Proposed Planning Process for the 2008 Area Source Emission Inventory

Technical Report

August 30th, 2010

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. Local and state planners employ a number of tools and data sets to evaluate regional air quality and compare ambient concentrations with the NAAQS. Chief among these evaluation tools is an emissions inventory that accurately describes, chemically, spatially and temporally, the emissions that contribute to regional air pollution. The compilation of the 2008 emissions inventory (EI) for the AACOG region requires extensive research and analysis, providing a vast database of regional pollution sources and emission rates. By understanding these varied sources that create ozone precursor pollutants, planners, political leaders, and citizens can work together to protect heath and the environment. The objective of the proposal is to provide a review of and update the area source portion of the 2008 National Emissions Inventories published by TCEQ. AACOG staff identified emission sources and prepared a plan to carry out “bottom-up” research that will provide improved emission inventory inputs. AACOG proposes to update and expand the following emission inventory categories: dry cleaning, municipal solid waste landfills, oil and gas well production, and stationary diesel generators. These categories accounted for 10.2% of the 2005 anthropogenic VOC emissions in the 12-county AACOG region.

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

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Introduction

Background

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, the EPA has recognized six "criteria" pollutants that can injure health, harm the environment, or cause property damage. The EPA refers to these pollutants as criteria air pollutants because health-based criteria (science-based guidelines) are the bases for setting permissible levels. The primary NAAQS sets the threshold levels, concentration values above which human health is put at risk, for each criteria pollutant.

San Antonio is currently in attainment of the ozone NAAQS. However, "on January 6, 2010, EPA proposed to strengthen the national ambient air quality standards (NAAQS) for ground-level ozone, the main component of smog. The proposed revisions are based on scientific evidence about ozone and its effects on people and the environment. EPA is proposing to strengthen the 8-hour "primary" ozone standard, designed to protect public health, to a level within the range of 0.060-0.070 parts per million (ppm). EPA is also proposing to establish a distinct cumulative, seasonal "secondary" standard, designed to protect sensitive vegetation and ecosystems, including forests, parks, wildlife refuges and wilderness areas. EPA is proposing to set the level of the secondary standard within the range of 7-15 ppm-hours."[2] 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."[3]

To meet the stricter standard, local and state air quality planners need to have an accurate record of emissions sources in the region. The compilation of the 2008 emissions inventory (EI) for the AACOG region requires extensive research and analysis, providing a vast database of regional pollution sources and emission rates. By understanding these varied sources that create ozone precursor pollutants, planners, political leaders, and citizens can work together to protect heath and the environment.

Objectives and Approach

The objective of the proposal is to provide a review of and update the area source portion of the 2008 National Emissions Inventories published by TCEQ. The proposal follows the four steps listed below.

1. Review the area portion of the National Emissions Inventories (NEI) provided by the TCEQ and compare emissions 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 input at a sub-county level can be provided.

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[1] US Congress, 1990. "Clean Air Act". Available online: http://www.epa.gov/air/caa/. Accessed 07/19/10

[2] EPA, January 6, 2010. "Fact Sheet: Proposal to Revise the National Ambient Air Quality Standards for Ozone"., p. 1. Available online: http://www.epa.gov/air/ozonepollution/pdfs/fs20100106std.pdf. Accessed 06/28/10.

[3] 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.

3. Identify sources and prepare a plan to carry out “bottom-up” research that will provide improved emission inventory inputs.
4. Develop a plan to generate raw local inputs such as population figures, local activity profiles, spatial surrogates, temporal profiles, etc.

Emphasis is placed on the 2008 NEI because it reflects the latest available inputs and methodology. The focus of these improvements are 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 minimum desired sample size.

Inventory Pollutants

Ozone is a secondary pollutant because it forms as the result of chemical reactions between other pollutants, namely:

- Nitrogen Oxides (NO_x)
- Volatile Organic Compounds (VOC)
- Carbon Monoxide (CO)

Photochemical modeling used to determine a region’s ability to comply with the NAAQS depends on accurately identifying and quantifying ozone precursor emission rates.

Geographic Area

The proposed updates to the 2008 area emission inventory will include all emission sources in the AACOG region, which consists of twelve counties located in South Central Texas and part of the Hill Country. These counties include: Atascosa, Bandera, Bexar, Comal, Frio, Gillespie, Guadalupe, Karnes, Kendall, Kerr, Medina, and Wilson counties (figure 1).

Data Sources

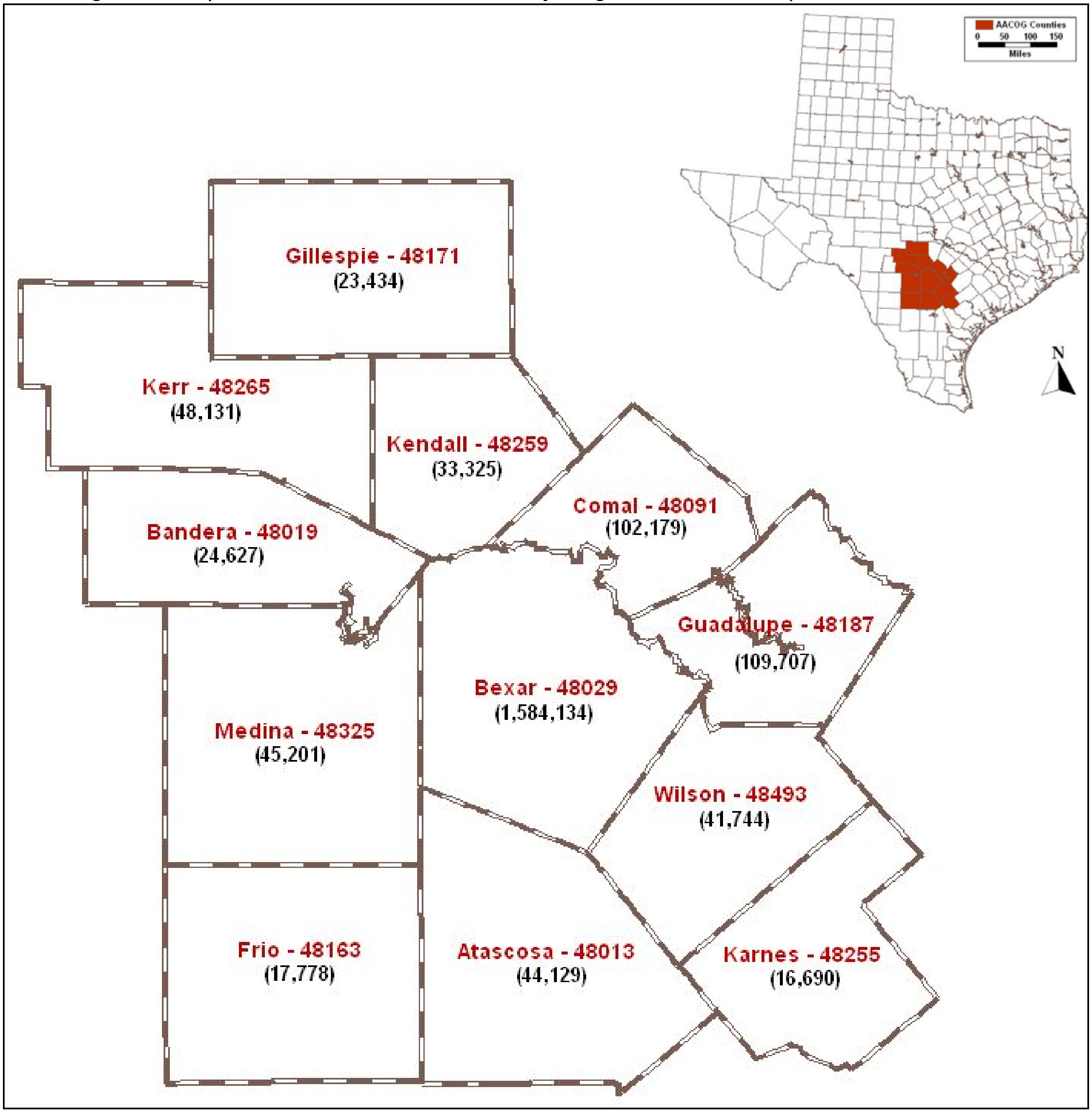
Emissions from each category will be calculated by AACOG based on protocols provided by EPA and TCEQ. Emission calculations will be based on local activity data. Other data sources include the Texas Water Development Board,[4] County Business Patterns,[5] and Texas Workforce Commission.[6] All current federal and state regulations will be taken into account when calculating emissions.

