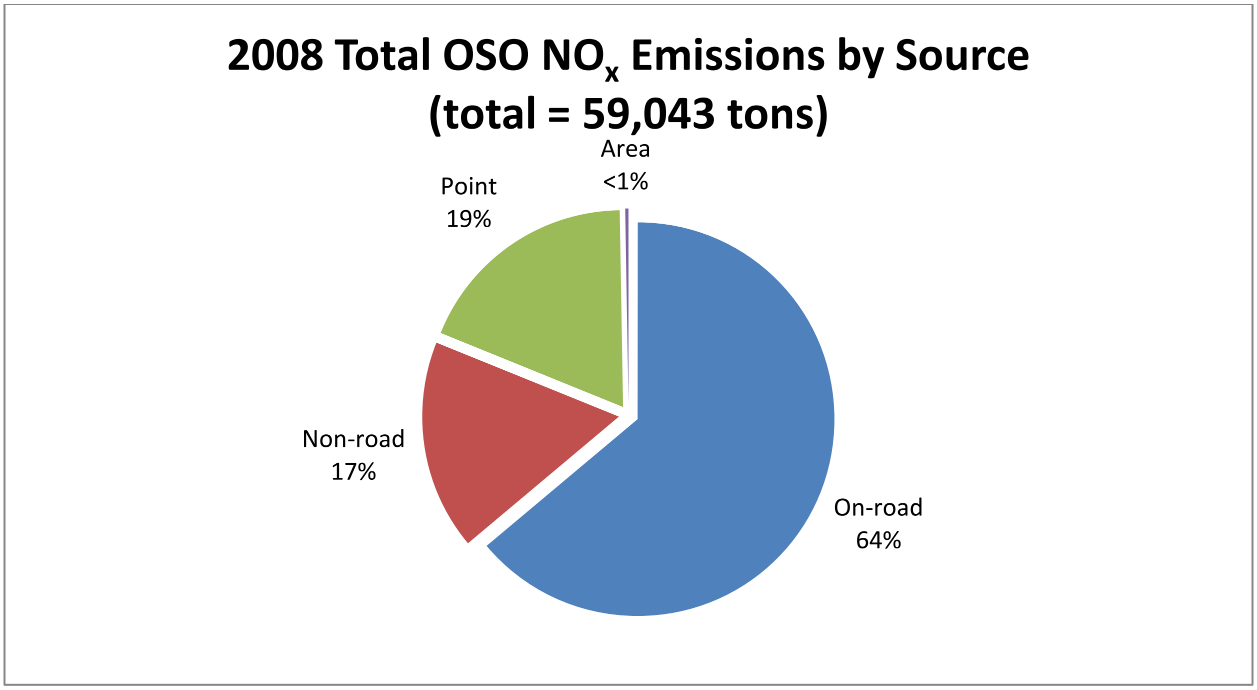

Figure 13 – 2008 Total NO_x emissions for the OSO area

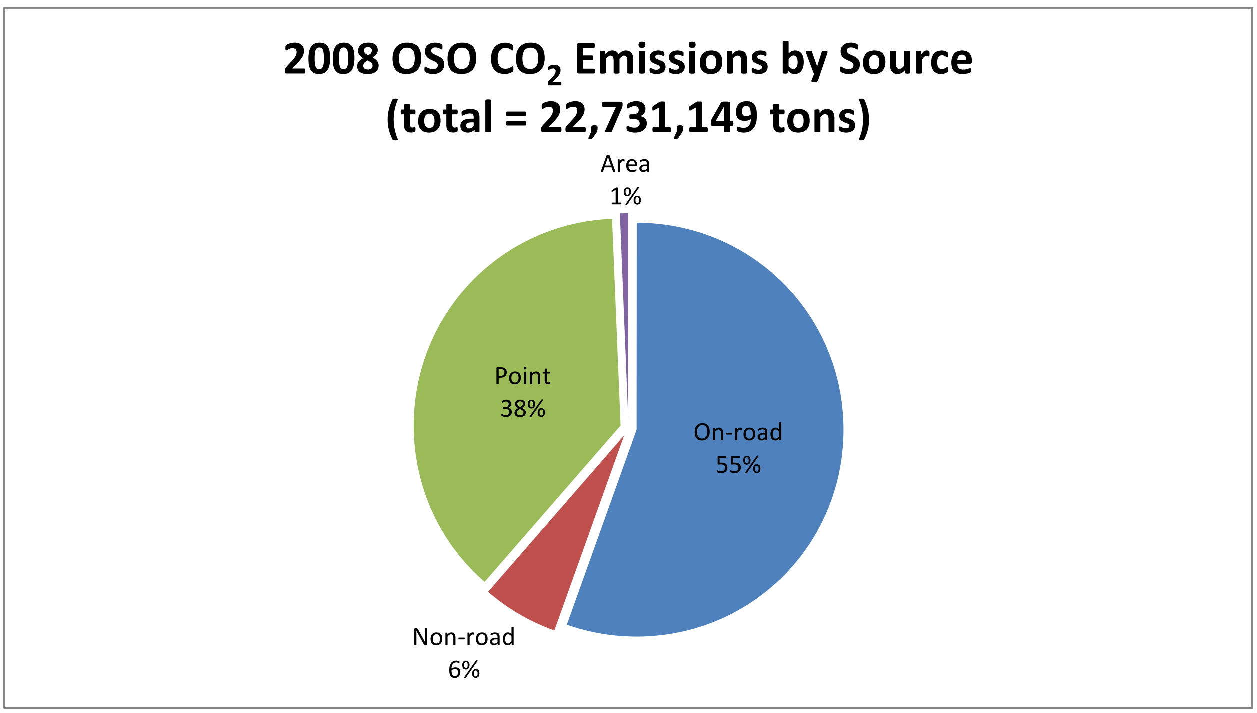

Figure 14 – 2008 Total CO_2 emissions for the OSO area

Appendix

This section contains information about source category emissions by county. Then, total emissions for each county are broken down by source category. The graphs serve as a visual aid to show from where the largest emissions are coming.

