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Task 3.2

Proposed Planning Process for the Emission Inventory

Technical Proposal

June 1st, 2012

Prepared by:

Alamo Area Council of Governments

Prepared in Cooperation with the Texas Commission on Environmental Quality

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Abstract: The Clean Air Act is the comprehensive federal law that regulates airborne emissions across the United States. This law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. San Antonio is currently in attainment of the “criteria” pollutants according to the NAAQS. However, high concentrations of ground level ozone, one of the “criteria” pollutants, are measured periodically at local monitors. Ozone forms in the lower atmosphere when organic compounds (VOC) and nitrogen compounds (NO_X) react in the presence of sunlight. Currently, the ozone primary standard, which is designed to protect human health, is set at 75 parts per billion (ppb). Local and state air quality planners need to have an accurate account of emissions and their sources in the region to identify trends, analyze the effects of regulatory actions, and simulate air quality and atmospheric processes through computer dispersion modeling. The objective of the proposal is to provide a review and update of the emission inventory for 2011 including the following categories: municipal and small airports, recreational marine vessels, commercial lawn and garden equipment, and agricultural pesticide applications. Emission estimates from these categories have been over estimated or under estimated when traditional methodologies were used. By using local data and surveys, improvements in the amount and spatial allocation of emissions are achieved. When improved emission estimates are developed, control strategy modeling and SIP development is improved. The proposed updates will include sources in the San Antonio-New Braunfels MSA, consisting of eight counties located in South Central Texas and part of the Hill Country. The results could be considered for inclusion in the regional photochemical model.

Related Reports:	**Distribution Statement:**	**Permanent File:**
2005 Emission Inventory for the Alamo Area Council of Governments Region	Alamo Area Council of Governments, Natural Resources/Transportation Department	Alamo Area Council of Governments, Natural Resources/Transportation Department

EXECUTIVE SUMMARY

The Clean Air Act is the comprehensive federal law that regulates airborne emissions across the United States.[1] This law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. Of the many air pollutants commonly found throughout the country, EPA has recognized six pollutants named "criteria" pollutants that can injure health, harm the environment, or cause property damage. Air quality monitors measure concentrations of these pollutants throughout the country. As of the end of 2011, San Antonio/Bexar County is in attainment of the "criteria" pollutants based on current NAAQS thresholds. However, high concentrations of ground level ozone, one of the "criteria" pollutants, are measured periodically at monitors located in northern Bexar County, placing the area at risk for failing the NAAQS in the future. Ozone forms when organic compounds (VOC) and nitrogen compounds (NO_X) react in the presence of sunlight.[2]

Currently, the ozone primary standard, which is designed to protect human health, is set at 75 parts per billion (ppb). The secondary standard, which is designed to protect the environment, is in the same form and concentration as the primary standard. One of the air quality management tools local and state planners use to identify trends, analyze the effect of regulatory actions, and run photochemical models is an accurate account of emissions and their sources.

The objective of the proposal is to provide a review and update of the emission inventory in 2011 for the San Antonio region including the following categories: small airports, recreational marine vessels, commercial lawn and garden equipment, and agricultural pesticide applications. Emission estimates from these categories have been over estimated or under estimated when traditional methodologies were used. By using local data and surveys, improvements in the amount and spatial allocation of emissions are achieved. When improved emission estimates are developed, control strategy modeling and SIP development is improved. The proposed updates will include sources in the San Antonio-New Braunfels MSA, consisting of eight counties located in South Central Texas and part of the Hill Country. The results could be considered for inclusion in the regional photochemical model.

[1] US Congress, 1990. "Clean Air Act". Available online: http://www.epa.gov/air/caa/. Accessed 07/19/10.
[2] EPA, Sept. 23, 2011, "Ground-level Ozone". Available online: http://www.epa.gov/air/ozonepollution/. Accessed 10/31/11.

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1. INTRODUCTION

1.1. Background

The Clean Air Act is the comprehensive federal law that regulates airborne emissions across the United States.[3] This law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. Of the many air pollutants commonly found throughout the country, EPA has recognized six pollutants, often referred to as "criteria" pollutants that can injure health, harm the environment, or cause property damage. Air quality monitors measure concentrations of these pollutants throughout the country. San Antonio is currently in attainment of all "criteria" pollutants in accordance with thresholds established for the NAAQS. However, there are concerns over the high concentrations of ground level ozone, one of the "criteria" pollutants, which local monitors are recording. Ozone forms in the lower atmosphere when organic compounds (VOC) and nitrogen compounds (NO_X) react in the presence of sunlight.[4]

According to the EPA, "the health effects associated with ozone exposure include respiratory health problems ranging from decreased lung function and aggravated asthma to increased emergency department visits, hospital admissions and premature death. The environmental effects associated with seasonal exposure to ground-level ozone include adverse effects on sensitive vegetation, forests, and ecosystems."[5] Currently, the ozone primary standard, which is designed to protect human health, is set at 75 parts per billion (ppb). The secondary standard, which is designed to protect the environment, is in the same form and concentration as the primary standard. Developing an accurate account of emissions and their sources in the region is a basic step in the air quality management process and allows local and state planners to identify appropriate controls and analyze their effectiveness. The results for the emission inventory could be considered for inclusion in the regional photochemical model.

1.2. Objectives and Approach

The objective of the proposal is to provide a review of and a proposal to update the 2011 emission inventory input data using local data and surveys. By using local data and surveys, accuracy of estimates and spatial allocation of emission sources are improved. The proposal follows the four steps listed below.

1. Review the National Emissions Inventories (NEI) provided by the TCEQ and compares those estimates to AACOG's emission inventory.
2. Identify any significant source categories that are under or over estimated or where additional or more detailed emissions inventory inputs at a sub-county level can be provided.
3. Identify emission sources and prepare a plan to carry out "bottom-up" research that will provide improved emissions inventory inputs.
4. Develop a plan to generate raw local inputs such as population figures, local activity profiles, spatial surrogates, temporal profiles, or TexN Model files, etc.
5. Provide all electronic data sets to TCEQ, including but not limited to: TexN files; TexN run specifications; EPS3 input files; and EPS3 spatial and temporal surrogates.

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[3] US Congress, 1990. "Clean Air Act". Available online: http://www.epa.gov/air/caa/. Accessed 07/19/10.
[4] EPA, Sept. 23, 2011, "Ground-level Ozone". Available online: http://www.epa.gov/air/ozonepollution/. Accessed 10/31/11.
[5] EPA, September 16, 2009. "Fact Sheet: EPA to Reconsider Ozone Pollution Standards", p. 1. Available online: http://www.epa.gov/air/ozonepollution/pdfs/O3_Reconsideration_FACT%20SHEET_091609.pdf. Accessed 06/28/10.

The focus of these improvements is not the end-product generation of emissions estimates in units of tons per day, but rather the raw local inputs such as population figures, local activity profiles, spatial surrogates, temporal profiles, and other input data. All proposed survey work in this plan is accompanied by a survey design describing the population, the information to be collected from the population, a description of how AACOG intends to collect a sample, the type of sample to be drawn from the population, and the desired margin of error.

1.3. Inventory Pollutants

Ozone is a secondary pollutant because it forms from the chemical reaction between other pollutants, namely:

- Nitrogen Oxides (NO_X)
- Volatile Organic Compounds (VOC)

The photochemical modeling that is conducted to determine a region's ability to comply with the NAAQS depends on accurate input, such as identifying and quantifying emission rates from these pollutants.

1.4. Geographic Area

The proposed updates to the emission inventory will include all sources in the San Antonio-New Braunfels MSA, consisting of eight counties located in South Central Texas and part of the Hill Country. These counties are: Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson counties (figure 1-1).

1.5. Modeling Domain Parameters

Development of input files and/or spatial surrogates for photochemical model emission processing shall be based on a grid system consistent with EPA's Regional Planning Organizations (RPO) Lambert Conformal Conic map projection with the following parameters:

- First True Latitude (Alpha): 33°N
- Second True Latitude (Beta): 45°N
- Central Longitude (Gamma): 97°W
- Projection Origin: (97°W, 40°N)
- Spheroid: Perfect Sphere, Radius: 6,370 km

All future TCEQ photochemical model emissions processing work shall be based on this grid system.

1.6. Data Sources

Specific emissions input data will be calculated by AACOG based on protocols provided by EPA and TCEQ. Emission calculations will be based on the local activity data collected through surveys and TexN Model[6]. Other data sources include County Business Patterns,[7] Federal Aviation Administration,[8] Airport IQ Data Center[9], Texas Agricultural Statistics[10], and Texas

[6] Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency, July 2009. "NONROAD2008a Model". Available online: http://www.epa.gov/otaq/nonrdmdl.htm. Accessed 06/13/11.

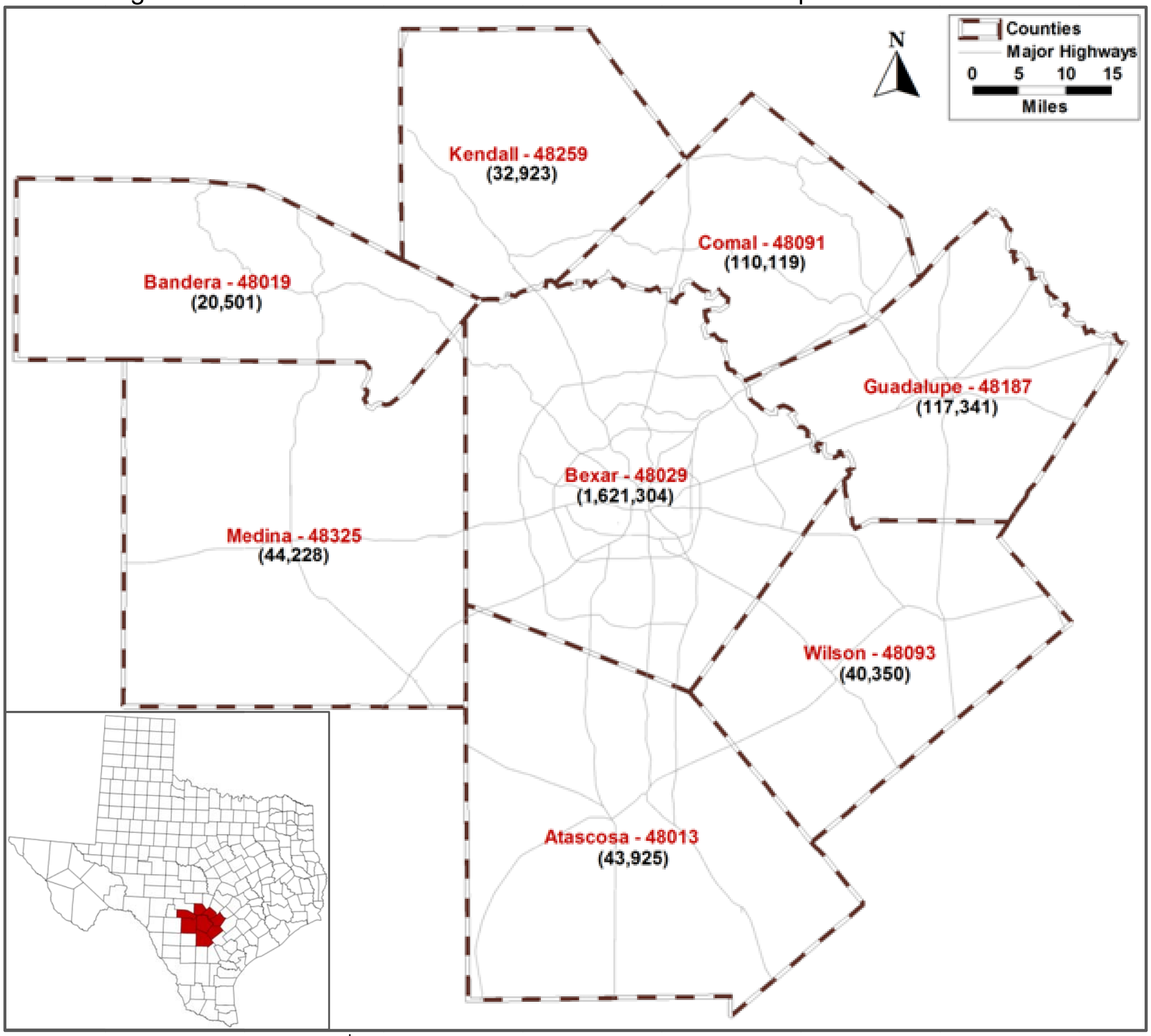
[7] U.S. Census Bureau, July 2009. "2007 County Business Patterns (NAICS)". Available online: http://www.census.gov/econ/cbp/index.html. Accessed 07/21/11.

[8] Federal Aviation Administration, June 2, 2005. "Air Quality Procedures for Civilian Airports and Air Force Bases, Appendix D: Aircraft Emission Methodology". Office of Environment and Energy. Washington, DC. p. D-5. Available online: http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/airquality_handbook/media/App_D.PDF. Accessed 08/05/11.

[9] GCR & Associates, Inc., 2005. Airport IQ Data Center. Available online: http://www.gcr1.com/5010WEB/

A&M University (TAMU)[11]. All current federal and state regulations will be taken into account when calculating emissions.