[4] Texas Water Development Board, May 2010. “2011 Regional Water Plan County Population for 2010 – 2060”. Austin, TX. Available online: http://www.twdb.state.tx.us/wrpi/data/proj/popwaterdemand/2011Projections/Population/2CountyPopulation.pdf. Accessed 07/20/10.

[5] U.S. Census Bureau, July 2009. “2007 County Business Patterns (NAICS)”. Available online: http://www.census.gov/econ/cbp/index.html. Accessed 07/21/10.

[6] Texas Workforce Commission, 2008. “Employment Data for 3rd quarter 2008”. Austin, Texas.

Figure 1: Map of the AACOG Twelve-County Region with 2008 Population Estimates



Plot Date:	July 27, 2010
Map Compilation:	July 27, 2010
Source:	Texas Water Development Board, May 2010. "2011 Regional Water Plan County Population for 2010 – 2060". Austin, TX.

Refined Categories

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

- Dry Cleaners
- Municipal Landfills
- Oil and Gas Production Wells
- Stationary Diesel Generators

Table 1 lists the daily estimated emission of NOx and VOCs from AACOG's 2005 Emissions Inventory for each of the proposed categories and compares these rates to the total VOC and NOx emissions from all anthropogenic sources.

Table 1: Contribution of Emissions for Each Proposed Refined Category in the 2005 AACOG Emission Inventory, tons/day

Emission Inventory Category	VOC		NOx	
	Tons	Percentage	Tons	Percentage
Dry Cleaners	1.03	0.70%	0.00	0.00%
Municipal Landfills	0.32	0.22%	0.00	0.00%
Oil and Gas Production Wells	13.40	9.12%	5.19	2.15%
Stationary Diesel Generators	0.30	0.20%	3.68	1.52%
Total Anthropogenic Emissions	146.93	100.0%	241.54	100.0%

Texas and AACOG Area Emission Inventories

AACOG reviewed TCEQ's 2005 and 2008 emission inventories. Any significant source categories that are under or over estimated or where additional or more detailed emission inventory inputs at a sub-county level can be provided were identified. By increasing the accuracy of emission rates and spatial allocations, model predictions of the region's airshed and estimates of control strategies' impacts on ground level ozone are improved.

Table 2 provides a comparison between the TexAER 2005 emission inventory and AACOG's 2005 emission inventory. The categories in bolded text represent sources with an absolute difference greater than 1.0 tons of NO_x or VOC between the two inventories. There were significant differences in emission totals for onshore oil and gas production, stationary diesel generators, municipal solid waste landfills, architectural surface coatings, solvent utilization, graphic arts, asphalt, pesticides, gasoline breathing losses, and petroleum transport and refueling.

Sources were identified and a plan was prepared to carry out "bottom-up" research that will provide improved emissions inventory inputs. Steps to calculate and spatially allocate emissions from the selected sources are provided in this proposal. Raw local input data produced by the emission inventory improvements, such as population size, local activity profiles, and spatial surrogates, will be provided to TCEQ.

Table 2: Comparison between TexAER 2005 Emission Inventory and AACOG's 2005 Emission Inventory (tons/day)

Source Description	SCC	TCEQ 2005			AACOG 2005			Difference, Tons		
		VOC	NOx	CO	VOC	NOx	CO	VOC	NOx	CO
Stationary Diesel Generators	**20200102**	**-**	**-**	**-**	**0.30**	**3.68**	**0.79**	**-0.30**	**-3.68**	**-0.79**
SSFFU: Boilers and Engines	**210xxxxxxx**	**0.17**	**3.61**	**2.28**	**0.27**	**6.56**	**3.91**	**-0.10**	**-2.95**	**-1.63**
Heavy Duty Diesel Vehicle Idling	**2230070000**	**-**	**-**	**-**	**0.69**	**2.20**	**0.00**	**-0.69**	**-2.20**	**-0.00**
Commercial Cooking: Frying and Charbroiling	230200xxxx	-	-	-	0.46	0.00	1.31	-0.46	0.00	-1.31
Industrial Processes: Food: Bakeries	2302050000	0.83	0.00	0.00	0.91	0.00	0.00	-0.08	0.00	0.00
On Shore Oil & Gas Production: All Processes	**2310001000**	**25.69**	**3.75**	**1.26**	**13.41**	**5.67**	**4.90**	**12.28**	**-1.92**	**-3.64**
Fertilizers	**2325050000**	**0.00**	**4.56**	**0.00**	**0.00**	**3.32**	**0.00**	**0.00**	**1.24**	**0.00**
Architectural Surface Coatings: All Types	**2401001000**	**13.32**	**-**	**-**	**10.20**	**-**	**-**	**3.12**	**-**	**-**
Auto Refinishing	2401005000	1.30	-	-	1.79	-	-	-0.49	-	-
Traffic Markings	2401008000	0.00	-	-	0.10	-	-	0.10	-	-
Coating Solvents	240xxxxxxx	**7.87**	**-**	**-**	**5.58**	**-**	**-**	**2.29**	-	-
Solvent Utilization	**24xxxxxxxx**	**17.90**	**-**	**-**	**14.64**	**-**	**-**	**3.26**	**-**	**-**
Surface Cleaning: Cold Cleaning	**2415300000**	**0.40**	**-**	**-**	**2.17**	**-**	**-**	**-1.77**	**-**	**-**
Dry Cleaning: All Solvents	2420000000	0.62	-	-	1.03	-	-	-0.41	-	-
Graphic Arts	**2425000000**	**4.85**	**-**	**-**	**0.63**	**-**	**-**	**4.22**		
Asphalt Application	**246102xxxx**	**12.38**	**-**	**-**	**5.20**	**-**	**-**	**7.18**	**-**	**-**
Pesticide Application: All Processes	**2461800000**	**5.11**	**-**	**-**	**0.21**	**-**	**-**	**4.90**	**-**	**-**
Petroleum Storage: All: Breathing Losses	**25010xxxxx**	**3.10**	**-**	**-**	**6.48**	**-**	**-**	**-3.38**	**-**	**-**
Petroleum Transport and Refueling	**250xxxxxxx**	**30.53**	**-**	**-**	**10.35**	**-**	**-**	**20.18**	**-**	**-**
Gas Cans: All Types	25010xxxxx	-	-	-	**3.51**	-	-	**-3.51**	-	-
Oil/Gasoline Pipelines	2505040000	-	-	-	0.04	-	-	-0.04	-	-
Open Burning/Fires	**26/28xxxxxxxx**	**1.88**	**0.21**	**27.54**	**4.42**	**0.82**	**38.66**	**-2.54**	**-0.61**	**-11.12**
Municipal Landfills: All Types	**2620000000**	**1.47**	**0.00**	**0.00**	**0.32**	**0.00**	**0.04**	**1.15**	**0.00**	**-0.04**
Municipal Wastewater	2630000000	0.38	0.00	0.00	0.33	0.00	0.00	0.05	0.00	0.00
Leaking Underground Storage Tanks	2660000000	0.17	-	-	0.55	-	-	-0.38	-	-
Catastrophic/Accidental Releases	2830000000	0.05	0.01	0.00	0.03	0.01	0.00	0.02	0.00	0.00
Total		128.02	12.14	31.08	83.63	22.24	49.61	44.39	-10.10	-18.53