Mobile Sources

On-road

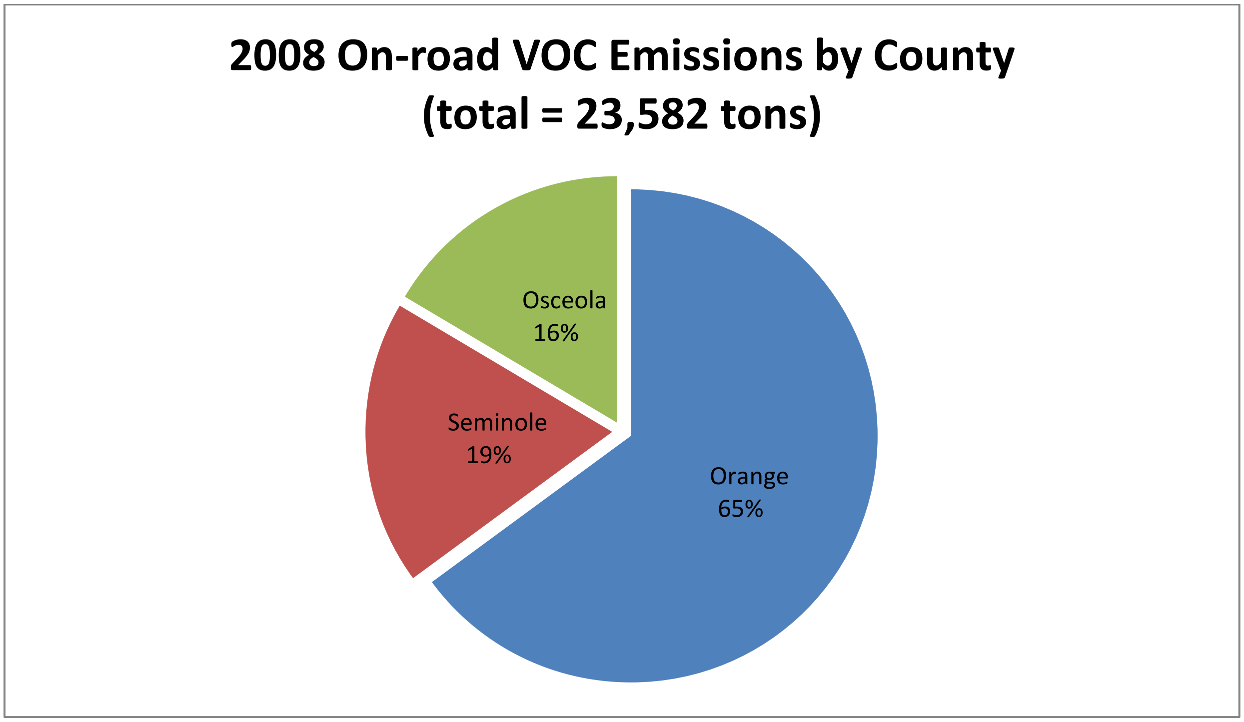

Figure 15 – 2008 On-road VOC Contributions for OSO

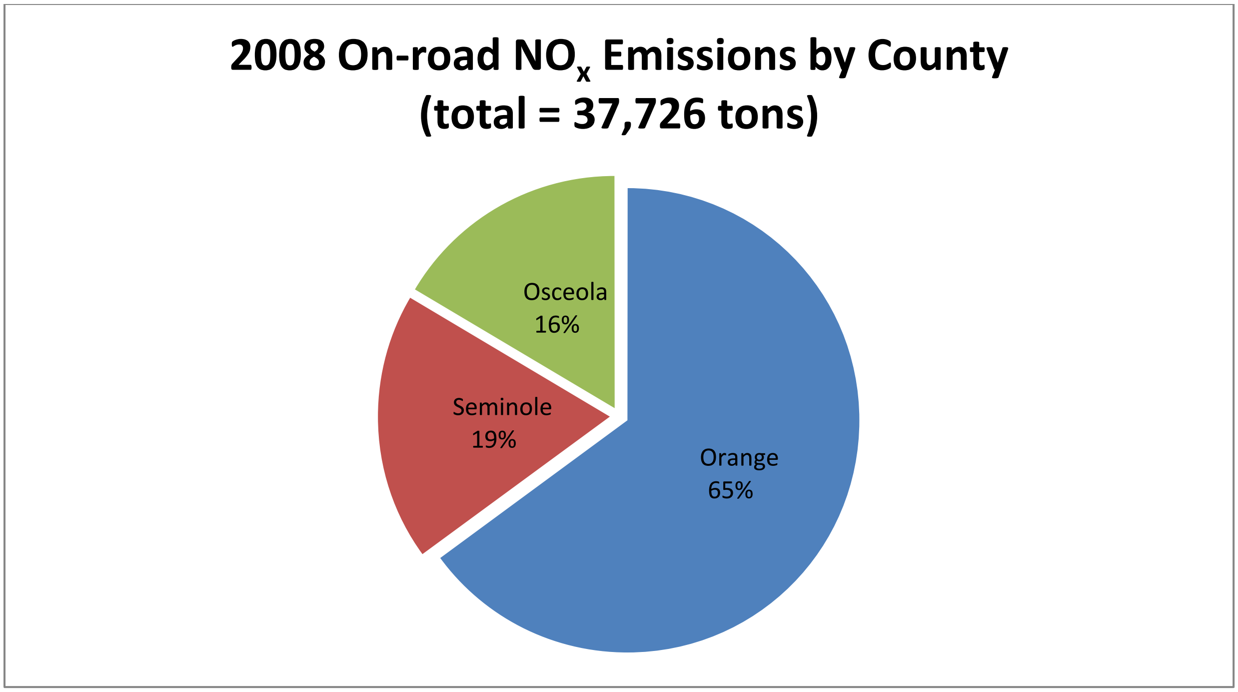

Figure 16 – 2008 On-road NO_x Contributions for OSO

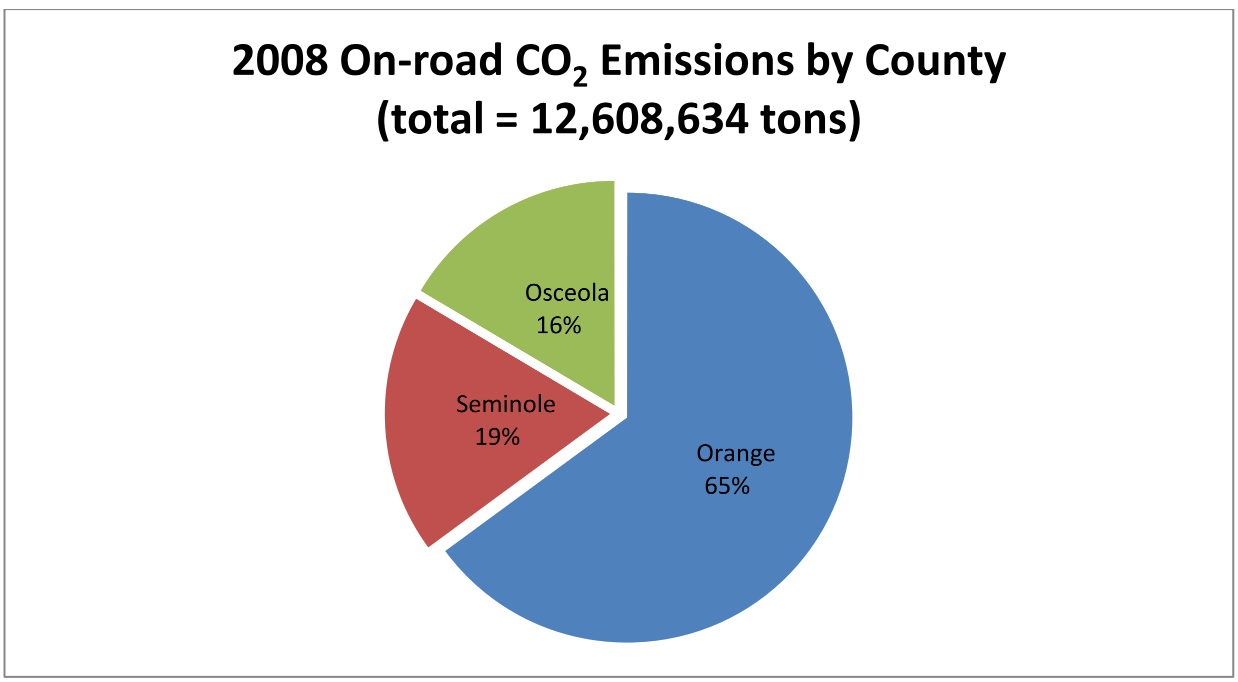

Figure 17 – 2008 On-road CO_2 Contributions for OSO

Non-road

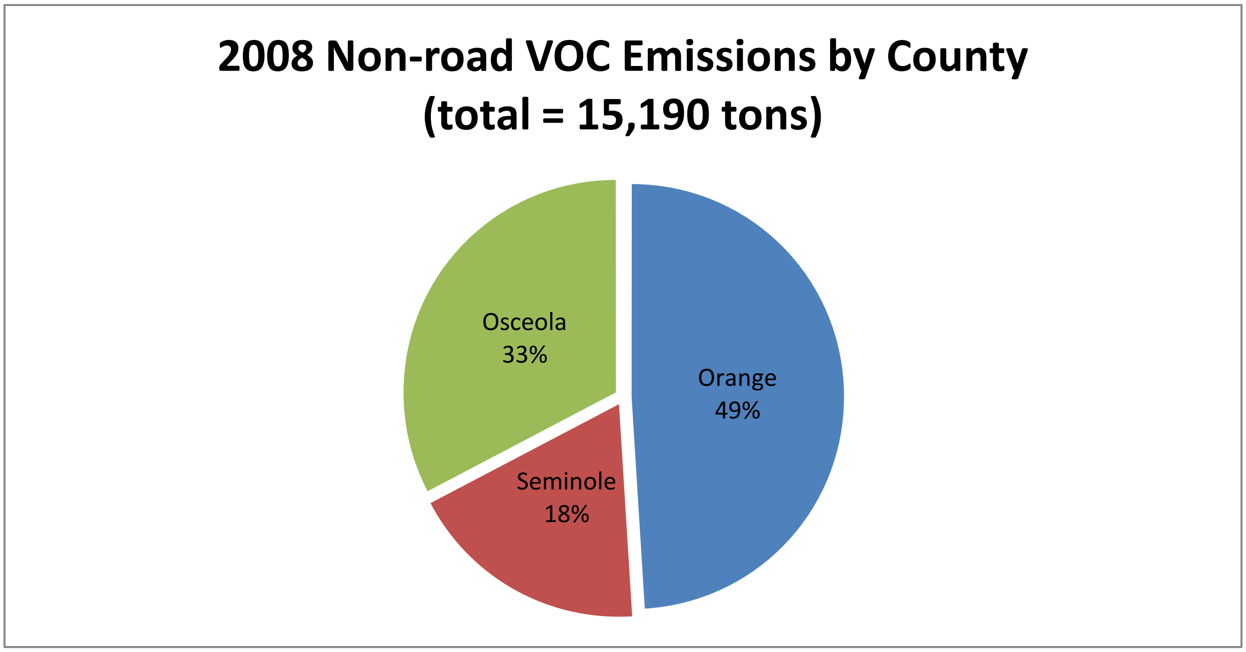

Figure 18 – 2008 Non-road VOC Contributions for OSO

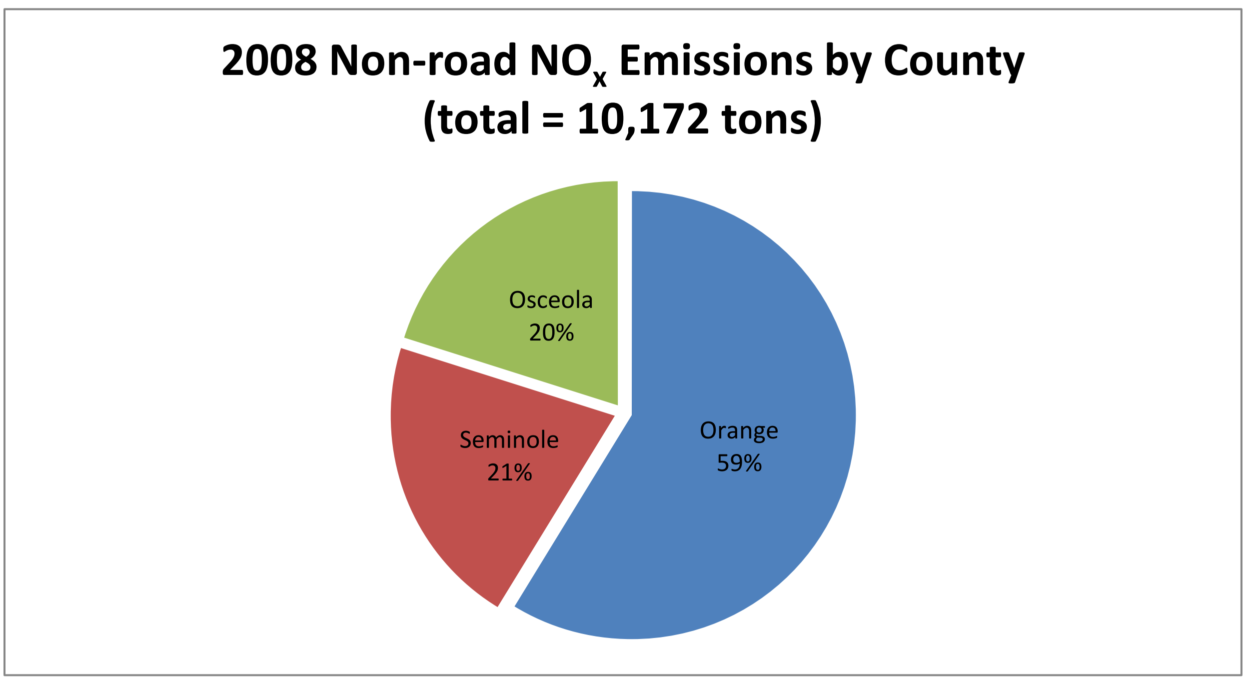

Figure 19 – 2008 Non-road NO_x Contributions for OSO

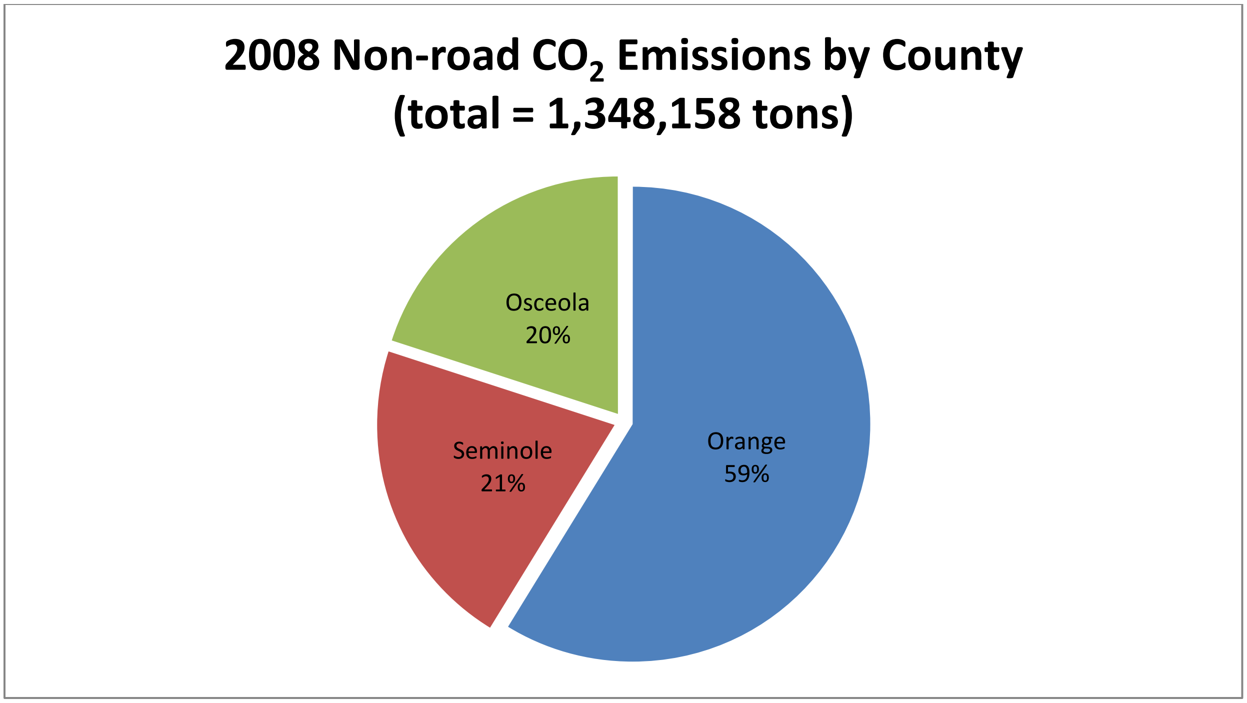

Figure 20 – 2008 Non-road CO_2 Contributions for OSO

Point Sources