Figure 1-1: San Antonio-New Braunfels MSA and 2008 Population Estimates[12]



Plot Date: Oct. 3rd, 2011
Map Compilation: Oct. 3rd, 2011
Source: US Census Bureau

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[10] United States Department of Agriculture, Updated December 2009. "Texas Agricultural Statistics, 2006". National Agricultural Statistics Service, Texas Field Office". Available online: http://www.nass.usda.gov/Statistics_by_State/Texas/Publications/Annual_Statistical_Bulletin/bull2006.pd. Accessed 10/06/11.

[11] Doug Stevenson, Ph.D. Sept. 2, 2005 E-mail "Agricultural Pesticides" Extension Associate - Ag Chem, Texas Cooperative Extension, TAMU, College Station, TX

[12] U.S. Census Bureau, Population Division, December 2009. "Metropolitan and Micropolitan Statistical Area Population and Estimated Components of Change: April 1, 2000 to July 1, 2009". Available online: http://www.census.gov/popest/datasets.html. Accessed 09/21/2011.

1.7. Refined Categories

AACOG identified sources and prepared a plan to carry out "bottom-up" research that will provide improved emissions inventory inputs. AACOG proposes to update and expand the following emission inventory categories:

- Municipal and Small Airports
- Recreational Marine Vessels
- Commercial Lawn and Garden Equipment
- Agricultural Pesticide Applications

Emission estimates from these categories have been over estimated or under estimated when traditional methodologies were used. By using local data and surveys, improvements in the amount and spatial allocation of emissions are achieved. When local emission estimates are developed, control strategy modeling and SIP development is improved. Emission contributions for each of the proposed categories are provided in table 1-1 from the 2005 AACOG emission inventory. The results of the data collection process can be used in the TexN Model or other appropriate models to update the model inputs and refine emission estimates.

Table 1-1: Contribution of Emissions for Each Proposed Refined Category in the 2005 San Antonio in Tons per Day and as a Percentage of Total Anthropogenic Emissions – New Braunfels MSA Emission Inventory, tons/day

Emission Inventory Category	NO_X		VOC	
	Tons	Percentage	Tons	Percentage
Small Airports	0.10	0.04%	0.32	0.20%
Recreational Marine Vessels	0.09	0.06%	0.83	0.31%
Commercial Lawn and Garden Equipment	1.94	1.21%	6.67	2.52%
Agricultural Pesticide Applications	0.00	0.00%	0.16	0.10%
Total Anthropogenic Emissions (mobile, point, non-road, area)	264.19	100.0%	160.95	100.0%

2. MUNICIPAL AND SMALL AIRPORTS

Sources of ozone pre-cursor emissions from municipal and small airports include aircraft, evaporative emissions, and non-road equipment. There are 13 municipal and small airports operating in the San Antonio-New Braunfels MSA.

• Pleasanton Municipal Airport	Atascosa
• Boerne Stage Field Airport	Bexar
• Horizon Airport	Bexar
• Stinson Municipal Airport	Bexar
• San Geronimo Airpark	Bexar
• Twin-Oaks Airport	Bexar
• Bulverde Airpark	Comal
• Kestrel Airpark	Comal
• Huber Airpark Civic Club Airport	Guadalupe
• New Braunfels Municipal Airport	Guadalupe
• Castroville Municipal Airport	Medina
• Devine Municipal Airport	Medina
• Hondo Municipal Airport	Medina

There are a number of other private, ranch, helicopter, and recreational airports in the San Antonio-New Braunfels MSA, but these airports are very small, and rarely handle more than 1,000 operations annual. When using default methodologies, only an average aircraft is used at each airport to calculate emissions. By using specific local data on engine types and operations, the accuracy of the emission inventory is improved.

2.1. Aircraft at Municipal and Small Airports

The methodology used to calculate emissions from aircraft at municipal and small airports in the San Antonio-New Braunfels MSA relies on local data and on existing data in the EDMS Model. The methodology involves the following steps:

1. Collecting data on general aviation aircraft types and operations at each municipal and small airport
2. Collecting data on military aircraft usage at municipal and small airports
3. Conducting a survey of local municipal and small airports operations
4. Estimating VOC and NO_X ozone season day emissions by using local data and the latest version of the EDMS model
5. Spatially allocating emissions from aircraft operations at municipal and small airports
6. Providing updated data to TCEQ in electronic format. Raw local input data such as local activity profiles and spatial surrogates will be provided to TCEQ including EDMS files.

2.1.1. Collect Activity Data for General Aviation Aircraft

Landing and take-off data for commercial and general aviation (GA) aircraft can be obtained from GCR Inc.[13] The data includes information on aircraft type, the number of landing and take-off, and arrival and departure time for each flight. GCR's database does not include all operations at every airport and the latest available data, 2008, will be used. The database will allow emissions to be calculated for each specific engine type on the aircraft used at municipal and small airports. By calculate emissions for each aircraft operation and type, improvements in the emission inventory are achieved.

[13] GCR and Associates, Inc. "Airport IQ Data Center". Available online: http://www.airportiq.com/ Accessed 09/21/11.

For consistency and accuracy, GCR data will be compared with data from other sources such as the Federal Aviation Administration's software Terminal Area Forecast (TAF)[14] and City Data.[15] Aircraft activity data at small airports includes:

- Commercial Aircraft/Air Taxi
- General Aviation Aircraft
  - Jet
  - Piston
  - Turboprop
- Military Aircraft

The initial step in calculating aircraft emissions involves determining the number of operations by aircraft type and airport. This step is accomplished by comparing civil aircraft operation data with total aircraft operations from the TAF reports (Table 2-1) using the following formula

Equation 2-1, Number of operations for each aircraft type at each airport

$$NUM_{AB} = OPS_A \times TTAF_B / TGCR_B$$

Where,

NUM_{AB} = Number of operations for aircraft type A at airport B in 2006
OPS_A = Number of recorded operations of aircraft type A in 2008 (from GCR Inc)
$TTAF_B$ = Total number of recorded operations by TAF in 2006 at airport B (Local Data or Terminal Area Forecast Reports in table 2-1)
$TGCR_B$ = Total number of recorded operations by GCR at airport B in 2008 (GCR Inc)

Sample Calculation. Number of Beech 36 aircraft operations using a 225hp Continental IO-470-J engine at Twin Oaks Airport in 2006

NUM_{AB} = 177 operations for Beech 36 aircraft from GCR data x 7,800 total operations from TAF / 1,589 total operations recorded by GCR
= 869 total operations of Beech 36 aircraft at Twin Oaks Airport in 2006

Examples of the results obtained from utilizing the proposed formula are provided in table 2-2 for Twin Oaks Airport in 2006. The table shows aircraft types from the GCR database and total aircraft operations from TAF with the results broken down into Piston, Turboprop, and Jet aircraft types. Since the runway at Twin Oaks is short (2,225 ft), most of the jet operations are by helicopters at the airport. If an engine types is not available in the EDMS model, a similar or default engine type will be used.

2.1.2. Collect Data on Military Aircraft

The military also uses three municipal airports in the San Antonio-New Braunfels MSA for training purposes: Hondo Municipal Airport, Stinson Municipal Airport, and Pleasanton Municipal Airport. The Federal Aviation Administration (FAA) provides annual landing and takeoff (LTO) cycles for military aircraft. However, FAA data does not provide detail of the exact military aircraft types for each LTO; consequently, data on the exact military aircraft types will be obtained from the personnel at each airport and Randolph Air Force Base.

[14] Federal Aviation Administration, Jan. 10, 2011. "Terminal Area Forecast Reports". Washington, DC. Available online: http://aspm.faa.gov/main/taf.asp. Accessed 10/10/11.
[15] City-data, 2010. "FAA registered Airports and Heliports in San Antonio, Texas". Available online: http://www.city-data.com/airports/San-Antonio-Texas.html#T94. Accessed 10/10/11.

Table 2-1: Operations and Based Aircraft at Small Airports, 2006

Airport	Source Date	FAA Identifier	Based Aircraft	Air Carrier	Air Taxi	Itinerary GA	Itinerary Military	Local Civilian	Local Military	Total Ops
Pleasanton Municipal Airport	2010	PEZ	27	0	200	2,000	1,080	3,000	0	6,280
Boerne Stage Field Airport	2007/2008	5C1	98	0	0	9,800	0	19,600	0	29,400
Horizon Airport	2007/2008	74R	7	0	0	40	0	400	0	440
Stinson Municipal Airport	2010	SSF	257	101,636	18,963	83,036	4,289	6,281	743	214,948
San Geronimo Airpark	2007/2008	8T8	38	0	0	3,500	0	7,000	0	10,500
Twin-Oaks Airport	2006/2007	T94	26	0	0	5,200	0	2,600	0	7,800
Bulverde Airpark	2006/2007	1T8	86	0	0	8,200	0	16,400	0	24,600
Kestrel Airpark	2006/2007	1T7	33	0	0	3,300	0	6,600	0	9,900
Huber Airpark Civic Club Airport	2006/2007	E70	20	0	0	1,000	0	2,000	0	3,000
New Braunfels Municipal Airport	2010	BAZ	145	0	1,000	15,000	0	10,000	0	26,000
Castroville Municipal Airport	2007	T89	72	0	0	7,200	0	14,400	0	21,600
Devine Municipal Airport	2010	23R	16	0	0	1,600	0	3,200	0	4,800
Hondo Municipal Airport	2010	HDO	22	0	0	7,565	144,570	10,087	0	162,222
Total			847	101,636	20,163	147,441	149,939	101,568	743	521,490

Table 2-2: Operations and Based Aircraft at Twin Oaks Airport, 2006

Aircraft	Type	Recorded Operations (GCR)	Total Operations (TAF)
Beech 36	Piston	177	869
Beech 58	Piston	18	88
Cessna 152	Piston	88	432
Cessna 172B	Piston	294	1,443
Cessna 182T	Piston	144	707
Cessna 206	Piston	70	344
Cessna 208	Piston	10	49
Cessna 210N	Piston	73	358
Cessna 310I	Piston	35	172
Cessna 340	Piston	13	64
Cessna 414	Piston	15	74
Cessna 421B	Piston	21	103
Cirrus SR20	Piston	5	25
Cirrus SR22	Piston	23	113
Columbia MFG LC41-550FG	Piston	9	44
Commander Aircraft CO 114	Piston	12	59
J Church RV-6	Piston	12	59
Long-EZ	Piston	21	103
Mooney M20R	Piston	119	584
Piper PA-23-250	Piston	22	108
Piper PA-24-180	Piston	14	69
Piper PA-30	Piston	9	44
Piper PA-32R-3	Piston	31	152
Piper PA-38-112	Piston	5	25
Rockwell International 500-S	Piston	10	49
Symphony Aircraft SA 160	Piston	8	39
Other Small Piston Aircraft	Piston	47	231
Aerocomp Comp Air 7SL	Turbo	2	10
Agusta Spa F.260D	Turbo	1	5
Beech 100	Turbo	3	15
Beech 200	Turbo	11	54
Beech 90	Turbo	22	108
Beech B300	Turbo	7	34
Cessna 441	Turbo	1	5
Dehavilland DHC-6	Turbo	1	5
Fairchild SA226-T	Turbo	2	10
Pilatus Aircraft LTD PC-12/47	Turbo	17	83
Piper PA-28RT-201T	Turbo	121	594
Piper PA-31T1	Turbo	26	128
Piper PA-34-220T	Turbo	28	137
Piper PA-42	Turbo	2	10
Piper PA-46-500TP	Turbo	18	88
Rockwell International 690B	Turbo	1	5
Swearingen SA226-T(B)	Turbo	4	20
Bell 407	Jet	1	5
Bell 430	Jet	1	5
Cessna 525	Jet	10	49
Cessna 560	Jet	1	5
Learjet 25D	Jet	1	5
Robinson Helicopter R44	Jet	1	5
S.N.I.A.S. AS-350B ECUREUIL	Jet	1	5
Sino Swearingen SJ30-2	Jet	1	5
Total		1,589	7,800

Although Hondo Municipal Airport was used extensively for training by the air force in 2006, military activity has significantly decreased in the last few years. Pleasanton Municipal Airport is being used for touch and go (TGO) practice by trainees from Randolph Air Force Base. Table 2-3 lists military operations at municipal and small airports, which will be update and used in the EDMS model to calculate emissions.

Table 2-3: Annual TGO Military Operations at Small Airports by Aircraft Type, 2006

Aircraft Type	Pleasanton Municipal Airport	Stinson Municipal Airport	Hondo Municipal Airport
T-6 Texan		2,185	144,570
T34/T-37		2,104	
Beech King Air 90	270		
Jet stream 32	270		
Piper PA23-160	270		
Piper PA-42	270		
Total	1,080	4,289	144,570

2.1.3. Perform Survey of Municipal and Small Airports

Managers will be contacted at each municipal, small, and private airport in the San Antonio-New Braunfels MSA to collect updated operation data. Survey data will include updated operation counts, fuel usage, types of aircraft, hours of operation, and other data that can be used to improve the emission inventory.

Each airport manager will be provided with a copy of the compiled activity data for their airport to review and to ensure that the data used for this project are appropriate and accurate. The data will be quality checked to ensure that it is complete and reasonable. Missing data will be identified along with appropriate surrogates used to quantify activity. The results will also be checked for duplicate data, particularly data associated with the TAF and GCR's 5010 datasets.