Dry Cleaners

VOCs are emitted by the evaporation of solvents used in dry cleaning processes. Dry cleaning typically use synthetic halogenated or petroleum distillate organic solvents for cleaning purposes. Solvents commonly used in the dry cleaning process include:

- Petroleum solvent
- PERC solvent
- DF-2000 solvent (Exxon)
- EcoSolv (Chevron-Phillips)
- Dri-rite solvent
- Water-based solvent

There are only a few coin-operated and industrial dry cleaning facilities located within the AACOG region. Since there are few facilities and industrial launderers typically use only soap and detergents, emissions from these two categories are minimal and will not be included. Furthermore, because PERC is not considered to be photochemically reactive,[7] emissions from PERC solvent dry cleaning will not be included in the emission inventory total. The proposed methodology to calculate emissions from commercial dry cleaning facilities is based on a local survey. The following steps will be used to calculate emissions from dry cleaners:

1. Compile data from a mailed survey requesting the type of solvent used in the dry cleaning process, usage amounts, waste amounts, and activity data.
2. Compile data from a supplemental telephone survey requesting information about the type of solvent used and what dry cleaning activities are performed.
3. Estimate per employee emission factors for solvent usage.
4. Calculate ozone precursor emissions.
5. Spatially allocate emissions to the 4 km photochemical model grid.

Raw local input data such as population size, local activity profiles, and spatial surrogates will be provided to TCEQ.

Step 1: Conduct a Mail Survey of Local Dry Cleaner Chemical Usage
A survey was mailed to 142 dry cleaners in the AACOG region, requesting information on solvent use (type of solvent and volume used) as well as employment and operations information. An example of the mail survey is included at the end of this section. In order to make a general conclusion about the targeted population, the number of returned surveys required for an accurate representation is an important concern. Since determining a suitable sample size is not always clear-cut, several major factors must be considered. Due to time and budget constraints, a 95% level of confidence, which is the risk of error the researcher is willing to accept, was chosen. Similarly, the confidence interval, which determines the level of sampling accuracy, was set at +/- 10%. Since the population is finite, the following equation was used to select the sample size.[8]

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[7] "Air Quality; Revision to Definition of Volatile Organic Compounds - Exclusion of Perchloroethylene, Final Rule." *Federal Register* 61 (7 February 1996): 4588-4591. Available online: http://www.epa.gov/ttn/atw/dryperc/fr07fe96.pdf. Accessed 06/08/10.
[8] Rea, L. M. and Parker, R. A., 1992. "Designing and Conducting Survey Research". Jossey-Bass Publishers: San Francisco.

Equation (1)

$$RN = [CLV^2 \times 0.25 \times POP] / [CLV^2 \times 0.25 + (POP - 1) CIN^2]$$

Where,

RN = Number of survey responses needed to accurately represent the population
CLV = 95% confidence level (1.96)
POP = Population size (207 Dry Cleaners)
CIN = ± 10% confidence interval (0.1)

For a 10% confidence interval:

$$RN = [(1.96)^2 \times (0.25) \times 207] / [(1.96)^2 \times (0.25) + (207 - 1) \times (0.1)^2]$$
$$= 65.82 \text{ responses}$$

Thus, 66 dry cleaners needed to be surveyed in order to meet the 95% level of confidence, and the ±10% confidence interval for solvent usage. Twenty-two dry cleaners responded to the mail survey. Since this mail survey was not significant at the 95% confidence level, the data was supplemented with a telephone survey.

Step 2: Conduct a Telephone Survey of the Type of Solvent Used

Telephone numbers of dry cleaners were collected from Texas Workforce Commission data,[9] phonebooks, the Internet, and other sources. All dry cleaners with a phone number were contacted using a phone survey to supplement data from the mailed survey. Responses from the telephone survey provided the type of solvent used by each facility. As in the mail survey, a response from 66 dry cleaners was needed to make the telephone survey statistically significant at the 95% confidence level. As evident in table 3, the majority of dry cleaners, 138 out of 207, responded to the telephone survey.

Table 3: Telephone Survey Results for Local Dry Cleaners, 2008

Activity data	Number of dry cleaners
No response	4
Drop-off only	40
Petroleum solvent	47
PERC solvent	25
DF-2000 solvent (Exxon)	20
EcoSolv (Chevron-Phillips)	4
Dri-rite solvent	1
Water-based solvent (no emissions)	1
Dry cleaners not contacted by phone	65
Total	207

Step 3: Formulate per Employee Emission Factors from Usage, Waste, and Activity Data

To determine solvent volatilization in lbs of total organic gas (TOG), a mass balance approach will be used to calculate emissions for the amount of solvent waste generated and picked up by waste haulers. The mass of solvent volatilized is the difference between the amount of solvent purchased by the facility and the amount of solvent removed by waste haulers during the year. For those facilities that did not report an amount of solvent removed, this value was estimated to be zero.

[9] Texas Workforce Commission, 2008. "Employment Data for 3rd quarter 2008". Austin, Texas.

To determine the error bounds of the dry cleaner surveys conducted by AACOG, per-employee solvent usage will be calculated from the responses. A 90% level of confidence (p = 0.10) was reported for solvent types with five or more observations (table 4). The results assume that the means are normally distributed.

Table 4: Confidence Interval at 90% for Per Employee Annual Dry Cleaning Solvent Use (gallons/employee/year)

Solvent Type	Parameter	n	Mean	Margin of Error	Percent of Average
PERC	Per Employee EF	8	8	4	50.7%
Petroleum	Per Employee EF	5	148	96	64.8%

Information from the mail survey responses will be used to calculate a per employee emission factor for each solvent used. Table 5 presents the densities and calculated emission factors for the chemicals used in dry cleaning in the AACOG region. The formula used to calculate the per employee emission factor for each solvent type is presented below.

Table 5: Dry Cleaning Emission Factors by Solvent

Type of Solvent	Density (TOG lbs/gal)	Emission Factor (lbs TOG/ employee/yr)
Petroleum (Stoddard Solvent)[10]	6.8	596.3
PERC (Perchloroethylene)[11]	13.47	55.4
DF-2000 (Exxon)[12]	6.4	63.4
EcoSolv (Chevron-Phillips)[13]	6.37	129.9
Dri-rite[14]	8.55	508.6

Equation (2)

$$EF_A = (SU_A - SW_A) \times DEN_A / TE_A$$

Where,

EF_A = Emission factor for solvent A

SU_A = Total amount of solvent A used (gal/yr) (from survey)

SW_A = Total amount of solvent A waste (gal /yr) (from survey)

DEN_A = Density of solvent A (lbs/gal), (from table 5)

TE_A = Total employment for all dry cleaners surveyed using solvent A (from TWC)[15]

From the information obtained from the telephone survey, the per-employee emission factors from the mail survey could be used for the facilities that responded to the telephone survey. The average per-employee emission factor will also be applied to the 65 facilities that were not

[10] State Coalition for Remediation of Drycleaners, January 2002. "Solvent Data Table". Office of Superfund Remediation and Technology Innovation of the Environmental Protection Agency, Washington D.C. Available online: http://www.drycleancoalition.org/download/solvent_table.pdf. Accessed 08/19/10.