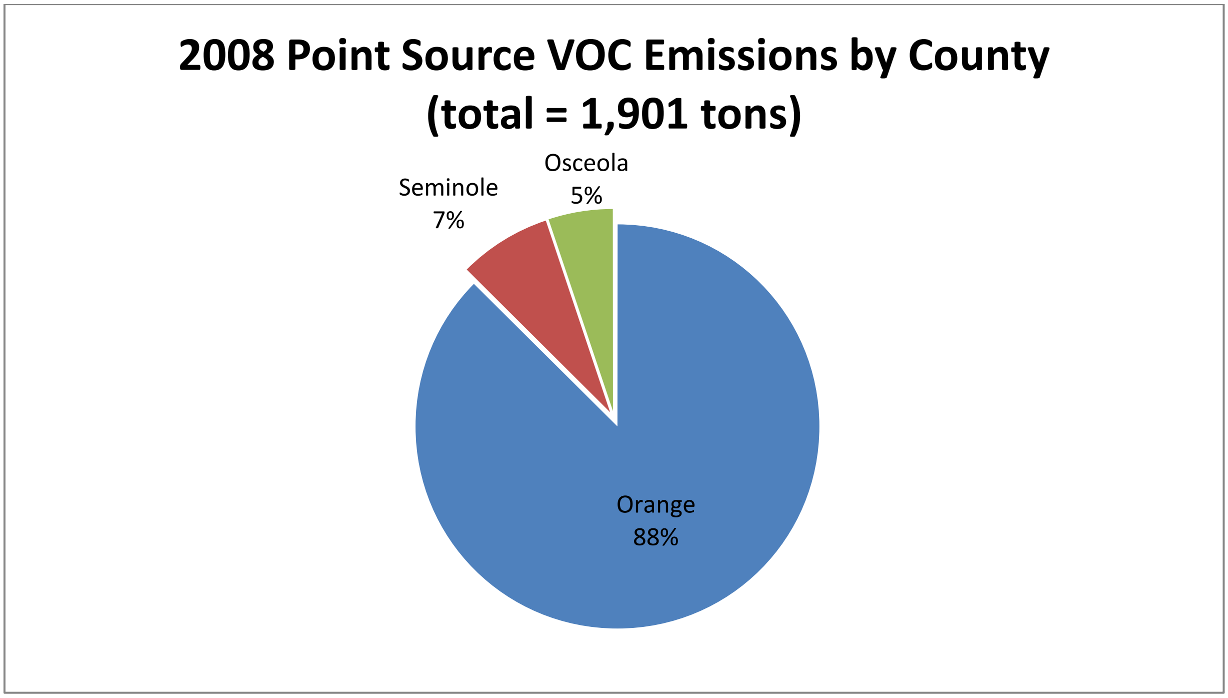

Figure 21 – 2008 Point Source VOC Contributions for OSO

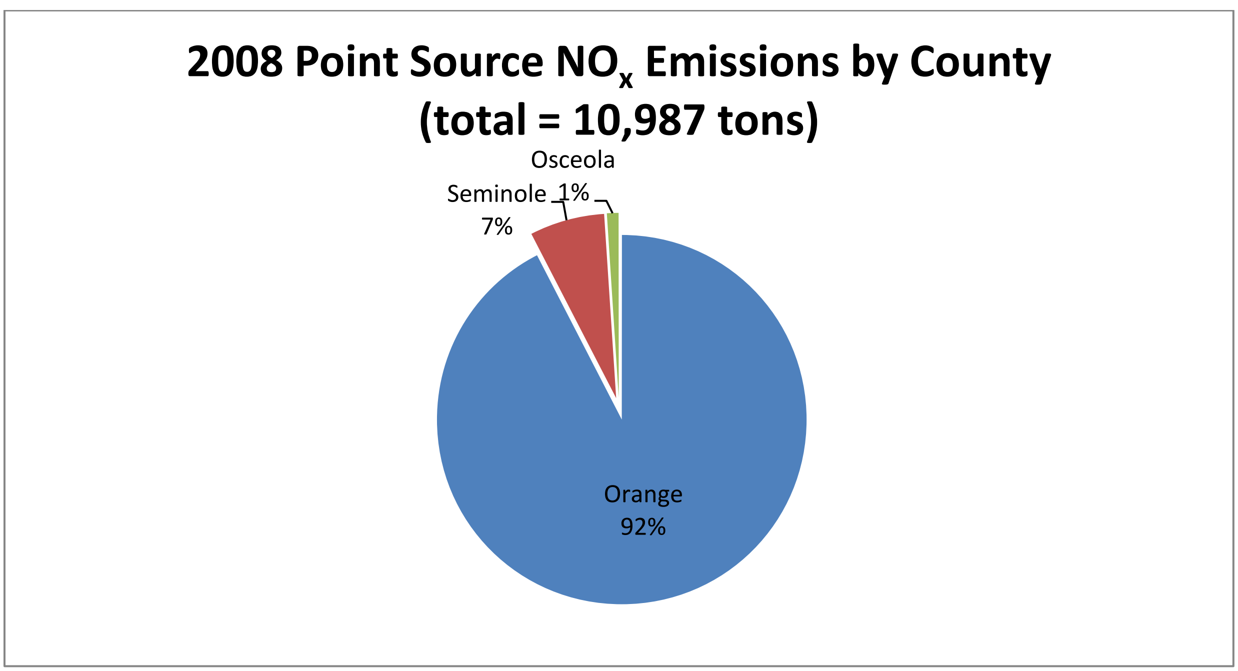

Figure 22 – 2008 Point Source NO_x Contributions for OSO

Area Sources

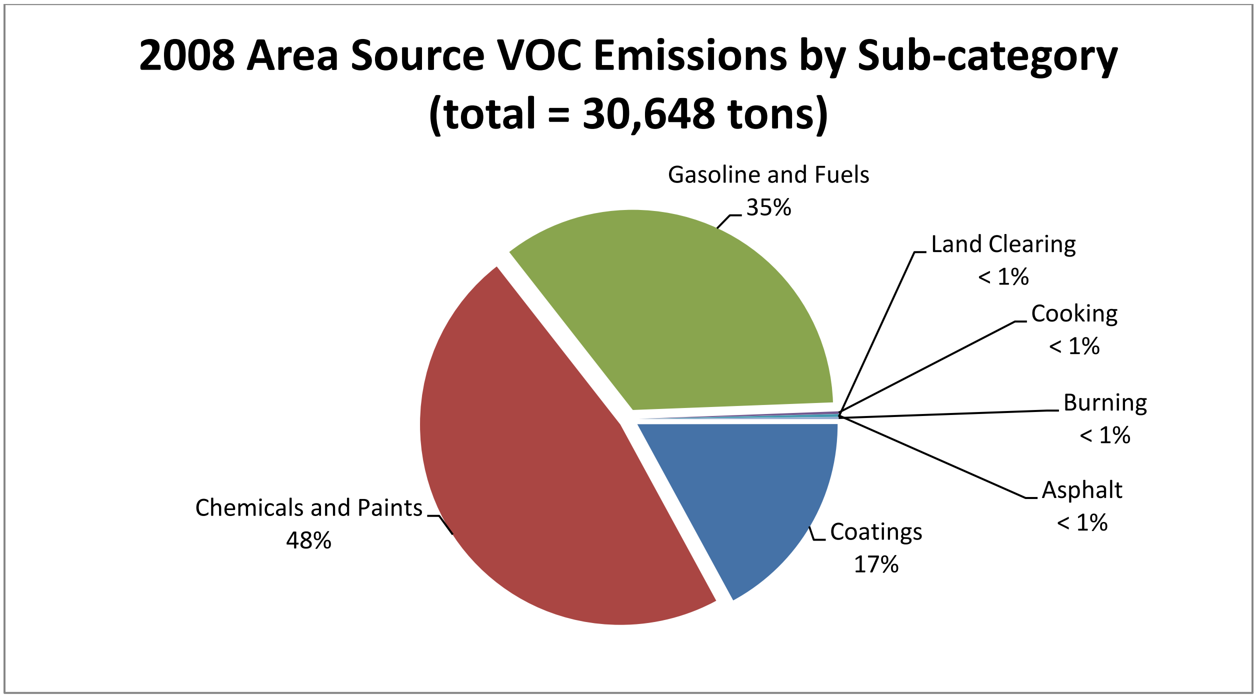

Figure 23 – 2008 Area Source VOC Contributions for OSO

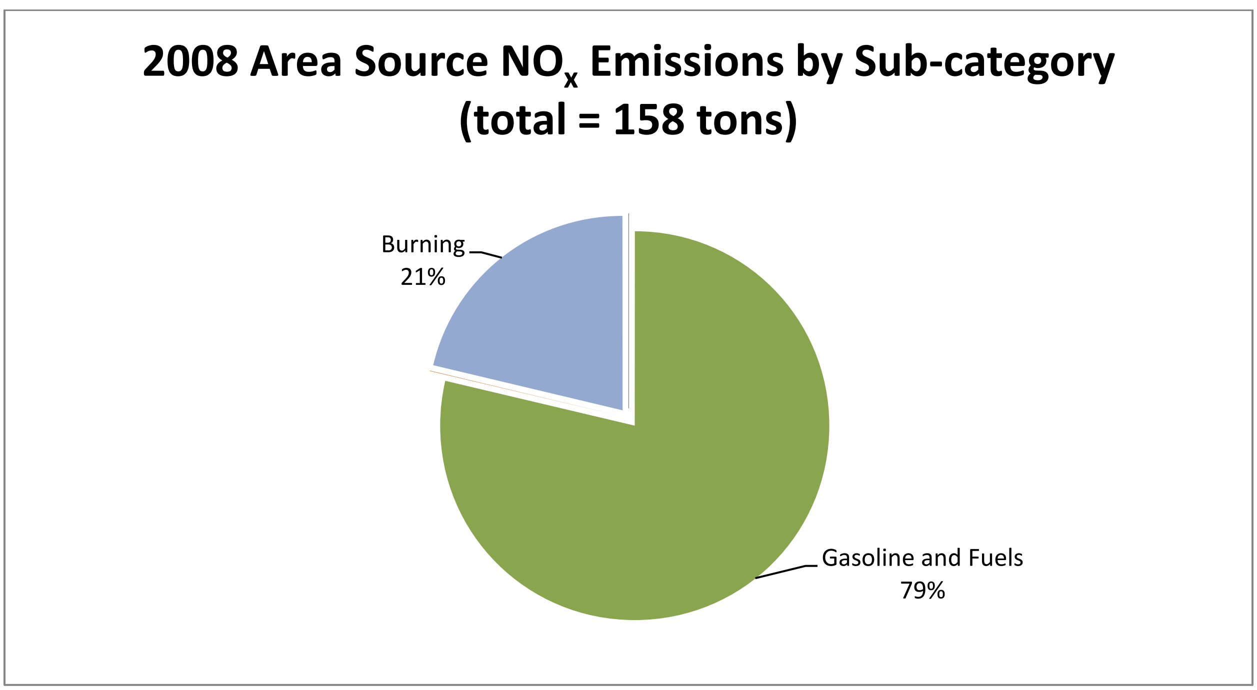

Figure 24 – 2008 Area Source NO_x Contributions for OSO

Total Emissions per County by Source Category

Orange County

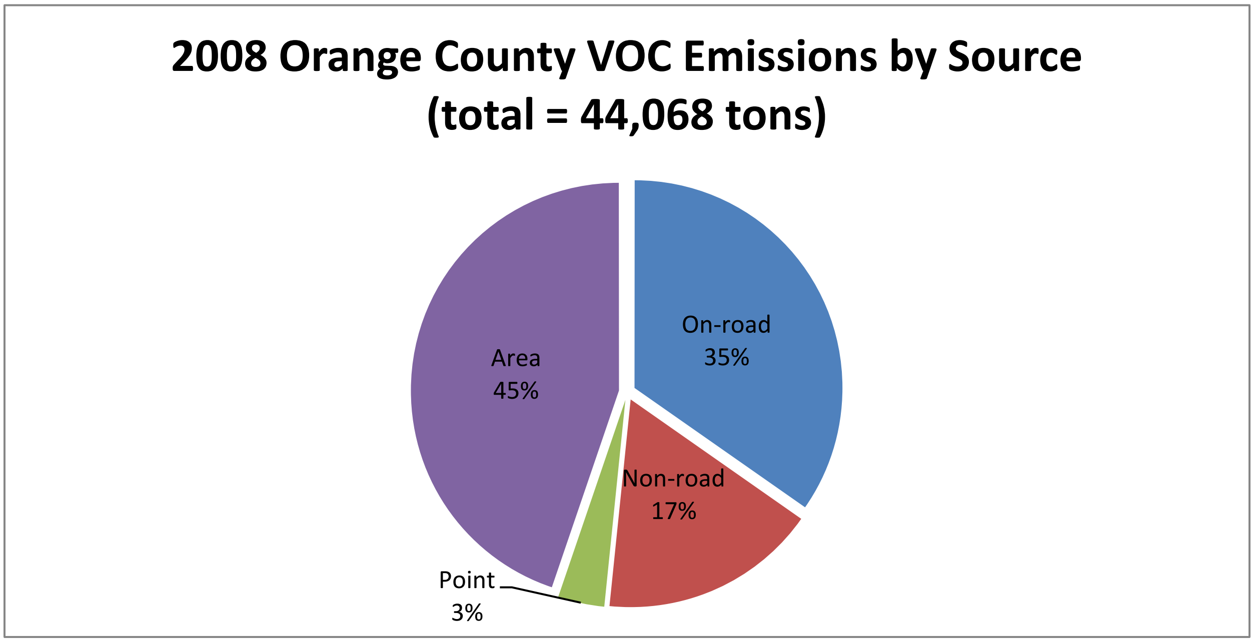

Figure 25 – 2008 Orange county VOC emissions by source

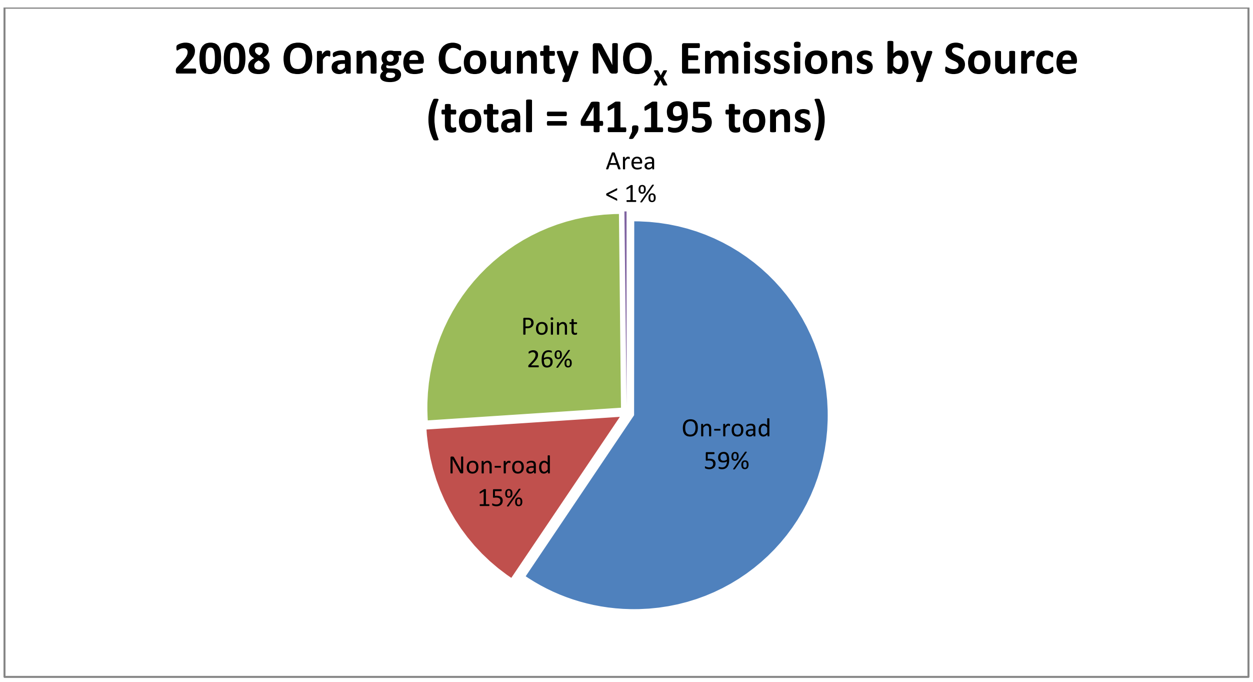