2.1.4. Calculate Emissions using EDMS Model

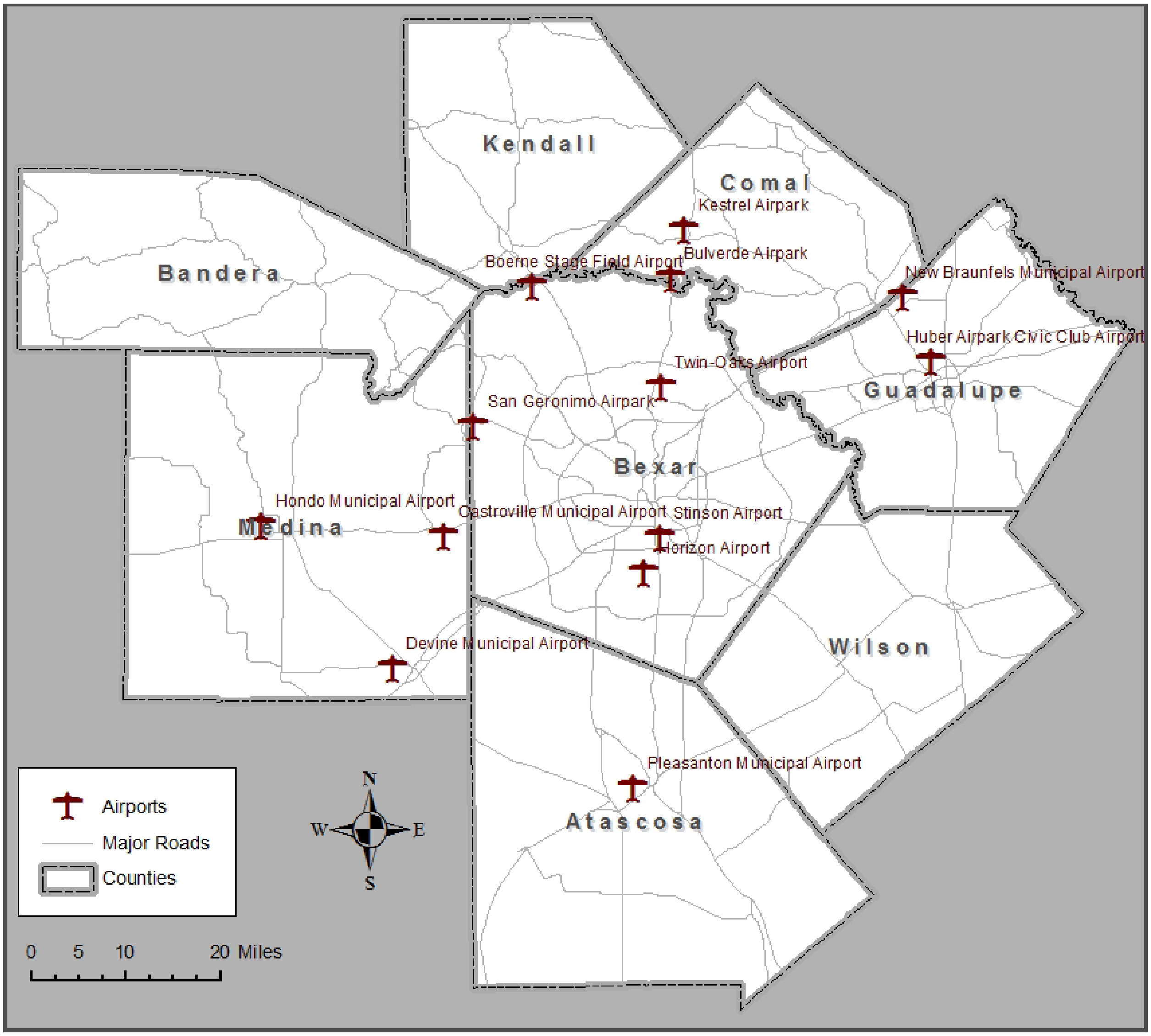
Activity data and the engine type for each aircraft will be entered into the latest version of the EDMS model[16] to calculate emissions from landing and take-off cycles for each aircraft type. Emissions will be estimated for all criteria pollutants where appropriate data are available. If no engine type is provided, a similar type of engine or EDMS' default engine data will be used. This "bottom-up" approach will enhance the accuracy of emission estimations and their spatial allocation.

2.1.5. Spatially Distribute Municipal and Small Airport Aircraft Emissions

Emissions from aircraft at municipal and small airports, within the San Antonio-New Braunfels MSA, will be geo-coded to the photochemical model grid system. Facilities will be mapped to ensure that the airport coordinates match the associated county Federal Information Processing Standard (FIPS) codes. Locations of municipal and small airports in the San Antonio-New Braunfels MSA are provided in figure 2-1.

[16] FAA, Nov. 2009. "Emissions & Dispersion Modeling System". Available online: http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model/. Accessed 09/21/11.

Figure 2-1: Location of Municipal and Small Airports in the San Antonio-New Braunfels MSA, 2011



Plot Date: October 17, 2011
Compilation Date: October 17, 2011
Source: Aerial Photography

2.2. Evaporative Emissions

Evaporative emissions are associated with refueling, diurnal, and pre-flight safety procedures used for piston aircraft. As described in Appendix D of "Air Quality Procedures for Civilian Airports & Air Force Bases"[17], most general aviation aircraft are powered by piston engines, which are fueled by aviation gasoline (AvGas). AvGas has a much higher volatility than jet fuel and fuel tanks are vented into the atmosphere resulting in significant evaporate emissions.

[17] Federal Aviation Administration, June 2, 2005. "Air Quality Procedures for Civilian Airports and Air Force Bases, Appendix D: Aircraft Emission Methodology". Office of Environment and Energy. Washington, DC. p. D-5. Available online: http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/airquality_handbook/media/App_D.PDF. Accessed 08/05/11.

Evaporative emissions from jet fuel are insignificant due to the low vapor pressure of the fuel and the use of quick-connect refueling nozzles.

Evaporative emissions are calculated for general aviation aircraft based at municipal and small airports, but not *itinerant* aircraft. Since the EDMS model does not estimate evaporative emissions, the following steps are proposed for performing these calculations:

1. Determine the number of local operations and number of piston aircraft based at each municipal and small airport.
2. Calculate evaporative emissions for based piston aircraft using EPA's approved methodology.
3. Spatially allocate emissions to the 4km grid system used in the photochemical model.
4. Provide updated data to TCEQ in electronic format. Raw local input data such as spatial surrogates will be provided to TCEQ.

2.2.1. Refueling and Spillage Loss

Municipal and small airports will be surveyed to estimate the amount of fuel sold at each location. According to the EPA, the conversion rate of hydrocarbons (HC) to VOCs is 1.000 for evaporative emissions.[18] If survey data on AvGAS usage is available, the following equation will be used to calculate emissions from refueling activities at each airport.

Equation 2-2, Emissions from AvGAS refueling at airports with survey data

$$DRE_A = FC_A \times REF / 907{,}184.74 \text{ grams/ton} \times CON / 365 \text{ days per year}$$

Where,

DRE_A = Refueling and spillage emissions for Airport A per day
FC_A = Total aviation fuel consumption, in gallons per year, for Airport A (from survey)
REF = Emission factor for refueling and spillage loss, 4.61 HC grams/gallon[19]
CON = HC to VOC conversion ratio, 1.000

If consumption of AvGAS is not available for the airport, the following formula will be used. Total numbers of piston engine aircraft based at small and municipal airports needed for the formula are available from TAF.[20]

Equation 2-3, Emissions from AvGAS refueling at airports without survey data

$$DRE_A = NUM_A \times FUEL \times REF / 907{,}184.74 \text{ grams/ton} \times CON / 365 \text{ days per year}$$

Where,

DRE_A = Refueling and spillage emissions for Airport A per day
NUM_A = Number of piston based aircraft for Airport A
FUEL = Fuel consumption per aircraft per year, 7,370 gallons[21]
REF = Emission factor for refueling and spillage loss, 4.61 HC grams/gallon
CON = HC to VOC conversion ratio, 1.000

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[18] U.S. Environmental Protection Agency, December 2005. "Conversion Factors for Hydrocarbon Emission Components". Office of Transportation and Air Quality Washington, DC. p. 3. Available online: http://www.epa.gov/otaq/models/nonrdmdl/nonrdmdl2005/420r05015.pdf. Accessed 08/05/11.
[19] EPA Office of Air and Radiation memorandum from Mary Manners to Susan Willis dated October 20, 1996. "Subject: Revised Methodology for Calculating the Refueling Losses for General Aviation Aircraft".
[20] Federal Aviation Administration, Jan. 10, 2011. "Terminal Area Forecast Reports". Washington, DC. Available online: http://aspm.faa.gov/main/taf.asp. Accessed 10/10/11.
[21] J. Borowiec, T. Qu, and C. Bell, March 2000. "1996, 1999, and 2007 Airport Emission Inventory". Texas Transportation Institute, College Station, Texas. p. 7.

2.2.2. Diurnal Losses

Diurnal evaporation is associated with fuel venting from the aircraft due to diurnal temperature changes. Airport based piston aircraft, while parked, are subject to ambient temperature variation which causes AvGAS fuel to evaporate from vents installed on the piston engine. The following equation, introduced in Appendix D of the EPA publication entitled, "Air Quality Procedures for Civilian Airports & Air Force Bases,"[22] is proposed for quantifying evaporative emissions from based piston aircraft diurnal losses:

Equation 2-4, Emissions from aircraft diurnal losses

DDE_A = NUM_A x DEF x CON / 2000 lbs/ton

Where,

DDE_A = Diurnal emissions for Airport A per day
NUM_A = Number of piston based aircraft for Airport A
DEF = Emission factor for diurnal losses (0.15 lbs of HC/day/based aircraft)
CON = HC to VOC conversion ratio, 1.000

2.2.3. Pre-flight Safety Check

For calculating evaporative emissions from safety checks, the number of aircraft with piston engines and the number of "local" aircraft operations are required. Since each operation consists of landing or take off, the number of operations is divided by 2. The following equation will be used to calculate pre-flight safety check emissions.

Equation 2-5, Pre-flight safety check emissions

PDE_A = (OPS / 2) x PEF / 2,000 lbs/ton x CON / 365 days per year

Where,

PDE_A = Pre-flight safety checks emissions for Airport A per day
OPS_A = Number of operations for piston aircraft at Airport A per year
PEF = Emission factor for pre-flight safety check (0.20 lbs of HC per LTO cycle[23])
CON = HC to VOC conversion ratio, 1.000

2.2.4. Spatially Allocate Evaporative Emissions

Evaporative emissions will be spatially allocated to the location of each airport in the June 2006 photochemical model 4-km photochemical grid system.

[22] Federal Aviation Administration, June 2, 2005. "Air Quality Procedures for Civilian Airports and Air Force Bases, Appendix D: Aircraft Emission Methodology". Office of Environment and Energy. Washington, DC. p. D-5. Available online: http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/airquality_handbook/media/App_D.PDF. Accessed 10/10/11.

[23] *Ibid*.

2.3. Non-road Equipment at Municipal and Small Airports

Inventory of non-road equipment at municipal and small airports takes into account the following types of equipment.

- Trimmers/Edgers/ Brush Cutters
- Leaf Bowers
- Turf Equipment
- Lawn Mowers
- Rear Engine Riding Mowers
- Front Mowers
- Shredders
- Lawn and Garden Tractors
- Compressors
- Concrete Saws
- Fork Lifts
- Generators
- Off-Highway Trucks
- Paint Machines
- Pressure Washers
- Sweepers
- Water/trash Pumps
- Welding Machines

The initial list of potential equipment included in the survey was based on previous surveys of airports in the San Antonio region. Emissions will be calculated for equipment based on local data collected through surveys and existing data used in the TexN Model. This methodology involves the following steps:

1. Conduct a survey of equipment to determine the usage rates and types used at municipal and small airports.
2. Estimate equipment population and usage for the small airports that did not respond to the survey.
3. Estimate VOC and NO_X emissions using survey data and existing data in the TexN Model
4. Calculate weekday versus weekend emissions for each equipment type
5. Provide updated data to TCEQ in electronic format that can be readily included in the TexN Model. Raw local input data such as local activity profiles and spatial surrogates will be provided to TCEQ for ease of incorporation in the TexN Model

To avoid double counting airport equipment emissions that could otherwise be combined with other off-road inventories, equipment populations at municipal and small airports will be removed from other equipment emission inventories for each county in the San Antonio-New Braunfels MSA. By conducting a local survey of non-road equipment population and activity at municipal and small airports, emissions estimates are improved.

2.3.1. Conduct a Survey of Equipment at Municipal and Small Airports

A survey of equipment used at small airports within the San Antonio-New Braunfels MSA will be conducted using the survey questionnaire attached at the end of this section. The survey will collect the following data on equipment usage:

- Activity – total annual hours of use by type of equipment
- Temporal Profiles – equipment use on weekdays and weekend days for each equipment type
- Population of each equipment type
- Engine Characteristics:
  - Engine Type – gasoline 2-stroke, gasoline 4-stroke, diesel, LPG, electricity
  - Engine Horsepower – rated power of the engine

The mean, margin of error, and standard deviation will be calculated for each equipment type from survey responses.