[11] *Ibid.*

[12] *Ibid.*

[13] Chevron Phillips Chemical Company LP, September 2008. "Materials Safety Data Sheet: EcoSolv Dry Cleaning Fluid". The Woodlands, Texas. Available online: http://www.cpchem.com/msds/100000013944_SDS_US_EN.PDF. Accessed 07/26/10.

[14] Provided on returned survey to AACOG.

[15] Texas Workforce Commission, 2008. "Employment Data for 3rd quarter 2008". Austin, Texas.

contacted by either the mail survey or the phone survey. The solvent type used by each facility will be estimated based on the percentage of dry cleaners using each solvent type.

Step 4: Calculate Ozone Precursor Emissions
For each dry cleaner solvent type, TOG emissions will be calculated using the following formula:

Equation (3)

$$AE_{XA} = (TE_{XA} \times EF_{A})$$

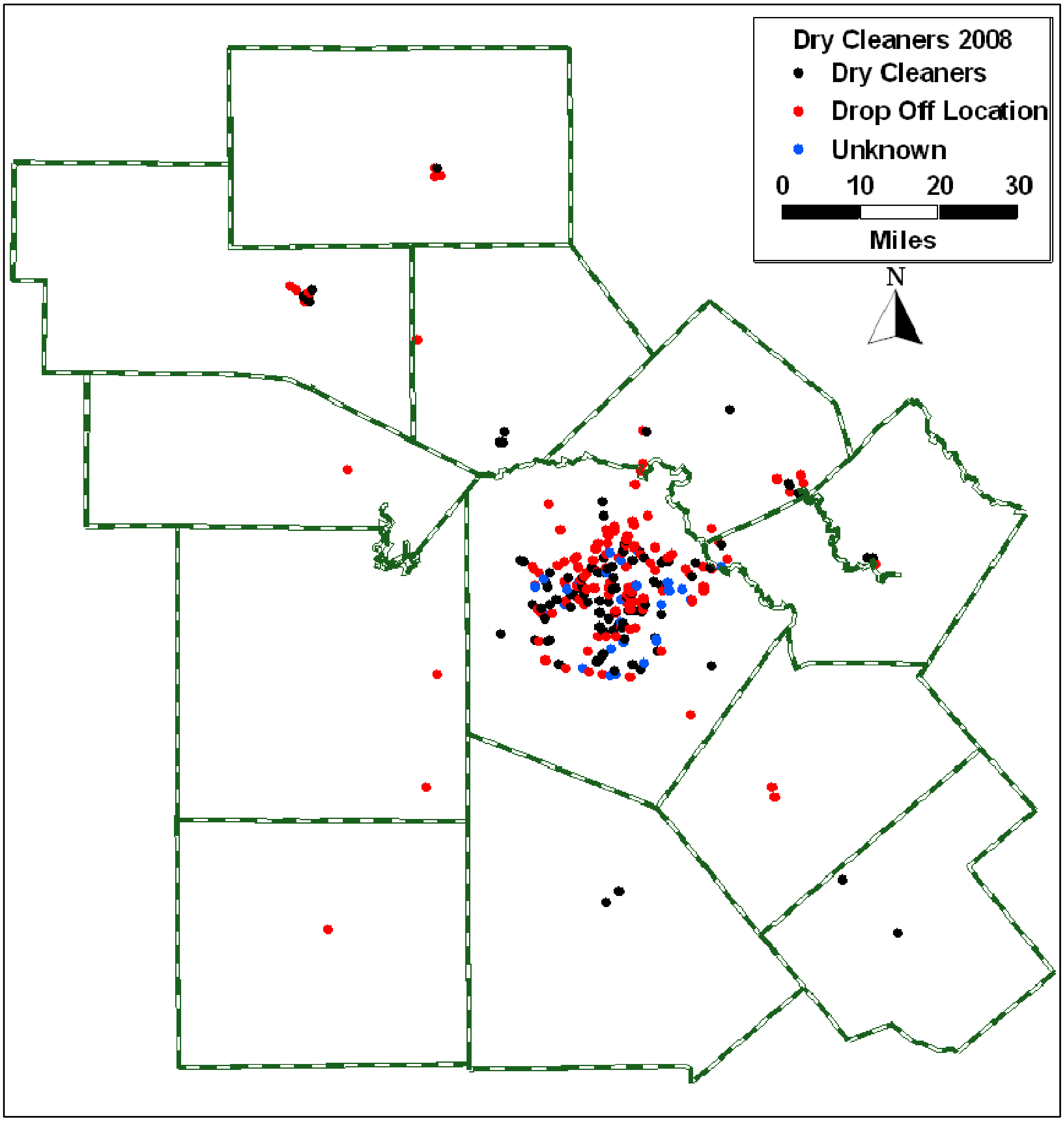
Where,

AE_{XA} = TOG emissions for dry cleaner X using solvent A
TE_{XA} = Total employment for dry cleaner X using solvent A, (from TWC)[16]
EF_{A} = Emission factor for solvent A (lbs TOG/Emp./yr), (from equation (2))

Step 5: Spatially Allocate Ozone Precursor 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 location of dry cleaning facilities identified by address (figure 2).

[16] *Ibid*.

Figure 2: Locations of Dry Cleaning Facilities, 2008



Plot Date:	July 28, 2010
Map Compilation:	July 28, 2010
Source:	Location of dry cleaning facilities from the Texas Workforce Commission, 2008. "Employment Data for 3rd Quarter 2008". Austin, Texas.

Sample Survey

«Company»
«Address», «State» «Zip»

ATTENTION: OPERATIONS MANAGER

The Alamo Area Council of Governments (AACOG) requests your assistance in completion of the Dry Cleaners Emissions Inventory survey. The survey information will be used to assess and quantify emissions from dry cleaning operations within the AACOG 12-county region. Information on local dry cleaning activities is obtained through survey responses. This inventory is a significant part of the emissions management process because the San Antonio region was declared in non-attainment deferred of the National Ambient Air Quality Standards (NAAQS).

The purpose of this survey is to provide better information and services to the region, as well as help minimize additional regulations on the community. Your response is vital to this process and will enable a more precise emissions inventory.

To increase the accuracy of this information we ask that you review the attached survey and input the necessary data. You can return it to us in the self-addressed envelope or fax at (210) 225-5937 attention Steven Smeltzer, Environmental Manager, Alamo Area Council of Governments.

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

Regionally Yours,

Gloria C. Arriaga

Executive Director
Enclosures (1)

8700 Tesoro, Suite 700•San Antonio, Texas 78217•362-5200•Fax: (210) 225-5937•website: www.aacog.com•E-mail: mail@aacog.com

Dry Cleaning Emissions Survey

The purpose of this survey is to collect information about the amounts and types of chemicals used by dry cleaners in the San Antonio region. Completed surveys will allow a more accurate depiction of emissions per facility, thus allowing better analysis of San Antonio's air quality. Therefore, please enter as much of the following information as possible.

Please fill the appropriate box

SOLVENT	***GALLONS USED IN LAST 12 MONTHS***	***GALLONS OF SOLVENTS*** PICKED UP BY WASTE HAULER	***SOLVENT DENSITY (LBS/GAL OF VOC)****
PERC (Perchloroethylene)			
Petroleum (Stoddard Solvent)			
CFC-113 (Trichlorfluroethane)			
TCA (1,1,1-Trichloroethane)			
Carbon Dioxide (CO_2)			
Other Petroleum Solvents (please specify): ______________________			
Other (please specify): ______________________			

*If available, VOC density may be found by studying the Material Data Sheets (MSDSs).