Figure 26 – 2008 Orange county NO_x emissions by source

Seminole County

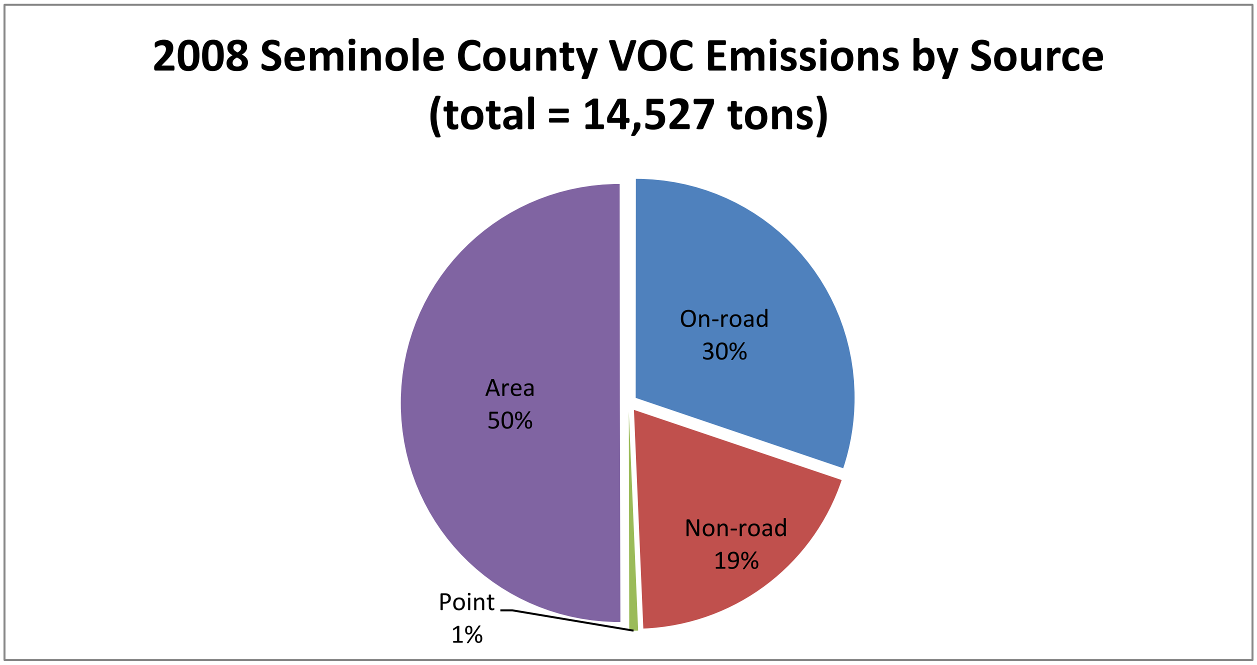

Figure 27 – 2008 Seminole county VOC emissions by source

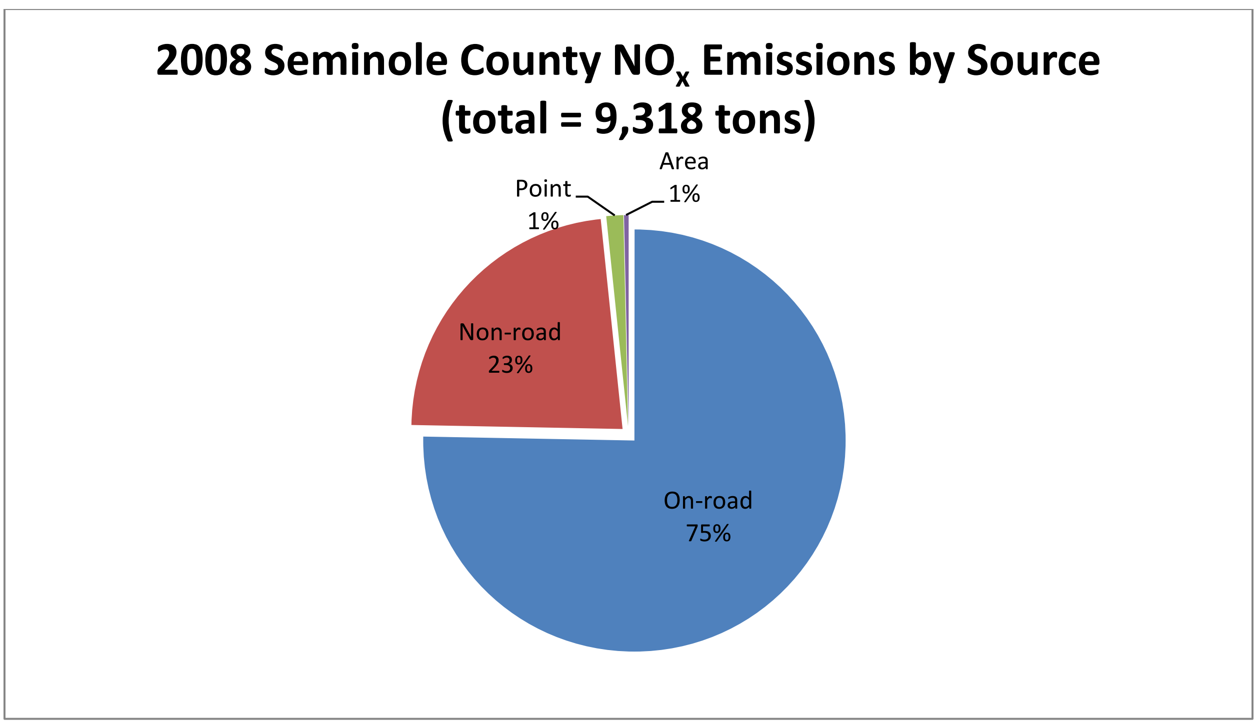

Figure 28 – 2008 Seminole county NO_x emissions by source

Osceola County

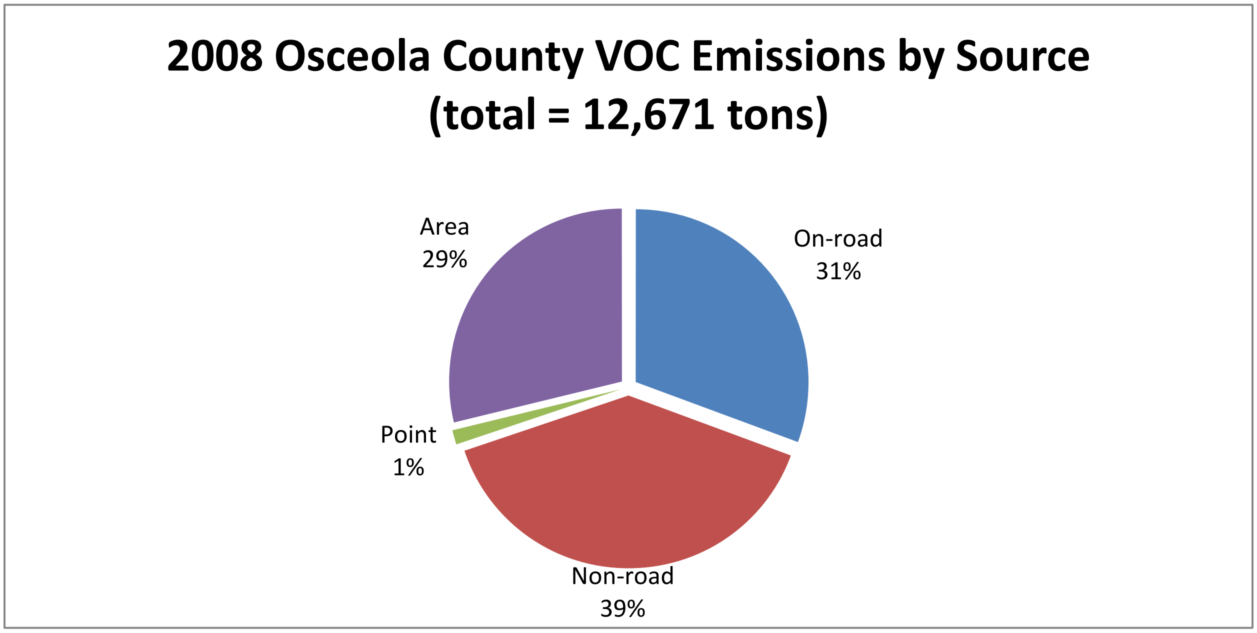

Figure 29 – 2008 Osceola county VOC emissions by source

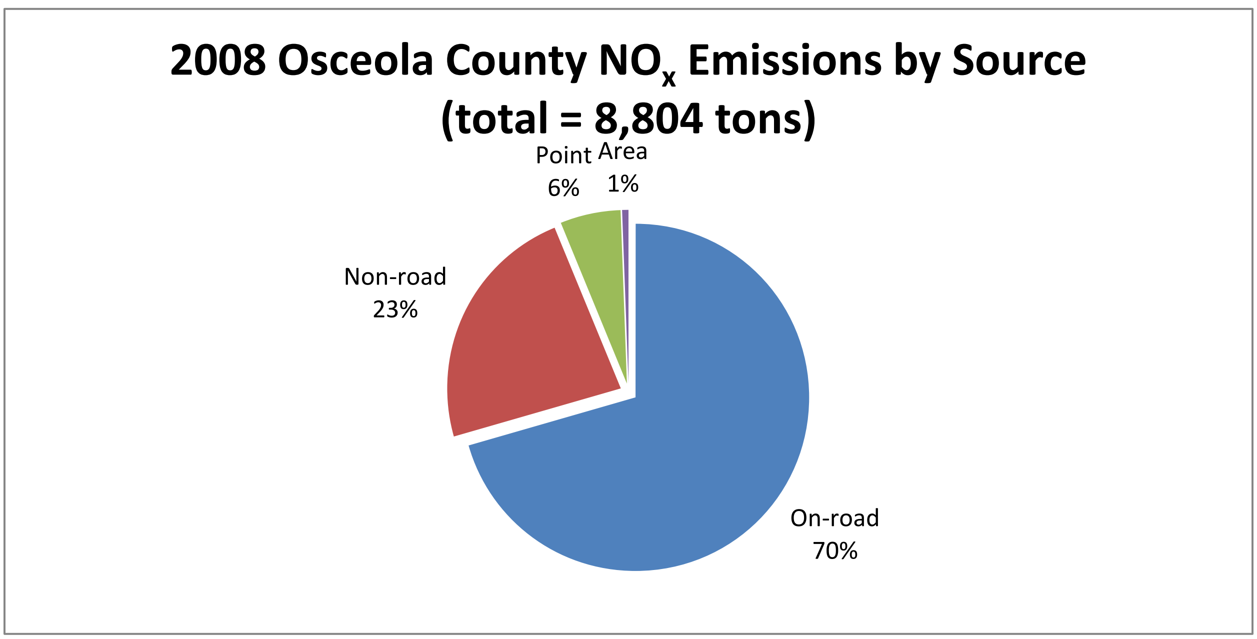

Figure 30 – 2008 Osceola county NO_x emissions by source

References

2008 National emissions inventory data & documentation. (2010, May 17). Retrieved from http://www.epa.gov/ttn/chief/net/2008inventory.html