2.3.2. Estimate Equipment Population and Usage for the Municipal and Small Airports that did not Respond to the Survey

A ratio of equipment type per airport will be calculated for municipal and small airports by dividing the total pieces of equipment counted in each equipment type by the total number of airports. This ratio will be used to calculate estimated equipment populations for the remaining airports, which did not respond to the survey.

Equation 2-6, Populations of equipment used at small airports in the San Antonio-New Braunfels MSA

$$POP_A = EQ_A / SURV$$

Where,

- POP_A = Number of pieces of equipment of type A at each airport
- EQ_A = Number of pieces of equipment of type A from the airports that responded to the survey
- $SURV$ = Number of airports that responded to the survey

2.3.3. Estimate VOC and NO_X Emissions from Non-road Equipment

Once equipment populations are calculated for each airport, VOC and NO_X emissions will be calculated using load and emission factors from the TexN Model.

Equation 2-7, Ozone Season Daily Equipment Emissions for Municipal and Small Airport

$$DE_A = POP_A \times OSD_A \times HP_A \times LF_A \times EF_A / 907{,}184.74 \text{ grams/ton}$$

Where,

- DE_A = Ozone Season Day emissions for equipment type A (tons/day)
- POP_A = Population of Equipment Type A (from survey or equation 2-6)
- OSD_A = Ozone Season Day activity rate for equipment type A, hours (from survey)
- HP_A = Average rated horsepower for equipment type A (from TexN Model)
- LF_A = Typical load factor for equipment type A (from TexN Model)
- EF_A = Ozone season day emissions factor per unit of use for equipment type A (g/hp-hr) (from TexN Model)

2.3.4. Weekday Adjustment for Equipment Use

A weekday versus weekend adjustment factor will be calculated based on the total hours of use during these time periods as determined from the surveys.

2.3.5. Spatial Distribution of Municipal and Small Airport Non-Road Equipment Emissions

Emissions from municipal and small airports non-road equipment, within the 8-County San Antonio-New Braunfels MSA, will be geo-coded to the photochemical model grid system.

Alamo Area Council Of Governments

Date

[COMPANY NAME]
[STREET ADDRESS]
[CITY] [STATE] [ZIP]

ATTENTION: OPERATIONS MANAGER

Re: San Antonio Regional Emissions Inventory

The Alamo Area Council of Governments (AACOG) requests your assistance in the development of an air quality emission inventory by completing and submitting to us the attached survey. Collectively, the data received from these surveys allows AACOG to develop an emissions inventory that serves as an important tool for air quality planning purposes. This inventory is especially significant because the San Antonio region is close to violating federal air quality standards for ground-level ozone pollution.

AACOG will calculate equipment emissions from information submitted by airports in the San Antonio region using responses to the enclosed survey. Specifically, this survey covers information on equipment usage at airports in Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson counties. Your input is vital to this process and will serve to achieve a true and correct emissions inventory, as well as allow us to provide better information and services to the region. Please provide your responses on the attached survey and return it to us in the self-addressed envelope by October 20th, 2012.

Thank you for your time and participation. If you have any questions or comments please feel free to contact Steven Smeltzer, Environmental Manager, at (210) 362-5266.

Sincerely,

Peter Bella,
Natural Resource Director
AACOG

Municipal and Small Airports Equipment Survey

Equipment Type	Fuel Type Diesel 2-stroke 4 stroke LPG Electricity	Approximate Horse-power Rating (each)	Number of Units	Average Daily Hours for each unit (Mon-Fri)	Average Daily Hours for each unit (Sat-Sun)
Trimmer/Edger/ Brush Cutter					
Leaf blower					
Turf Equipment					
Lawn Mower					
Rear Engine Riding Mower					
Front Mower					
Shredder					
Lawn and Garden Tractors					
Compressor					
Concrete Saws					
Fork Lift					
Generator					
Off-Highway Trucks					
Paint Machine					
Pressure Washers					
Sweeper					
Water/trash pump					
Welding Machines					
Other Equipment (specify type)					

3. Recreational Marine Vessels

Recreational marine vessels include pleasure craft powered by inboard or outboard engines, as well as personal watercraft such as jet skis. Although this subcategory of non-road vehicles encompasses a variety of engine and fuel types, most recreational marine vessels are fueled with gasoline and powered by spark-ignition engines.[24] The following recreational marine vessels are included in this proposal: 2-stroke outboard, 2-stroke personal water craft, 4-stroke inboard/sterndrive, diesel inboard/sterndrive, and diesel outboards. Outboard engines are located on small to medium size recreational marine vessels including pontoon, fishing boats, and small runabouts, while the inboards power mid-size runabouts and ski boats. Personal watercrafts are usually powered by water jets and are classified as small recreational marine vessels. Diesel recreational marine vessels are rare and only make up 0.3 percent of the TexN Model population in the San Antonio-New Braunfels MSA.

3.1. Methodology

The methodology used to calculate emissions from recreational marine vessels for the San Antonio-New Braunfels MSA relies on local data produced from surveys and on existing data in the TexN Model. The methodology involves the following steps:

1. Identifying lakes and boating ramps in the San Antonio-New Braunfels MSA used by recreational marine vessels
2. Conducting a local survey of recreational boating activity to determine local equipment use rates and equipment characteristics.
3. Estimating VOC and NO_X ozone season day emissions by using local data and TexN Model load and emission factors.
4. Providing updated data to TCEQ in electronic format that can be readily included in TexN Model. Raw local input data such as local activity profiles and spatial surrogates will be provided to TCEQ for ease of incorporation with the TexN Model.

3.2. Lakes and Boating Ramps in the San Antonio MSA

Table 3.1 lists the locations and water surface area of the primary sites where recreational marine vessels are used in the San Antonio-New Braunfels MSA.[25] Several lakes were not included on this list because of a variety of reasons. For example, Mitchell Lake in Bexar County was not included because it is a wildlife sanctuary, Boerne Lake in Kendall County was not included because motor boats are not allowed on the lake, and Lake Nolte (Meadow Lake) in Guadalupe County was not included because the lake is too small. Boating activities occasionally take place on smaller bodies of water, but recreational marine vessel emissions from these locations are insignificant.

There is also a small 70 acre facility called the Texas Ski Ranch located at 6700 North IH 35, New Braunfels.[26] Boating, water skiing, and wakeboarding are offered at this facility. Although there are some recreational marine vessel activities occurring at the facility with a Mastercraft towboat, most of the activity uses cableway tows and does not require the use of a recreational marine vessel; therefore, this site will not be included in the survey.

[24] U.S. Environmental Protection Agency, December 18, 2009. “Gasoline Boats and Personal Watercraft”. Available online: http://www.epa.gov/otaq/marinesi.htm. Accessed 07/27/11.

[25] Texas Parks and Wildlife. “Texas Lake Finder”. Available online: http://www.tpwd.state.tx.us/fishboat/fish/recreational/lakes/. Accessed 10/07/11.

[26] “Texas Ski Ranch”. Available online: http://www.texasskiranch.com/. Accessed 10/07/11.

Table 3-1: Primary Lakes in the San Antonio-New Braunfels MSA where Recreational Marine Vessels Operate

Lake	County	Surface Area in Acres
Canyon Lake	Comal	8,064
Medina Lake	Bandera	5,459
Calaveras Lake	Bexar	2,675
Victor Braunig Lake	Bexar	1,318
Lake Dunlap	Guadalupe	410
Lake McQueeney	Guadalupe	400
Lake Placid	Guadalupe	400

All the public and the large private boat ramps are listed in table 3-2. Both Medina Lake and Canyon Lake have a significant number of large boat ramps with access to the water. Not all of these boating ramps can be surveyed because some of the boating ramps have restricted access or are private. However, the ramps with public access will be included in the survey.

Some of the smaller lakes only have one or two ramps with access to the water. "Since the closing of McQueeney Marina, there are currently no public ramps or private, fee based boat ramps on Lake McQueeney. Existing boat ramps are either those that belong to various subdivisions for their residents use or ramps on private property. The Guadalupe-Blanco River Authority (GBRA) is looking at the situation in conjunction with other state agencies as they develop their Lake Management Plan".[27] However, Texas A&M survey of recreational watercraft most often used during the 2009 ozone season can be used to determine boating types on Lake McQueeney.[28]

3.3. Survey of Recreational Marine Vessels

To determine recreational marine types, diurnal profile, weekday/weekend allocation, and spatial locations, a boat count survey similar to the Rachel Anderson study conducted in Houston is proposed.[29] A log of activity at each accessible boat ramp will be collected in the San Antonio-New Braunfels MSA during the summer months: June, July, and August. Data collectors will be positioned at each surveyed boat ramp from the time when the ramp opens to when the ramp closes. The number, size, and type of recreational marine vessels entering and leaving the water at the boat ramp will be recorded by hour. A survey protocol for recreational marine vessels will be developed and sent to TCEQ for review.

[27] Friends of Lake McQueeney. "Public Boat Ramp Status". McQueeney, Texas. Available online: http://www.lakemcqueeney.org/. Accessed 10/07/11.

[28] Department of Recreation, Park & Tourism Sciences, Texas A&M University, March 27, 2010. "Study of Recreational Boating use on Lakes Dunlap, McQueeney, Placid, Nolte (Meadow Lake), Gonzales (H4) & Wood (H5)". Guadalupe-Blanco River Authority (GBRA) Public Meeting
Available online: http://www.gbra.org/documents/studies/lakeloading/PublicMtgPresentationMar2010.pdf. Accessed 10/07/11.

[29] Rachel Anderson, Ph.D., Kirstin Thesing, and Jim Wilson, 2009. "Using a Recreational Marine Survey to Improve Spatial and Temporal Allocations in the Houston-Galveston-Brazoria Area". E.H. Pechan & Associates, Inc. Presented at the 18th Annual International Emission Inventory Conference, Baltimore, Maryland - April 15, 2009. Available online:
http://www.epa.gov/ttn/chief/conference/ei18/session4/wilson.pdf. Accessed 10/07/11.

Table 3-2: Boat Ramps in the San Antonio-New Braunfels MSA[30]

County	Body of Water	Boat Ramp Name
Bandera	Medina Lake	Thousand Trails Park[31]
		Joe's Marina and Resort (2 ramps)[32]
		Pop's Place
		Lake Medina RV Resort
		Red Cove Camp
		Bandera County Park on Medina Lake[33]
Bexar	Braunig Lake	Braunig Lake Ramp[34]
	Calaveras Lake	Calaveras Lake's San Antonio River Authority Access
Comal	Canyon Lake	Canyon Lake's Canyon Park
		Rebecca Creek
		Potter's Creek Park, West Ramp
		Potter's Creek Park, Main Ramp
		County Ramp 23
		Tom Creek 2
		Tom Creek 1
		Jacob's Creek Park, North Ramp
		Jacob's Creek Park, South Ramp
		Turkey Cove
		Skyline Park/Canyon Dam
		Canyon Lake's Comal Park
		Canyon Lake's Cranes Mill Park
		Canyon Lake Marina
		Cranes Mill Marina
		Lake Canyon Yacht Club
Guadalupe	Lake Dunlap/ Guadalupe River	Schumans Beach Road (Private)
		IH35 Boat Ramp
	Lake McQueeney	No Public Ramps
	Lake Placid	Exit 605 and Interstate Highway 10

The surveyors will only record vessels entering or leaving the water at the assigned boat ramp. Boat types will be recorded including sailboats with an engine, pontoons, fishing boats, runabouts, ski boats, and other types of recreational marine vessels. The recreational marine vessel data set will include the number of boats at each location for the two day-of-the week

[30] Boat Owners Association of the United States, 2011. “Places to Boat and Fish”. Available Online: http://www.boatus.com/trailerclub/ramp_locator.asp. Accessed 10/07/11.
[31] Equity LifeStyle Properties, 2011. “Thousand Trails”. http://www.1000trails.com/getaways/texas/medinalake.asp. Accessed 10/07/11.
[32] Joe’s Place Marina and Resort, 2004. Available online: http://www.joesplacemedinalake.com/fees.php. Accessed 10/07/2011.
[33] Texas Parks & Wildlife. “Medina Lake: Public Access Facilities”. Austin, Texas. Available online: http://www.tpwd.state.tx.us/fishboat/fish/recreational/lakes/medina/access.phtml. Accessed 10/07/11.
[34] Texas Parks & Wildlife. “Braunig Lake: Public Access Facilities”. Austin, Texas. Available online: http://www.tpwd.state.tx.us/fishboat/fish/recreational/lakes/braunig/access.phtml. Accessed 10/07/11.

categories: weekday (Monday-Friday) and weekend (Saturday-Sunday). During the survey procedure, date, location, meteorological conditions, and other variables will also be recorded.

Additional random surveys can be conducted at locations that were already surveyed to determine a margin of error for the collected data. After several random surveys are conducted, the margin of error will be reviewed to determine if additional sampling is required. Adjustments will be made to the temporal allocation of emissions to account for boats exiting or entering different ramps on the lake.