Please provide the number of employees, number of operating days, and number of machines at your facility.

Please fill the appropriate box

Facility Information	
1) Number of employees directly involved with dry cleaning activities	
2) Days of operation per week	
3) Number of dry to dry machines	
4) Number of transfer machines	
5) Number of coin-operated dry cleaning machines	
6) Number of other dry cleaning machines	

Municipal Solid Waste Landfills

Data on open landfills in the AACOG region are provided by the TCEQ FY 2008 landfill report "Municipal Solid Waste in Texas: A Year in Review."[17] In addition to the active landfills, numerous closed municipal solid waste (MSW) facilities in the AACOG region emit emissions.[18] Only MSW facilities will be included in the emission estimates because other waste landfills in the region do not emit significant emissions. Two landfill gas power plants operating at open landfills are included in the TCEQ point source emissions database. The following steps will be used to calculate emissions from landfills:

1. Obtain information on both active and closed landfills in the area, including the average acceptance rate, and the opening and closing years of each landfill.
2. Calculate ozone precursor emissions using LandGEM version 3.02.
3. Estimate ozone precursor emissions from landfill with gas power stations.
4. Spatially allocate landfill emissions to the 4 km photochemical model grid.

Raw local input data such as population size, local activity profiles, and spatial surrogates will be provided to TCEQ.

*Step 1: Obtain Locations and Information on Active and Closed Landfills*
Emissions from active and closed landfills in the AACOG region will be calculated using the EPA LandGEM model version 3.02.[19] The parameters that are required by the LandGEM model include the average acceptation rate, the year the landfill opened, and the year the landfill closed. In addition to active landfills, EPA guidance recommends calculating emissions from closed landfills. Inactive landfills continue to generate emissions after closure, although emission rates decrease with time. According to EPA documentation, it is important to set a cutoff level for landfill size and age in order to avoid excessive investment of resources in landfill calculations.[20] Therefore, only inactive landfills that were closed after 1987 and accepted more than an average of 5 tons of waste a day will be included in the calculations. Table 6 lists all landfills, open and closed, that will be included in the 2008 Emission Inventory calculations.[21]

Parameters for closed landfills required by LandGEM are available from AACOG's Closed Landfill Inventory.[22] This Closed Landfill Inventory will be updated by AACOG from information furnished by Texas Commission on Environmental Quality (TCEQ), permitting records on file with TCEQ, and the Texas Department of Health (TDH), and from aerial photography and GIS

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[17] Waste Permits Division, October 2009. "Municipal Solid Waste in Texas: A Year in Review FY 2008 Data Summary and Analysis". Available online: http://www.tceq.state.tx.us/permitting/waste_permits/waste_planning/wp_annual.html. Accessed 07/01/10.
[18] Waste Permits Division, September 2007. "Municipal Solid Waste in Texas: A Year in Review 2006 Data Summary and Analysis". TCEQ publication, Available online: http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/as/187_07.pdf. Accessed 07/01/10.
[19] Environmental Protection Agency, May 2005. "LandGEM: Landfill Gas Emission Model: Version 3.02". Office of Research and Development, Research Triangle Park, North Carolina. Available online: http://www.epa.gov/ttn/catc/products.html. Accessed 07/01/10.
[20] Eastern Research Group, Inc. January 2001. "Volume III: Chapter 15, Landfills". Prepared for the Area Sources Committee: Emission Inventory Improvement Program, p. 15.3-2. Available online: http://www.epa.gov/ttnchie1/eiip/techreport/volume03/iii15_apr2001.pdf. Accessed 08/19/10.
[21] Alamo Area Council of Governments, 2005. "Closed Landfill Inventory". San Antonio, Texas. Available online: http://regmapr.aacis.net/website/aacogclis/viewer.htm. Accessed 07/01/10.
[22] _*Ibid*_.

data developed by AACOG. Individual maps and legal descriptions of the closed landfills will represent AACOG's best judgment about the landfill's location and legal description based on the best available information.

Table 6: Landfills Inventory by County, 2008

Status	Name	Permit No.	County	Power Plant	Date Open***	Date Closed	Acceptation rate (tons/yr)
Open Permits	Waste Man. of TX	66	Comal	No	5/1/1975	2068	361,021
	Tessman Road	1410	Bexar	Yes	1993	2060	1,212,229
	City of Kerrville	1506	Kerr	No	1983	2019	57,984
	Rosillo Creek	1986	Bexar	No	12/14/1990	-	Not Active*
	Fredericksburg	1995	Gillespie	No	1993	2050	26,967
	Covel Gardens	2093	Bexar	Yes	1993	2086	1,239,751
Closed Landfills	City of Seguin	97	Guadalupe	No	1975	1993	14,600
	City of Hondo	185	Medina	No	1974	1997	4,015
	Atascosa Landfill	260	Atascosa	No	1975	1985	7,300
	Joint Cities	505	Bexar	No	7/1/1975	11/7/1990	9,490
	Devine	1020	Medina	No	1976	1993	5,475
	Nelson Gardens	1237	Bexar	Yes	1982**	1993	1,450,875
	City of San Antonio	1296	Bexar	No	5/5/1981	3/1/1991	109,500

* Rosillo Creek Landfill has not received waste and may never be active.

** Nelson Gardens was opened in 1972 or 1978 by Clarks, but did not accept significant amounts of waste until the city of San Antonio bought the landfill in 1982. A landfill gas power generating station now operates on site and will be included in area source calculations.

*** Opening dates for open landfills were provided by a report on solid waste management in the AACOG region.[23]

Step 2: Calculate Ozone Precursor Emissions Using LandGEM Version 3.02.

The LandGEM model provides several emission estimation options including the calculation of emission rates for CO, total NMOC, and individual NMOC species. Total NMOC includes both VOCs and hazardous air pollutants (HAPs). To determine total VOC emissions, individual VOC species estimates in tons will be summed for each landfill run. The inventory defaults in LandGEM "are based on emission factors in EPA's *Compilation of Air Pollutant Emission Factors (AP-42)* and can be used to generate emission estimates for use in emission inventories and air permits."[24] The following input factors that will be used in the model:

[23] Malcolm Pirnie, Inc., December 1993. "Solid Waste Management in the AACOG Region (1990-2010)". Ch. 2: p. 38-40. Texas Natural Resource Conservation Commission. Austin, TX.

[24] Eastern Research Group, May 2005. "Landfill Gas Emissions Model (LandGEM) Version 3.02 User'sGuide". p. ii. ERG, Morrisville, NC. Available online: http://www.epa.gov/ttn/catc/products.html. Accessed 07/01/10.

- Methane Generation Rate (k) = 0.04 (emission inventory constant for conventional landfill in area with rainfall over 25 inches per year)
- Potential Methane Gen. Capacity = 100 m^3/Mg (emission inventory value for conventional landfill)
- NMOC Concentration ppmv = 595 (emission inventory default because co-disposal of hazardous waste did not occurred at the landfills)
- Methane Content = 50 percent methane and 50 percent CO_2 (default)

LandGEM will be run with the listed input factors to produced emissions estimates for the open and closed landfills in the AACOG region. Emission calculations methodology for fugitive from landfills with a gas collection system and the landfill gas power station at Nelson Gardens landfill are provided in step 3.