Arbrandt, M. (2003) 2002 Emission inventory for central Florida. M.S. Thesis, University of Central Florida, Orlando, FL.

Florida Department of Environmental Protection. (2010, March 29). *Emission Sources – Permitting*. Retrieved from http://www.dep.state.fl.us/air/emission/permitting.htm.

Florida Department of Environmental Protection. (2010, January 04). *Emission Sources – Emission Inventory*. Retrieved from http://www.dep.state.fl.us/air/emission/inventory.htm.

Florida Department of Transportation. (2009). *Public Road Mileage and Miles Traveled, 2008*. Retrieved from http://www.dot.state.fl.us/planning/statistics/mileage-rpts/public08.pdf.

Pokharel, S.S., Bishop, G.A., & Stedman, D.H. (2002). An on-road motor vehicle emissions inventory for Denver: an efficient alternative to modeling. *Atmospheric Environment*, *36*, 5177-5184.

Strum, M., Mintz, D., & Driver, L. (2007). *Estimating the monthly variation in California's nonroad equipment emissions for the 2002 emissions and air quality modeling platform*. Retrieved from www.epa.gov/ttn/chief/conference/ei16/session4/strum.pdf.

Theophanides, M., & Anastassopoulou, J. (2009). Air pollution simulation and geographical information systems (GIS) applied to Athens International Airport. *Journal of Environmental Science and Health, Part A*, *44*(8), 758-766.