3.4. Estimate VOC and NO_X annual emissions

Once county level activity rates and boating types are estimated, VOC and NO_X emissions will be calculated using horsepower ratings, load factors, and emission factors from the TexN Model. Local survey data will be inputted into the following formula to calculate ozone season daily emissions.

Equation 3-1, Ozone season daily emissions for recreational marine vessels

$$DE_A = POP_A \times OSD_A \times HP_A \times LF_A \times EF_A / 907{,}184.74 \text{ grams/ton}$$

Where,

- DE_A = Daily ozone season emissions for recreational marine vessel type A (tons/day)
- POP_A = Population of equipment type A (from survey)
- OSD_A = Ozone season day activity rate for recreational marine vessel type A (hrs) (from survey and TexN Model)
- HP_A = Average rated horsepower for recreational marine vessel type A (hp) (from TexN Model)
- LF_A = Typical load factor for recreational marine vessel type A (from TexN Model)
- EF_A = Average emissions factor for recreational marine vessel type A (g/hp-hr) (from TexN Model)

By using this methodology, Pechan & Associates found daily NO_X ozone season emissions where 30% lower and VOC emissions were 20% lower in the Houston Area. Also, spatial allocation of emissions changed significantly with Galveston County emissions being reduced by over 60% while Harris and Montgomery County emissions doubled.[35]

3.5. Temporal Allocation

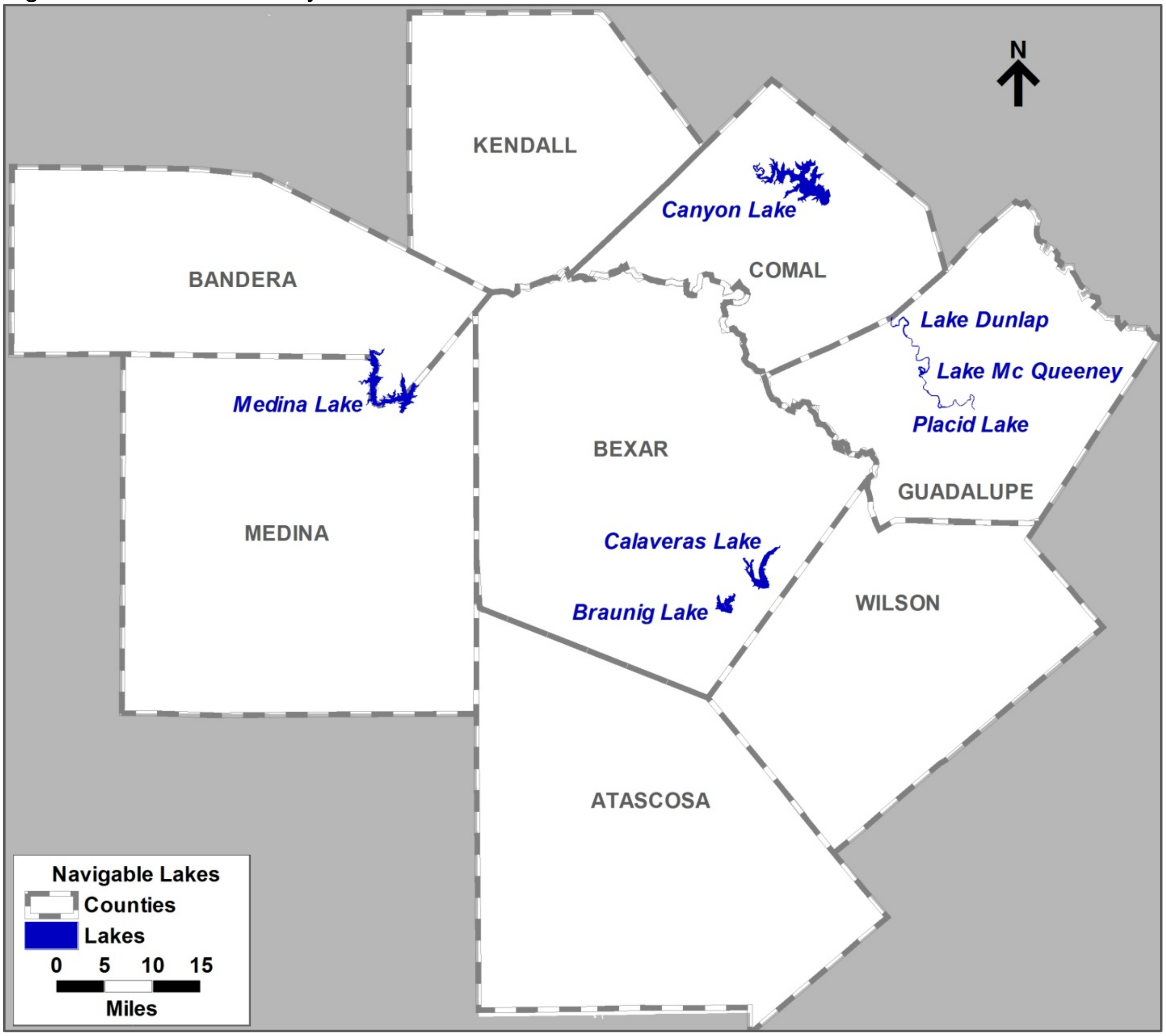
A weekday versus weekend adjustment factor will be calculated based on the total hours of recreational marine vessel activity for each time period as determined from the surveys. The proposed survey will also provide a diurnal profile of activity on each water body for recreational marine activity.

3.6. Spatial Allocation of Emissions

Emissions will be spatially allocated to the 4-km photochemical grid system used in the June 2006 photochemical model. Emissions will be geo-coded to the locations of navigable lakes shown in figure 3-1.

[35] Jim Wilson, E.H. Pechan & Associates, Inc. April 2009. "A Recreational Marine Survey in the Houston-Galveston-Brazoria Area". Available online: http://www.epa.gov/ttnchie1/conference/ei18/session4/wilson_pres.pdf. Accessed 05/23/12.

Figure 3-1: Lakes Used by Recreational Marine Vessels in the San Antonio-New Braunfels MSA



Plot Date: October 17, 2011
Compilation Date: October 17, 2011
Source: Aerial Photography

4. Commercial Lawn and Garden Equipment

Small gasoline and diesel engines used by commercial businesses and government agencies contribute to NO_X and VOC ozone pre-cursor emissions. Having local survey data on commercial lawn and garden equipment usage will improve emission estimates and spatial allocation of emissions. Businesses and agencies that utilize commercial lawn and garden equipment can be broken down into 5 categories:

- Golf Courses
- Universities/Colleges
- Public Schools
- Commercial Lawn and Garden Companies and Land Clearing Companies (both for residential properties and commercial properties)
- Non-Military Government Facilities, Parks, and Hospitals

Lawn and garden equipment used at airports and military bases will not be included in the emission estimations because they are under the emission inventories for the airports and military bases. Cemetery lawn and garden equipment will not be included because the emissions are expected to be insignificant, as cemeteries do not cover large improved areas in the San Antonio-New Braunfels MSA.

4.1. Methodology for Commercial Lawn and Garden Equipment

The methodology proposed to calculate emissions from commercial lawn and garden equipment for the San Antonio-New Braunfels MSA relies on local data produced from surveys and on existing data in the TexN Model. The methodology involves the following steps:

1. Conducting a survey of local commercial lawn and garden equipment activity to determine local equipment use rates and equipment characteristics.
2. Determining equipment population and activity for commercial lawn and garden equipment for facilities without local data by calculating an equipment ratio of sites with local equipment data to facilities without data.
3. Conducting a second survey of facilities that did not respond to the first survey with estimations of local equipment activity. These facilities will be asked to make corrections and send back the survey.
4. Estimating VOC and NO_X ozone season day emissions by using local data and TexN Model load factor and emission factors.
5. Providing updated data to TCEQ in electronic format that can be readily included in TexN Model. Raw local input data such as local activity profiles and spatial surrogates will be provided to TCEQ.

Raw local input data such as population size, local activity profiles, and spatial surrogates will be provided to TCEQ for ease of incorporation with the TexN Model.

4.2. Survey of Commercial Lawn and Garden Equipment Activity

The preferred method for calculating commercial equipment emissions involves conducting a “bottom-up” survey of equipment use within the San Antonio-New Braunfels MSA. The survey will collect the following data for commercial lawn and garden equipment used in the region:

- Activity Rates (HRS) – total annual hours of use by type of equipment
- Temporal Profiles – equipment use on weekdays and equipment use on weekend days for all types of equipment
- Population of each equipment type
- Engine Characteristics:
  - Fuel Type – gasoline 2-stroke, gasoline 4-stroke, diesel, LPG, electricity
  - Engine Horsepower – rated power of the engine

The proposed survey letter for commercial lawn and garden is on the following page.

4.3. Determine Equipment Population for Facilities that are Missing Local Data

Equipment population and activity information for commercial lawn and garden equipment at facilities without local data will be determined by calculating an equipment ratio of sites with local equipment data and applying the ratio to facilities without data.

4.3.1. Golf Courses

Aerial photography and appraisal district data will be used to determine the improved acres for each golf course that did not respond to the first survey (Table 4-1). An equipment to acre ratio will be calculated for golf courses by dividing the total pieces of equipment counted for each category in the first survey by the total number of acres covered by the golf courses reporting use of the equipment. This ratio will be used to calculate estimated equipment populations for the remaining golf courses.

Equation 4-1, Equipment to acre ratio for golf courses

$$RATIO_A = EQ_A / TOTAL$$

Where,

- $RATIO_A$ = Ratio of equipment type A used per acre
- EQ_A = Total pieces of equipment type A for used by golf courses that responded to the first survey (from survey data)
- TOTAL = Total number of acres for golf courses that responded to the first survey (from aerial photography and county appraisal districts)

Golf course acres will be multiplied by the equipment ratio using the following formula.

Equation 4-2, Estimated golf course equipment population by equipment type

$$GPOP_{AB} = ACRES_B \times RATIO_A$$

Where,

- $GPOP_{AB}$ = Population of equipment type A for golf course B
- $ACRES_B$ = Number of acres for golf course B (from aerial photography and county appraisal districts)
- $RATIO_A$ = Ratio of equipment type A per acre (from equation 4-1)

Commercial lawn and garden equipment usage will not include equipment at golf courses located on military bases. These golf courses are included in the military base emission inventories.

Date

[COMPANY NAME]
[STREET ADDRESS]
[CITY] [STATE] [ZIP]

ATTENTION: OPERATIONS MANAGER

Re: San Antonio Regional Emissions Inventory

The Alamo Area Council of Governments (AACOG) requests your assistance in the development of the air quality emission inventory. This inventory is especially significant because the San Antonio region is close to violating federal air quality standards, the National Ambient Air Quality Standards.

AACOG will calculate equipment emissions from information submitted by local organizations involved in landscaping and lawn and garden activities in the San Antonio region using the enclosed survey. With this survey, we are requesting information on lawn and garden equipment used in Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson counties. The purpose of this survey is to provide better information and services to the region. Your input is vital to this process and will serve to achieve a true and correct emissions inventory. Please provide your responses on the attached survey and return it to us in the self-addressed envelope by the date indicated. Please submit your response by October 20th, 2012.

Thank you for your time and participation. If you have any questions or comments please feel free to contact Steven Smeltzer, Environmental Manager, at (210) 362-5266.

Sincerely,

Peter Bella,
Natural Resource Director
AACOG

Lawn and Garden Equipment Survey
Facility: **Address:**

Equipment Type	Fuel Type 2-stroke, 4 stroke, LPG, Diesel, Electricity	Approximate Horse-power Rating (each)	Number of Units	Average Daily Hours for each unit (Mon-Fri)	Average Daily Hours for each unit (Sat-Sun)
Tillers					
Chain Saw					
Trimmer/Edger/ Brush Cutter					
Leaf blower					
Turf Equipment					
Lawn Mower					
Rear Engine Riding Mower					
Front Mower					
Shredder					
Lawn and Garden Tractors					
Chipper/Stump Grinder					
Other Lawn and Garden Equipment (specify type)					

Table 4-1: Number of Acres for Golf Courses by County, 2008

FIPS	County	Total Acres	Percentage
48013	Atascosa	142	1.7%
48019	Bandera	595	7.3%
48029	Bexar	4,631	56.8%
48091	Comal	491	6.0%
48187	Guadalupe	687	8.4%
48259	Kendall	1,080	13.3%
48325	Medina	347	4.3%
48493	Wilson	177	2.2%
Total (San Antonio – New Braunfels MSA)		8,150	100.0%

4.3.2. Universities/Colleges

Equipment population estimations will be based on the number of improved acres at each university/college that did not provide a survey response (Table 4-2). Aerial photography and county appraisal district data will be used to determine the number of improved acres for each university/college. Equipment to acre ratio will be estimated for universities/colleges by dividing the total pieces of equipment counted for each category by the total number of acres using data supplied from facilities responding to the survey.