Step 3: Estimate Ozone Precursor Emissions from Landfill with Gas Power Stations
Two active landfills in Bexar County, Tessman Road Landfill and Covel Gardens Landfill, each have a gas collection system that is estimated to reduce 75 percent of the methane emissions that are emitted directly.[25] The 75 percent estimation was provided to Allied Waste Services, which runs the Tessman Road landfill and gas collection system.[26] Since the landfill gas power stations are included in the point source database, emissions from the combustion of the collected gas will not be accounted for in the area source section. Fugitive emissions from these landfills will be 25% of the total emissions calculated in the LandGEM model, since 75% of the landfill gas is recovered for the power stations.

Nelson Gardens landfill started operating an on-site power generating facility in 2006 to create electricity from burning methane collected from the landfill's gas collection system. Since this is not included in the point source database, it is necessary to account for combined controlled and uncontrolled emissions from the landfill. Equation (1) will be used to estimate total gas produced by the landfill using the gas collection system flow rate and collection efficiency. The formula to calculate total non-methane organic compound emissions (NMOC) is presented in equation (2).[27] According to EPA,[28] the first part of the equation 2 "accounts for emissions from uncollected landfill gas", while the second part "accounts for emissions of the pollutant that were collected but not combusted in the control or utilization device." The Nelson Gardens gas collection system flow rate for was 2,677 scfm in 2008, according to documents from the EPA's Landfill Methane Outreach Program (LMOP).[29] The mass flow rate will be determined by multiplying the volumetric flow rate of uncontrolled landfill gas by the NMOC concentration (595 ppmv)[30] and the molecular weight of NMOC (86.18 as hexane).[31]

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[25] EPA, May, 2006. "Waste Reduction Model (WARM) Version 8". Available online: http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_UsersGuide.html. Accessed 07/01/10.
[26] Allied Waste, personal communication, March 18, 2008.
[27] EPA, November 1998. "AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Chapter 2.4 Municipal Solid Waste Landfills", p. 6. Available online: http://www.epa.gov/ttn/chief/ap42/ch02/index.html. Accessed 07/30/10.
[28] *Ibid.*
[29] EPA Landfill Methane Outreach Program, August 2008. "Landfill Gas Energy Cost Model – Summary Report". Available online: http://epay.sanantonio.gov/rfplistings/uploads/RFI_147_200808181053261.pdf. Accessed 07/30/10.
[30] EPA, November 1998. "AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Chapter 2.4 Municipal Solid Waste Landfills", p. 12. Available online: http://www.epa.gov/ttn/chief/ap42/ch02/index.html. Accessed 07/30/10.
[31] *Ibid*.

Equation (1)

$UM_{NMOC} = F_v \times (100/n_{COL}) \times CON_1 \times C_{NMOC} \times CON_2 \times MW_{NMOC} \times CON_3$

Where,

UM_{NMOC} = Uncontrolled mass emissions of NMOC (kg/yr)
F_v = Total volumetric flow rate from gas collection system (2677 scfm)[32]
n_{COL} = Collection efficiency of the landfill gas collection system, percent (33%, from LMOP)[33]
CON_1 = Conversion factor 1 (1.49×10^7 L-yr^{-1}/scfm)
C_{NMOC} = Concentration of NMOC in landfill gas (0.000595 for 595 ppmv), (AP-42)[34]
CON_2 = Conversion factor 2 (1/22.4 mol/L)
MW_{NMOC} = Molecular weight of NMOC (86.18 g/mol as hexane), (from AP-42)[35]
CON_3 = Conversion factor 3 (1/1000 kg/g)

The equation that will be used to calculate combined controlled and uncontrolled emissions is presented below:

Equation (2)

$CM_{NMOC} = [UM_{NMOC} \times (1 - n_{COL}/100)] + [UM_{NMOC} \times n_{COL}/100 \times (1 - n_{CNT}/100)]$

Where,

CM_{NMOC} = Controlled mass emissions of NMOC (kg/yr)
UM_{NMOC} = Uncontrolled mass emissions of NMOC (kg/yr), (from Equation (1))
n_{COL} = Collection efficiency of the landfill gas collection system, percent (33%, from LMOP)[36]
n_{CNT} = Control efficiency of the landfill gas control or utilization device, percent (94.4%, from AP-42)[37]

Since equation (2) does not take into account emissions emitted by the combustion of landfill gas, but only the un-combusted emissions, it will be necessary to include NO_x and VOC emissions from combustion. For Nelson Gardens Landfill, the following emissions from the combustion of landfill gases are provided by TCEQ.

- Compressor Engine: NO_x = 98.2 tons/yr VOC = 11.0 tons/yr
- Thermal Oxidizer: NO_x = 0.7 tons/yr VOC = 0.2 tons/yr
- Flare: NO_x = 3.6 tons/yr VOC < 0.1 tons/yr
- Fugitives: VOC < 0.1 tons/yr[38]

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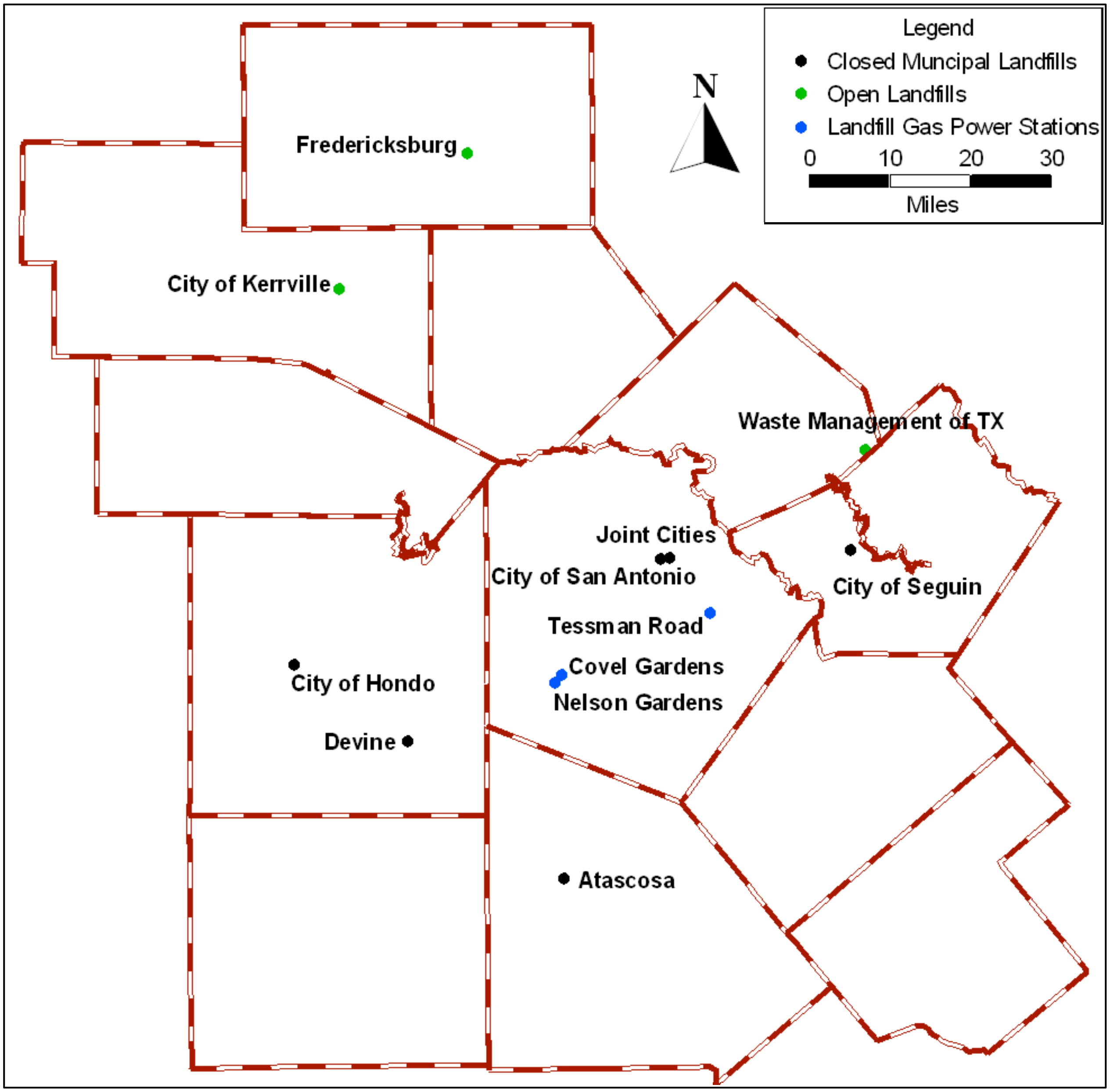
[32] EPA Landfill Methane Outreach Program, August 2008. "Landfill Gas Energy Cost Model – Summary Report". Available online: http://epay.sanantonio.gov/rfplistings/uploads/RFI_147_200808181053261.pdf. Accessed 07/30/10.
[33] *Ibid*.
[34] EPA, November 1998. "AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Chapter 2.4 Municipal Solid Waste Landfills", p. 12. Available online: http://www.epa.gov/ttn/chief/ap42/ch02/index.html. Accessed 07/30/10.
[35] *Ibid*.
[36] EPA Landfill Methane Outreach Program, August 2008. "Landfill Gas Energy Cost Model – Summary Report". Available online: http://epay.sanantonio.gov/rfplistings/uploads/RFI_147_200808181053261.pdf. Accessed 07/30/10.
[37] EPA, November 1998. "AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Chapter 2.4 Municipal Solid Waste Landfills", p. 13. Available online: http://www.epa.gov/ttn/chief/ap42/ch02/index.html. Accessed 07/30/10.