U.S. Environmental Protection Agency. (2004, August). *Introduction to emission inventories*. Retrieved from http://www.epa.gov/apti/course419a/index.html.

U.S. Environmental Protection Agency. (2010, May 10). *MOBILE6 vehicle emission modeling software*. Retrieved from http://www.epa.gov/otaq/m6.htm.

U.S. Environmental Protection Agency, Clean Air Markets Division. (2010). *Data and maps*. Retrieved from http://camddataandmaps.epa.gov/gdm/index.cfm?fuseaction= emissions.wizard.

U.S. Environmental Protection Agency, Office of Air and Radiation. (2003). *User's guide to MOBILE6.1 and MOBILE6.2* (EPA420-R-03-010). Retrieved from http://www.epa.gov/ otaq/m6.htm.

U.S. Environmental Protection Agency, Office of Air and Radiation. (2005). *User's guide for the final NONROAD2005 model* (EPA420-R-05-013). Retrieved from http://www.epa.gov/ otaq/models/nonrdmdl/nonrdmdl2005/ 420r05013.pdf.

U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. (1998). *NOx: How nitrogen oxides affect the way we live and breathe* (EPA-456/F-98-005). Retrieved from http://www.cleanairaction.org/pubs/pdfs/old_pubs/noxfldr.pdf.

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