Equation 4-3, Equipment to acre ratio for universities and colleges

$RATIO_A = EQ_A / TOTAL$

Where,

$RATIO_A$ = Ratio of equipment type A per acre

EQ_A = Total pieces of equipment type A for used by universities and colleges that responded to the first survey (from survey data)

TOTAL = Total number of acres for universities and colleges that responded to the first survey (from aerial photography and appraisal districts)

Table 4-2: Number of Acres for University and Colleges by County, 2008

FIPS	County	Total Acres	Percentage
48013	Atascosa	5	0.3%
48019	Bandera	0	0.0%
48029	Bexar	1,331	87.3%
48091	Comal	0	0.0%
48187	Guadalupe	189	12.4%
48259	Kendall	0	0.0%
48325	Medina	0	0.0%
48493	Wilson	0	0.0%
Total (San Antonio – New Braunfels MSA)		1,548	100.0%

This ratio will be used to calculate estimated equipment populations for the remaining universities/colleges.

Equation 4-4, Estimated universities and colleges equipment populations by equipment type

$UPOP_{AB} = ACRES_B \times RATIO_A$

Where,

$UPOP_{AB}$ = Population of equipment type A for universities and colleges B
$ACRES_B$ = Number of acres for universities and colleges B (from aerial photography and appraisal districts)
$RATIO_A$ = Ratio of equipment type A per acre (from equation 4-3)

4.3.1. Public Schools

A similar method will be used to calculate equipment for independent school districts, but it will be based on the number of public schools provided in Table 4-3. Emissions will be calculated for school districts instead of individual schools because school districts often have one central maintenance department for the whole district. The following formula will use local survey data to calculate lawn and garden equipment usage at all public schools.

Equation 4-5, Equipment to number of schools ratio for public school districts

$$RATIO_A = EQ_A / TOTAL$$

Where,

$RATIO_A$ = Ratio of equipment type A per public school
EQ_A = Total pieces of equipment type A for public schools that responded to the first survey (from survey data)
TOTAL = Total number of public schools that responded to the first survey (from survey data)

For school districts that did not respond to the first survey, average equipment population and types will be allocated to each school based on the following formula.

Equation 4-6, Estimated equipment population by equipment type for public schools that did not respond to the survey

$$SPOP_{AB} = NUM_B \times RATIO_A$$

Where,

$SPOP_{AB}$ = Population of equipment type A for school district B
NUM_B = Number of schools in school district B
$RATIO_A$ = Ratio of equipment type A per public school (from equation 4-5)

Table 4-3: Allocation of Public Schools by County, 2009[36]

FIPS	County	Total Number of Schools*	Percentage
48013	Atascosa	32	5%
48019	Bandera	6	1%
48029	Bexar	445	70%
48091	Comal	46	7%
48187	Guadalupe	40	6%
48259	Kendall	15	2%
48325	Medina	23	4%
48493	Wilson	29	5%
Total (San Antonio – New Braunfels MSA)		636	100%

[36] U.S. Department of Education. "Search for Public School Districts". National Center for Education Statistics, Washington, DC. Available online: http://nces.ed.gov/ccd/districtsearch/. Accessed 10/03/11.

*Military Base Schools are not included (lawn and garden equipment from these schools are included in the Airport/Military emission inventory)

4.3.2. Commercial Lawn and Garden and Land Clearing Companies

The methodology proposed to estimate commercial companies' lawn and garden equipment population and activity rates for the San Antonio MSA relies on local data produced from surveys. Also, a 10% adjustment factor will be applied to commercial lawn and garden equipment based on the methodology used by ERG.[37]

Equation 4-7, Equipment to number of commercial companies ratio

$$RATIO_A = EQ_A / TOTAL$$

Where,

- $RATIO_A$ = Ratio of equipment type A per commercial company
- EQ_A = Total pieces of equipment type A for commercial companies that responded to the first survey (from survey data)
- $TOTAL$ = Total number of commercial companies that responded to the first survey (from survey data)

Equation 4-8, Estimated commercial companies' equipment population by equipment type

$$CPOP_{AB} = NUM_B \times RATIO_A$$

Where,

- $CPOP_{AB}$ = Population of equipment type A for county B
- NUM_B = Number of commercial companies in county B
- $RATIO_A$ = Ratio of equipment type A per commercial company (from equation 4-7)

Table 4-4: Commercial Lawn and Garden Companies in the San Antonio-New Braunfels MSA, 2008[38]

FIPS	County	Number of Commercial Companies
48013	Atascosa	3
48019	Bandera	6
48029	Bexar	235
48091	Comal	44
48187	Guadalupe	25
48259	Kendall	16
48325	Medina	9
48493	Wilson	0
Total (San Antonio – New Braunfels MSA)		338

4.3.3. Non-Military Government Facilities, Parks, and Hospitals

Other facilities with large improved acreage will also be surveyed to determine if they conduct lawn and garden activities. These facilities include local municipalities, power generation

[37] Rick Baker and Sam Wells, Nov. 24, 2003. "Development of Commercial Lawn and Garden Emission Estimations for the state of Texas and Selected Metropolitan Areas". Prepared by Eastern Research Group and Starcrest Consulting Group for Texas Commission on Environmental Quality.
[38] U.S. Census Bureau, Sept. 28, 2011. "County Business Patterns". Available online: http://www.census.gov/econ/cbp/index.html. Accessed 10/03/11.

companies, hospitals, commercial parks, and state parks. If a facility does not respond, a lawn and garden equipment population will not be calculated for this entity.

4.4. Conduct a Second Survey of Commercial Lawn and Garden Equipment

After analyzing survey results, aerial photographs, district appraisal data, and other data sources, a second survey will be sent out to the local businesses that did not respond to the first survey with the estimations of their equipment population, horsepower, and activity rates. The second survey will use the same format as the initial survey. Companies and facilities will be asked to correct estimations and send the surveys back to AACOG.

Once the lawn and garden equipment is tallied for all categories, a comparison will be done between TexN Model existing data and the results from the survey. Table 4-5 shows the breakdown by category for AACOG's 2002 survey results and ERG's 2002 survey. AACOG results match closely with ERG findings for most categories. Overall, the TexN Model under predicts the number of lawn and garden equipment in the San Antonio-New Braunfels MSA compared to the results from previous studies. AACOG's 2002 survey of equipment is 310 percent higher than existing data in the TexN Model (ERG results indicate that the number was 223 percent, but they did not survey all categories).

There were significantly more rear-engine mowers and shedders in the AACOG survey than indicated by the TexN Model. Turf equipment, trimmers, leaf blowers, and chainsaws are also under-predicted in the TexN Model. At the same time, the TexN Model over predicted the number of tillers. AACOG's previous survey results for the San Antonio-New Braunfels MSA did not include the lawn and garden equipment at military bases that would increase the percentage of equipment. Military equipment was included in the airport and military base emission inventory.

4.5. Estimate Ozone Precursors Emissions

Once county level equipment population are calculated, VOC and NO_X emissions will be calculated using load factors and emission factors from the TexN Model. Local population and activity data from the survey will be used in the following formula to calculate ozone season daily emissions.

Equation 4-9, Ozone season daily emissions for commercial lawn and garden equipment

$$DE_A = POP_A \times OSD_A \times HP_A \times LF_A \times EF_A \,/\, 907{,}184.74 \text{ grams/ton}$$

Where,

- DE_A = Daily ozone season emissions for equipment type A (tons/day)
- POP_A = Population of equipment type A (from survey)
- OSD_A = Ozone season day activity rate for equipment type A, hrs (from survey)
- HP_A = Average rated horsepower for equipment type A, hp (from survey and TexN Model)
- LF_A = Load factor for equipment type A (from TexN Model)
- EF_A = Average emissions factor for equipment type A, g/hp-hr (from TexN Model)

Table 4-5: Comparison of Pervious Surveys Equipment Population Estimations, NONROAD Model 2008a, and TexN Model Existing Estimates, San Antonio-New Braunfels MSA

Commercial Equipment Type	NONROAD 2008a Model Default Population	TexN Model Existing Population (2002)	AACOG 2002 Survey*								Percent of TexN Model Population	ERG Results for San Antonio (2002)#
			Commercial Lawn and Garden Companies	Universities / Colleges	Public Schools	Golf Courses	Government Facilities / Parks / Hospitals	Other Companies	Commercial/ Private Airports	Total from AACOG's 2002 Survey		
Lawn Mowers	**12,957**	**2,744**	**2,894**	**20**	**437**	**35**	**167**	**34**	**9**	**3,596**	**131%**	**231%**
Tillers	**4,961**	**350**	**104**	**3**	**4**	**3**	**7**	**0**	**2**	**123**	**35%**	**292%**
Chainsaws	**6,218**	**2,489**	**5,099**	**26**	**47**	**7**	**547**	**9**	**3**	**5,736**	**230%**	**107%**
Trimmers	**15,847**	**2,734**	**5,430**	**320**	**3,729**	**256**	**2,221**	**70**	**115**	**12,140**	**444%**	**232%**
Blowers	**9,013**	**2,121**	**4,106**	**82**	**348**	**201**	**492**	**15**	**17**	**5,261**	**248%**	**347%**
Rear Mower	**414**	**995**	**716**	**77**	**128**	**536**	**155**	**1**	**10**	**1,622**	**163%**	**205%**
Front Mower	**3,205**	**440**	**4,203**	**61**	**200**	**1,429**	**195**	**3**	**16**	**6,106**	**1,388%**	**186%**
Shredder	**2,601**	**45**	**2,221**	**31**	**197**	**0**	**16**	**8**	**5**	**2,479**	**5,514%**	**0%**
Tractor	**3,280**	**0**	**103**	**8**	**395**	**90**	**82**	**3**	**8**	**690**	**0%**	**0%**
Chippers	**835**	**406**	**434**	**0**	**6**	**3**	**51**	**0**	**0**	**494**	**122%**	**201%**
Turf	**8,342**	**57**	**72**	**1**	**14**	**287**	**24**	**0**	**22**	**419**	**737%**	**359%**
Other	**6,217**	**1,312**	**3,607**	**5**	**0**	**0**	**60**	**43**	**0**	**3,716**	**283%**	**227%**
Total	**73,890**	**13,693**	**28,988**	**634**	**5,506**	**2,848**	**4,016**	**187**	**207**	**42,383**	**310%**	**223%**

*Does not include military Lawn and Garden Equipment
#Based on the 2000 4-county MSA: Bexar, Comal, Guadalupe, and Wilson Counties

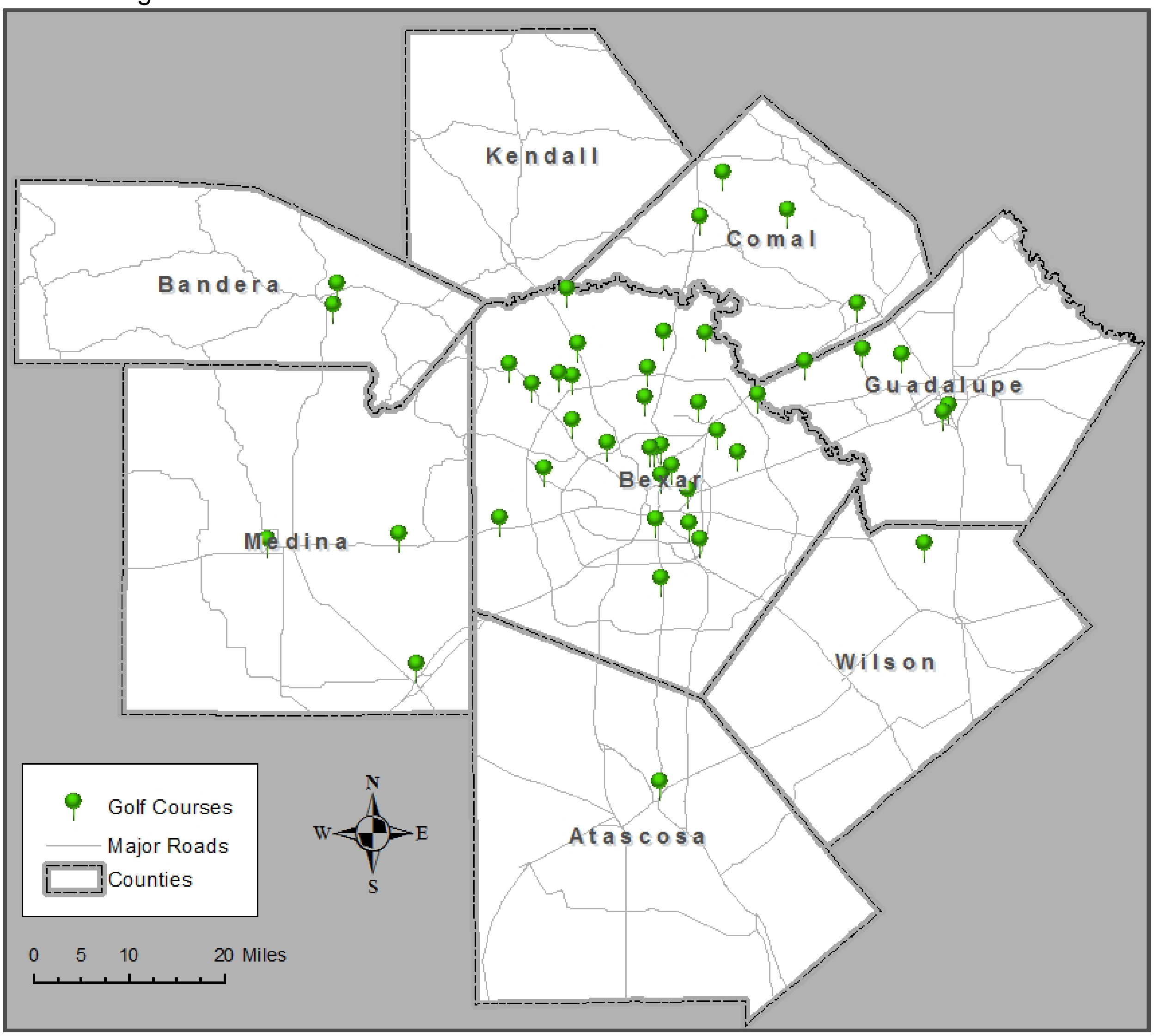
4.6. Temporal Allocation

A weekday versus weekend adjustment factor will be calculated based on the total hours of commercial lawn and garden equipment use for each time period as determined from the surveys for each equipment type and facility type.