Step 4: Spatially Allocate Ozone Precursor Emissions

Emissions will be allocated to the 4 km photochemical model grid based on the location of open and closed landfills. The locations of open and closed landfills in the AACOG area are presented in figure 3.

[38] TCEQ. 1998. "Re: Standard Permit No. 38956". Letter. Office of Air Quality, New Source Review Permits Division. Austin, TX. Available online: https://webmail.tceq.state.tx.us/gw/webpub. Accessed 08/01/10.

Figure 3: Location of Open and Closed Landfills, 2008.



Plot Date:	August 3, 2010
Map Compilation:	August 3, 2010
Source:	Open and Closed landfill locations were determined by aerial photography and Alamo Area Council of Governments, 2005. “Closed Landfill Inventory”. San Antonio, TX. Available online: http://www.aacog.com/cli/default.htm
Note:	The map includes landfills (Covel Garden and Tessman Road) that have landfill gas power stations included in the point source database.

Oil and Gas Production from Wells

Field production of crude oil and natural gas emits various pollutants including NO_x, CO, and VOC. Emissions attributed to oil and gas production come from a variety of sources, such as:

- Storage tanks - wells producing condensate and oil wells
- Dehydration and in-line heater - oil wells
- Fugitive emissions - oil and natural gas wells
- Compressors - natural gas wells
- Dehydrators - natural gas wells

Emissions from oil and gas production will be calculated using the methodology developed by ENVIRON.[39] Also, ERG methodology for compressor engines at natural gas wells will be used.[40] Working and breathing losses from storage tanks will be assessed through use of the Environmental Protection Agency's storage tank emissions calculation software, TANKS 4.09D.[41] The TANKS model allows users to enter specific information including storage tank dimensions, liquid contents, and turnovers to estimate emissions.[42] The following steps will be used to calculate oil and gas well emissions:

1. Obtain data on oil and gas wells in the region, including number of wells and production.
2. Calculate crude oil and natural gas well tank emissions using TANKS 4.09D and local data.
3. Calculate glycol dehydration and in-line heater emissions for oil wells.
4. Calculate fugitive ozone precursor emissions from oil and gas wells.
5. Calculate compressor ozone precursor emissions.
6. Calculate dehydrator ozone precursor emissions.
7. Spatially allocate ozone precursor emissions from oil and gas wells to the 4 km photochemical model grid.

Raw local input data such as population size, local activity profiles, and spatial surrogates will be provided to TCEQ. Although not part of this proposal, future emission inventories should estimate emissions from the Eagle Ford Shale development occurring in Atascosa and Wilson

[39] ENVIRON International Corporation. August 2001. "Area and Mobile Source Emissions Inventory Technical Support Project: 1999-2010 Emission Inventory Trends and Projections". Novato, CA. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/ei_trends_1990_2010-environ.pdf. Accessed 07/01/10.

[40] Clinton E. Burklin and Michael Heaney, August 31, 2005. "Natural Gas Compressor Engine Survey and Engine NOx Emissions at Gas Production Facilities". Eastern Research Group, Inc. Morrisville, North Carolina 27560. Available online: http://files.harc.edu/Projects/AirQuality/Projects/H040.T121.2004/H40T121FinalReport.pdf. Accessed 07/01/10.

[41] U.S. Environmental Protection Agency, October 5, 2006. "TANKS Emissions Estimation Software, Version 4.09D". Available online: http://www.epa.gov/ttnchie1/software/tanks/. Accessed 04/29/10.

[42] U.S. Environmental Protection Agency, September 1999. "User's Guide to TANKS". Research Triangle Park, North Carolina. Available online: http://www.epa.gov/ttn/chief/software/tanks/index.html. Accessed 07/01/10.

counties.[43] The development of the shale formation occurred after the 2008 inventory and will be a major source of future emissions.

Step 1: Obtain Data on Oil and Gas Wells in the Region

Data on regularly producing gas and oil wells for 2008 are available from the Texas Railroad Commission (RRC).[44] The data from the RRC includes barrels of oil, barrels of condensate, and amount of casing head and natural gas produced in each individual county (table 7).[45] Casing head natural gas is gas produced from oil wells, while condensate is a liquid produced from the by-product of raw natural gas processing.

Step 2: Calculate Crude Oil and Natural Gas Tank Emissions

Emissions from storage tanks in the oil and gas fields include working losses and breathing losses. Working losses are the combined losses attributed to filling and emptying the storage tanks. Breathing losses are the release of vapor from a tank due to vapor expansion caused by changes in the daily temperature and pressure.[46] ENVIRON estimated that there is one tank at each oil and condensate well.[47]

The EPA TANKS 4.09D model will be used to estimate the amount of emissions emitted by oil and gas wells. Specifications input into the TANKS model include roof type, average liquid height, volume, turnovers, shell color, shell condition, roof color, roof condition, roof height, roof radius, and the tank's component. The following specifications will be inputted for all of the counties:[48]

- Average volume of 12,600 gallons
- Average working volume of 8,813 gallons
- Shell color/shade of gray/light
- Good shell condition
- Roof color/shade of gray/light
- Good roof condition
- Dome Roof
- Roof height of 1 ft
- Roof radius of 11 ft

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[43] Energyindustryphotos.com, 2008. "The Eagle Ford Shale. What is the Eagle Ford Shale? Map and Info". Available online: http://www.energyindustryphotos.com/eagle_ford_shale__formation_of_s.htm . Accessed 07/01/10.

[44] Texas Railroad Commission, February 4, 2010. "Oil and Gas Statistics and Reports". Available online: http://www.rrc.state.tx.us/data/wells/wellcount/index.php. Accessed 07/01/10 .