4.7. Spatial Distribution

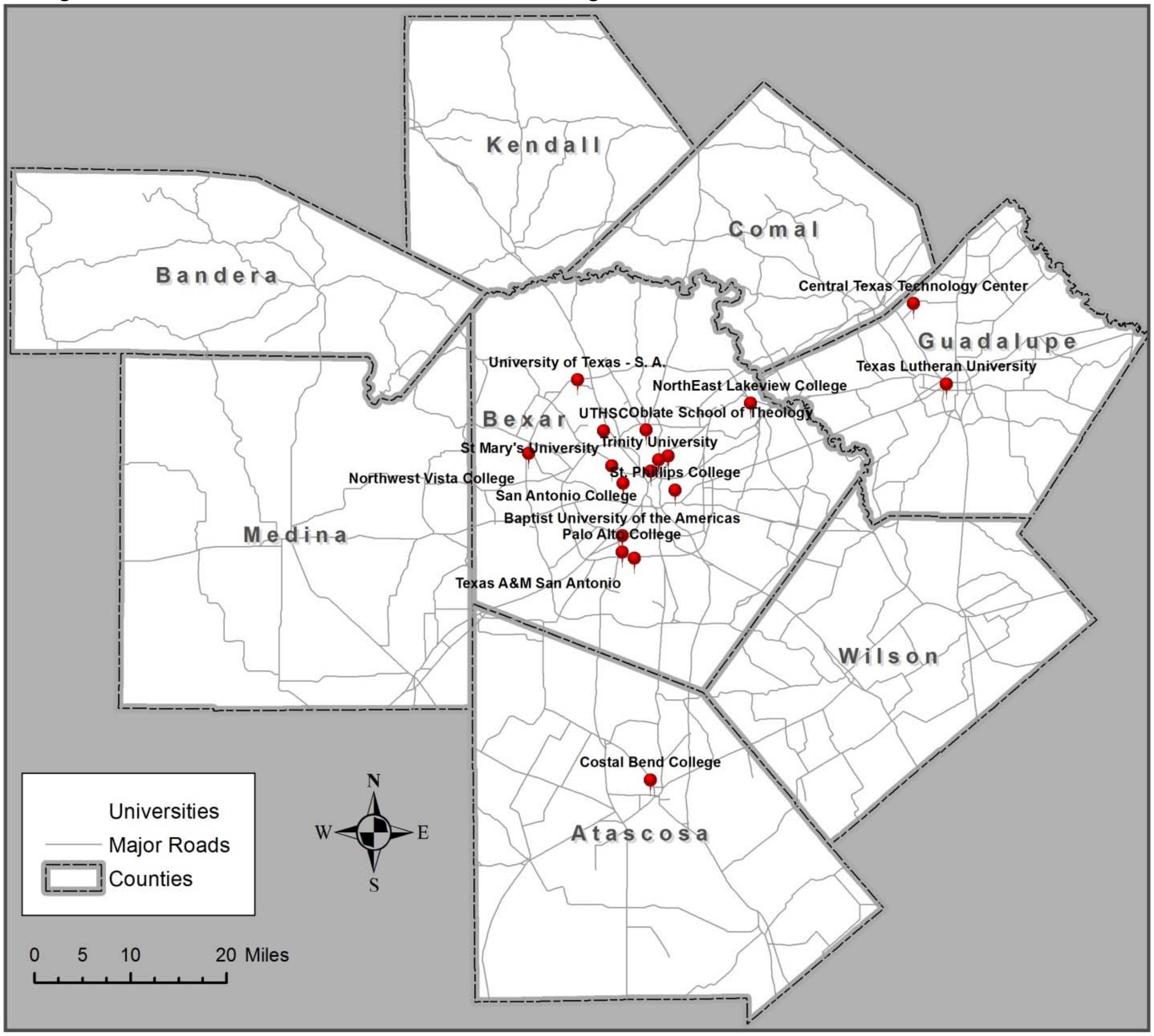
Emissions will be allocated to the 4km grid by the location of the golf courses, public schools, universities/colleges, population, and government facilities, parks, and hospitals. Golf course locations are provided in figure 4-1, while figure 4-2 shows the locations of universities/colleges in the San Antonio-New Braunfels MSA. Locations of public schools are provided in figure 4-3.

Figure 4-1: Location of Golf Courses in the San Antonio-New Braunfels MSA



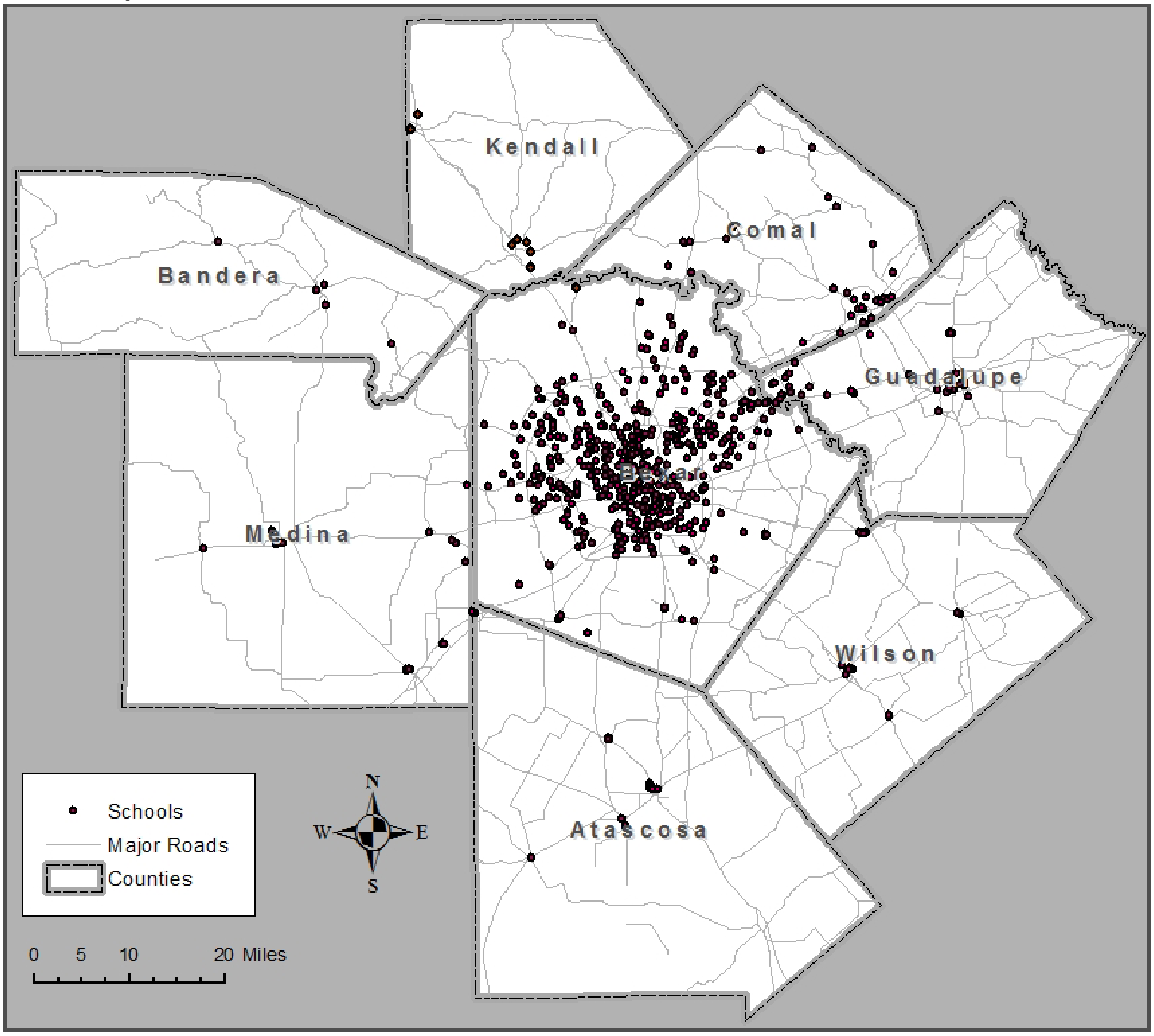
Plot Date: October 17, 2011
Compilation Date: October 14, 2011
Source: Aerial Photography, District Appraisal Data, and Telephone Survey

Figure 4-2: Locations of Universities and Colleges in the San Antonio-New Braunfels MSA



Plot Date: October 18, 2011
Compilation Date: October 21, 2011
Source: Aerial Photography

Figure 4-3: Locations of Public Schools in the San Antonio-New Braunfels MSA



Plot Date: October 18, 2011
Compilation Date: October 21, 2011
Source: Aerial Photography and U.S. Department of Education

5. Agricultural Pesticide Applications

The definition of a pesticide from the Title 7 U.S. Code 136 (FIFRA) Sec. 2 is:

> (1) "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest,
> (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and
> (3) any nitrogen stabilizer, except that the term "pesticide" shall not include any article that is a "new animal drug" …. The term "pesticide" does not include liquid chemical sterilant products (including any sterilant or subordinate disinfectant claims on such products) for use on a critical or semi-critical device."[39]

EPA's Emission Inventory Improvement Program (EIIP) prescribes the preferred methodology for calculating emissions from agricultural pesticide applications. This methodology will be used with local data to estimate emissions from the use of agricultural pesticides in the AACOG region, and involves the following steps:

1. Identify the pesticides used in significant volumes in the San Antonio-New Braunfels MSA along with the percentage of active ingredients, vapor pressure of active ingredients, fraction of VOC, application rate for each pesticide, and application time for each crop.
2. Calculate emission factors based on vapor pressure of active ingredients, fraction VOC in the formulation, and the application rate of the pesticides.
3. Estimate ozone precursor emissions from volatilization of pesticides. Emission factors are multiplied by the number of acres of each crop to estimate total emissions of pesticides by crop for each county.[40]
4. Spatially allocate emissions based on crop locations.
5. Provide raw local input data such as local activity profiles and spatial surrogates to TCEQ.

Note that pesticides used in the home and gardens are categorized as consumer/commercial solvent use and are not included in this proposal. By using default emission factors and usage rates of pesticides, emissions are significantly over estimated. When local data on pesticide types, usage, acres by crop type, and application rates are used, emission estimates are significantly improved.

5.1. Determine Pesticides Used on Area Crops and Application Timetable

Agricultural pesticides are applied to the following harvested crops in the San Antonio-New Braunfels MSA:

- Corn
- Peanuts
- Sorghum
- Cotton
- Wheat

To calculate agricultural pesticide emissions, crop acres planted and harvested for each county will be collected. Crop acreages by crop types are available from the 2006 Texas Agricultural Statistics report published by USDA (Table 5-1).[41]

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[39] Title 7, Chapter 6, Subchapter II § 136. "Federal Insecticide, Fungicide, and Rodenticide Act: Definitions". p. 12. Available online: http://www.epa.gov/opp00001/regulating/fifra.pdf. Accessed 10/24/11.
[40] U.S. Environmental Protection Agency, June 2001. "Emissions Inventory Improvement Program: Volume 3, Chapter 9 – Pesticides – Agricultural and Nonagricultural". Research Triangle Park, North Carolina. Available http://www.epa.gov/ttnchie1/eiip/techreport/volume03/. Accessed 10/24/11.
[41] United States Department of Agriculture, Updated December 2009. "Texas Agricultural Statistics, 2006". National Agricultural Statistics Service, Texas Field Office". Available online:

Table 5-1: Acres Harvested by Crop Type for Each County in the San Antonio-New Braunfels MSA, 2006.

FIPS	County	Corn	Sorghum	Wheat	Cotton	Peanuts
48013	Atascosa	0	0	500	2,200	2,200
48019	Bandera	0	0	0	0	0
48029	Bexar	4,200	2,500	400	2,400	0
48091	Comal	1,200	0	0	0	0
48187	Guadalupe	6,300	11,900	4,200	2,400	0
48259	Kendall	0	0	0	0	0
48325	Medina	13,100	5,400	3,600	12,000	0
48493	Wilson	2,600	3,100	600	1,100	0
Total		27,400	22,900	9,300	20,100	2,200

Types of pesticides commonly used for these crops were obtained from the Bexar County Texas Cooperative Extension.[42] The Extension service provided information on pesticides used in the San Antonio-New Braunfels MSA and the times of the year the pesticides are applied (Table 5-2). To determine the composition of each pesticide, the county extension office recommended the Clemson University Cooperative Extension website.[43] The website contains a "Pest Management Handbook" that lists and describes pesticides used for each agricultural crops.

Table 5-2: Types of Pesticides Used and Seasonal Adjustment[44]

Crop Type	Pesticide	Monthly Usage		
		After crops are planted	Pegging	Spray at heading
Corn	Aztec	March	N/A	N/A
	Counter 15	March	N/A	N/A
	Counter 20	March	N/A	N/A
Sorghum	Karate Z 2.08 CS	N/A	N/A	June-July
Peanuts	Lorsban 15 G	June/July	N/A	N/A
	Temik 15 G	May	June/July	N/A
Cotton	Bidrin 8 EC	May/June	N/A	N/A
	Orthene 97 PE	May/June	N/A	N/A
	Temik 15 G	June	N/A	N/A
Wheat	Lorsban 4E	March/April	N/A	N/A
Hay	none	N/A	N/A	N/A

http://www.nass.usda.gov/Statistics_by_State/Texas/Publications/Annual_Statistical_Bulletin/bull2006.pd. Accessed 10/06/11.

42 August 2004. "The Texas Cooperative Extension, Bexar County office". Available online: http://bexar-tx.tamu.edu. Accessed 10/24/11

43 Clemson University Cooperative Extension. 2011. "Pesticide Product Registration". Clemson University. Clemson, SC. Available online: http://www.clemson.edu/public/regulatory/pesticide_regulation/our_service_areas/pesticide_product_registration/index.html. Accessed 10/24/11

44 Jerry W Warren. Sept. 4, 2005. e-mail "Agricultural Pesticides"

It is important to note that many “Pesticides are applied as a band over the row and not the total area. For example, a herbicide may be sprayed in a 10 inch band on rows planted 40 inches apart - so the actual herbicide use would by 10/40 or about 25% of the planted acreage.”[45] Once the application rates were calculated, an average application rate will be obtained per pesticide per acre (Table 5-3). Practically none of the 7.2 million acres of small grain crops that are planted in Texas receive pesticide treatments. According to Doug Stevenson Ph.D. from the Texas Cooperative Extension at Texas A&M University,

> “Texas plants about 7.2 million acres of wheat every year. About 6.9 million are fall grain, and about 300,000 are spring grain. About 6.7 million of those acres are wheat. All wheat planted in Texas is grazed to some extent. According to USDA Ag Statistics Service, only 2.8 to 3.4 million acres are harvested for grain. The rest are either grazed off completely or cut for hay. Grazing also eliminates problems with the key pests of wheat, such as greenbug (Schizaphis graminum), bird-oat-cherry aphid (Rhopalosiphum padi), corn leaf aphid (Rhopalosiphum maidis), Russian wheat aphid (Diuraphis noxia) and English grain aphid (Macrosiphum avenae). Grazing also eliminates problems from occasional pests, such as chinch bugs (Blissus leucopterus), brown wheat mite (Petrobia latens) and winter grain mite (Penthaleus major), armyworms (Pseudaletia unipuncta, Spodoptera eridania, Spodoptera frugiperda, Spodoptera ornithogalli), and grasshoppers. Resistant varieties are used to eliminate Hessian fly and the wheat rusts. Seed certification eliminates smuts. Grazing replaces virtually all insecticide and fungicide treatments of the crop.
>
> Texas plants about 2.5 to 3.5 million acres of sorghum. About half is grazed and harvested for hay, with less than 10% receiving pesticide applications. About 1.5 to 2 million acres are harvested for grain. These are grown in rotation with other crops. Between half and three-fourths of the grain sorghum requires minimum weed control, usually achievable by cultivation; weed control in the previous crop suppresses most weeds. Between 25 and 50 percent of grain sorghum crops receive herbicide treatments. Serious insect pests, such as greenbug and sorghum midge are controlled with resistant varieties or cultural practices. Late planted fields in South Texas may require pesticide treatment, but these account for only about 5% of the total acres in Texas. Taking herbicide and insecticide application figures into account, slightly more than 600,000 acres are treated with pesticide.
>
> Some estimates of treated crops refer to the large proportion of treated seed planted. About 85% of the crops planted in the United States use commercial seed. The other 15% comes from farmers who save their seed for replanting. Virtually 100% of commercial seed receives treatment by fungicides and about half is treated with additional insecticide. The average treatment usually applies about 100 grams of active ingredient per 100 kilograms of treated seed (1g/kg). Since the average seeding rate for most crops is about 5 to 16 kilograms (12.5 to 40 lb) of seed per acre, the amount of any particular seed treatment pesticide entering the environment is about 0.005 to 0.016 kg. (0.01 to 0.02 lb) per acre.”[46]

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[45] Smith, Dudley, July 26, 2005 e-mail, “Ag practices Pesticides”, Soil and Crop Sciences, Texas A&M University

[46] Doug Stevenson, Ph.D. Sept. 2, 2005 E-mail “Agricultural Pesticides” Extension Associate - Ag Chem, Texas Cooperative Extension, TAMU, College Station, TX

Table 5-3: Pesticide Application, Usage Rate, and Number of Applications

Crop	Pesticide	% of Crop that use each pesticide	Usage Rate	Number of Applications
Corn	Aztec	85%	0.0125 - 0.0400 lbs	1
	Counter 15 G	85%	0.0125 - 0.0400 lbs	1
	Counter 20 CR	85%	0.0125 - 0.0400 lbs	1
Sorghum	Karate Z 2.08 CS	25%	0.96-1.28 oz/ac	1
Peanuts	Lorsban 15 G	1%	13.3 lbs/ac	1
	Temik 15 G	3%	4-7 lbs/ac	2
Cotton	Bidrin 8 EC	85%	0.0125 - 0.0400 lbs	1
	Orthene 97 PE	85%	0.0125 - 0.0400 lbs	1
	Temik 15 G	85%	0.0125 - 0.0400 lbs	1
Wheat	Lordban 4E	0.1%	16 oz/ac	1
Hay	None	0%	N/A	0

Emission factors per acre will be calculated for both active and inert ingredients by crop type. For active ingredients, emission factors per acre is based on pounds of pesticide used per acre multiplied by the fraction of active ingredients and emission factor per pound of active ingredient. A similar calculation will be used to calculate inert ingredient emission factors per acre. The emissions per acre for active ingredients are added to the emissions per acre for inert ingredients to get a total emission factor by acre for each pesticide. Table 5-4 lists the emission factors by crop and pesticide for both active and inert ingredients.

Emissions for each pesticide will be summed by crop type[47] and multiplied by the number of acres for each crop type in each county and the percentage of area the pesticide is applied to each acre to estimate county total emissions.

5.2. Calculate Emission Factors for Each Pesticide

Below are the equations that will be used to calculate pesticide emission factors for each pesticide type

Equation 5-1, Active ingredient emission factor per acre for pesticides

$$AEF_A = AR_A \times FA_A \times VEF_A$$

Where,

AEF_A = Active ingredient emission factor per acre for pesticide A
AR_A = Average application rate for pesticide A, lbs/acre (from Table 5-3)
FA_A = Fraction of active ingredient for pesticide A (from Table 5-4)
VEF_A = Active ingredient emission factor for pesticide A, lbs/ton (from Table 5-4)

[47] Smith, Dudley and Anisco, Juan, August 2000. "Crop Brief on Production, Pests, & Pesticides". Texas A&M AgriLife, Texas A&M University, Texas Agricultural Experiment Station, and the Texas AgriLife Extension Service. Available online: http://aggie-horticulture.tamu.edu/extension/cropbriefs/. Accessed 10/24/11.

Table 5-4: Pesticide Use and Emission Factors by Crop Type

Crop	Pesticide	Application Rate (lbs/acre)	Active Ingredient					Inert Ingredient			Total EF per acre (Inert + Active) (lbs/ton)
			Active Ingredient	Percentage of Active ingredient	Vapor Pressure	EF of Active Ingredient (lbs/ton)	Active EF per acre	Inert Formulation Type	EF of Inert Ingredient	Inert EF per acre (lbs/ton)	
Corn	Aztec	3.93	Cyfluthrin	0.1%	2.1E-08	0.35	0.029	Granule/flake	0.25	0.96	0.99
			Tebupirimphos	2.0%	N/A						
	Counter 15 G	0.09	terbufos	90.0%	3.2E-04	0.58	0.048	Granule/flake	0.25	0.00	0.05
	Counter 20 CR	0.09	terbufos	90.0%	3.2E-04	0.58	0.048	Granule/flake	0.25	0.00	0.05
	Total for Corn										**1.09**
Sorghum	Karate Z 2.08 CS	0.10	lambda cyhalothrin	22.8%	1.5E-09	0.35	0.008	Pressurized sprays	0.39	0.03	0.04
	Total for Sorghum										**0.04**
Peanuts	Lorsban 15 G	13.3	chlorpyrifos	15.0%	1.7E-05	0.35	0.029	Granule/flake	0.25	0.12	0.15
	Temik 15 G	5.5	aldicarb	15.0%	3.0E-05	0.35	0.029	Granule/flake	0.25	0.12	0.15
	Total for Peanuts										**0.29**
Cotton	Bidrin 8 EC	0.10	dicrotophos	82.0%	1.6E-04	0.58	0.048	Emulsifiable concentrate	0.56	0.01	0.06
	Orthene 97 PE	0.09	acephate	97.0%	1.7E-06	0.35	0.029	Pellet/Tablet	0.27	0.00	0.03
	Temik 15 G	0.55	aldicarb	15.0%	3.0E-05	0.35	0.029	Granule/flake	0.25	0.12	0.15
	Total for Cotton										**0.23**
Wheat	Lorsban 4E	1.00	chlorpyrifos	44.9%	1.7E-05	0.35	0.16	Emulsifiable concentrate	0.56	0.31	0.47
	Total for Wheat										**0.47**

N/A = Not Established

Equation 5-2, Inert ingredient emission factor for pesticides

$IEF_A = AR_A \times (1-FA_A) \times VEF_A$

Where,

IEF_A = Inert ingredient emission factor for pesticide A
AR_A = Average application rate for pesticide A, lbs/acre (from Table 5-3)
FA_A = Fraction of active ingredient for pesticide A (from Table 5-4)
VEF_A = Inert ingredient emission factor of pesticide A, lbs/ton (from Table 5-4)

Equation 5-3, Total emission factor for each pesticide

$TEF_A = AEF_A + IEF_A$

Where,

TEF_A = Total emission factor per acre for pesticide A, lbs/acre
AEF_A = Active ingredient emission factor for pesticide A, lbs/acre (from equation 5-1)
IEF_A = Inert ingredient emission factor for pesticide A, lbs/acre (from equation 5-2)

5.3. Estimate Precursor Emissions from Pesticides

Once county level pesticide use and emissions factors are calculated, VOC emissions will be calculated. Local pesticide use will be used in the following formula to calculate ozone season daily emissions.

Equation 5-4, Ozone season daily VOC emissions for pesticides use

$AE_{AB} = \sum (ACRE_B \times TEF_A \times NUM_A \times PER_A / 2000 \text{ lbs/ton}) / 214$ ozone season days per year

Where,

AE_A = Ozone season daily VOC emissions for pesticide A for crop type B (tons/day)
$ACRE_B$ = Crop acres for crop type B (from U.S. Department of Agriculture (USDA) National Agricultural Statistics Service, Table 5-1)
TEF_A = Total emission factor per acre for pesticide A, lbs/acre (from equation 5-3)
NUM_A = Number of applications for pesticide A during the ozone season (from Table 5-2)
PER_A = Fraction of acres with pesticides A (from Table 5-2)

5.4. Spatial Allocation of Emissions

Data from the Natural Agricultural Statistics Service will be used to geo-code pesticide emissions.[48] The following crops were identified and will be used to estimate acres in each 4km grid square:

- Corn
- Peanuts
- Wheat
- Sorghum
- Cotton

[48] National Agricultural Statistics Service. "CropScape – Cropland Data Layer". United States Department of Agriculture. Available online: http://nassgeodata.gmu.edu/CropScape/. Accessed 06/06/11.

Draft maps of crop acreage provided in figure 5-1 will be checked using satellite imagery and data from 2006 Texas Agricultural Statistics reports[49] to make sure location of crops were accurate. Using the default methodology, agricultural pesticides are evenly distributed over a county or applied to all agricultural acreage. By applying the emissions to specific crop type, photochemical model performance can be improved.

Most crops, including corn, peanuts, wheat, sorghum, and cotton, are grown in the southern and central parts of the San Antonio-New Braunfels MSA. These crops are not grown in Bandera and Kendall counties because the soils are not suitable for extensive crop production. Once crop locations are identified, agricultural pesticide emissions will be spatially allocated to the 4-km photochemical grid system used in the June 2006 photochemical model. Future improvements can include averaging crop acreage and production over multiple years because farmers often rotate crops.

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[49] United States Department of Agriculture, Updated December 2009. "Texas Agricultural Statistics, 2006". National Agricultural Statistics Service, Texas Field Office". Available online: http://www.nass.usda.gov/Statistics_by_State/Texas/Publications/Annual_Statistical_Bulletin/bull2006.pd. Accessed 10/06/11.

Figure 5-1: Acres of Corn, Peanuts, Wheat, Sorghum, and Cotton for each 4km Photochemical Modeling Grid.