[45] Texas Railroad Commission, June 21, 2010. "Production Query Data System". Available online: http://webapps.rrc.state.tx.us/PDQ/home.do. Accessed 07/01/10.

[46] U.S. Environmental Protection Agency, September 1999. "Emissions Inventory Improvement Program, Volume II: Chapter 10, Preferred and Alternative Methods of Estimating Air Emissions from Oil and Gas Field Production and Processing Operations". Research Triangle Park, North Carolina. Available online: http://www.epa.gov/ttn/chief/eiip/techreport/volume02/ii10.pdf. Accessed 08/19/10.

[47] ENVIRON International Corporation. August 2001. "Area and Mobile Source Emissions Inventory Technical Support Project: 1999-2010 Emission Inventory Trends and Projections". Novato, CA. p 2-9. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/ei_trends_1990_2010-environ.pdf. Accessed 07/01/10.

[48] ENVIRON International Corporation. August 2001. "Area and Mobile Source Emissions Inventory Technical Support Project: 1999-2010 Emission Inventory Trends and Projections". Novato, CA. p 2-11. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/ei_trends_1990_2010-environ.pdf. Accessed 07/01/10.

Table 7: Production of Oil, Casing Head, GW Gas, and Condensate by County, 2008[49]

FIPS	County	Oil (BBL)	Casing head Natural Gas (Mcf)	Natural Gas from Gas Well (Mcf)	Condensate (BBL)
48013	Atascosa	571,452	209,203	5,975,387	32,533
48019	Bandera	1,737	0	0	0
48029	Bexar	118,557	40	0	0
48091	Comal	0	0	0	0
48163	Frio	606,749	663,751	1,162,643	2,631
48171	Gillespie	0	0	0	0
48187	Guadalupe	1,147,366	66,005	10,286	250
48255	Karnes	6,009	47,225	477,252	3,862
48259	Kendall	0	0	0	0
48265	Kerr	0	0	0	0
48325	Medina	86,911	265	137,994	0
48493	Wilson	283,390	26,571	27,589	417
Total		2,822,171	1,013,060	7,791,151	39,693

BBL = barrel of oil or condensate
Mcf = thousand cubic feet

Turnovers vary by county. The turnover factor is determined by dividing barrels of production in the county (table 8) by average working volume (8,813 gallons)[50] for both oil and condensate. The TANKS model defaults will be used for the other required factors. Once the specifications are inputted, the TANKS model outputs emission estimates in pounds per year for one individual tank. Emissions will be multiplied by the number of oil or natural gas wells producing condensate for each county. The TANKS model is also used to calculate emissions by month, which is converted into tons/day for average ozone season days. The equation that will be used to calculate oil tank emissions or gas condensate tank emissions is presented below:

Equation (1)

$$E_A = TOWY_A \times OW_A$$

Where,

E_A = Crude oil/condensate tankage emissions for County A
$TOWY_A$ = TANKS 4.09D model emission estimate for regular producing oil wells or gas wells producing condensate for County A
OW_A = Number of oil wells or gas wells producing condensate for County A, (from table 8)

Step 3: Calculate Glycol Dehydration and In-line Heater Emissions for Oil Wells

Heater emissions are produced at oil well sites and are based on the size of the combustion source. ENVIRON surveyed heater types at oil wells in Texas and determined that the average size of oil well heaters is 0.5 MMBtu/hr.[51] Of the oil wells surveyed, approximately 75% of the wells are equipped with in-line heaters and 24% of wells are equipped with glycol heaters. Heater emissions will be estimated by multiplying the size of the heaters with the annual hours

[49] Texas Railroad Commission, June 21, 2010. “Production Query Data System”. Available online: http://webapps.rrc.state.tx.us/PDQ/home.do. Accessed 07/01/10.
[50] *Ibid*.
[51] *Ibid*. p 2-10.

of operation (8,760 hours per year) and the emission factor of the criteria pollutant. The average emission factors[52] for glycol dehydration and in-line heaters are:

- VOC 5.5 lbs/MMcf
- NO_x 100 lbs/MMcf
- CO 84 lbs/MMcf

Table 8: Producing Oil and Gas Wells by County[53] with Turnover Rates

FIPS	County	Regular Producing Oil Wells	Regular Producing Gas Wells	Wells Producing Condensate[54]	Turnovers (Oil Wells)	Turnovers (Condensate from Gas Wells)
48013	Atascosa	1,118	93	21	2.51	4.04
48019	Bandera	1	0	0	4.32	-
48029	Bexar	2,523	0	0	0.21	-
48091	Comal	0	0	0	-	-
48163	Frio	515	87	14	4.74	0.47
48171	Gillespie	0	0	0	-	-
48187	Guadalupe	1,902	1	1	3.01	0.45
48255	Karnes	102	114	72	12.14	5.06
48259	Kendall	0	0	0	-	-
48265	Kerr	0	0	0	-	-
48325	Medina	1,291	21	0	0.29	-
48493	Wilson	612	3	2	2.14	0.31
Total		8,064	319	110		

The equation that will be used to calculate glycol dehydration and in-line heater emissions is presented below:

Equation (2)

AE_A = HS x HOURS x EF x OW_A x PER / (1,000 MMBtu/MMcf) / (2,000 lbs/ton)

Where,

AE_A = Emissions per heater type, either glycol dehydration (GDH) or in-line (ILH) heaters (tons/yr) for County A
HS = Heater size (0.5 MMBtu /hr)[55]
HOURS = Hours of operation (8,760 hrs/yr)
EF = Emission factors for heaters (lbs/MMcf)[56]
OW_A = Number of oil wells in County A, (from table 8)
PER = Percentage of heaters by type (23.8% glycol dehydration heaters, 74.6% in-line heaters)[57]

[52] *Ibid*.
[53] Texas Railroad Commission, February 4, 2010. "Well Distribution by County – Well Counts". Available online: http://www.rrc.state.tx.us/data/wells/wellcount/index.php. Accessed 07/28/10.
[54] Texas Railroad Commission, July 21, 2010. "Production Query Data System". Available online: http://webapps.rrc.state.tx.us/PDQ/home.do. Accessed 07/28/10.
[55] ENVIRON International Corporation. August 2001. "Area and Mobile Source Emissions Inventory Technical Support Project: 1999-2010 Emission Inventory Trends and Projections". Novato, CA. p 2-10. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/ei_trends_1990_2010-environ.pdf. Accessed 07/01/10.
[56] *Ibid*.

Step 4: Calculate Fugitive Emissions from Oil and Gas Wells:
To calculate fugitive emissions, ENVIRON estimated the average number of valves and fittings at each well site (table 9).[58] The emission factor for each valve or fitting is multiplied by the total number of valves and fittings for each well.

Table 9: Emission Factors for Oil and Natural Gas Well Fugitive Emissions

Substance	Component	Average number per Well	Emission Factor (kg/hr/component)[59]
Gas Wells	Valves	21	0.0045
	Fittings	49	0.00039
Oil Wells (Light Crude)	Valves	5	0.0025
	Fittings	9	0.00011

The equation that will be used to calculate fugitive emissions from oil and gas wells is presented below:

Equation (3)

$$E_A = [(GW_A \times V \times EF) + (GW_A \times NF \times EF)] \times PER \times HOURS$$

Where,

E_A = Fugitive emissions for County A (tons/yr)
GW_A = Number of producing oil or gas wells in County A, (from table 8)
V = Number of valves, (from table 9)
EF = Emission factors for fugitive emissions (kg/hr/component), (from table 9)
NF = Number of fittings, (from table 9)
PER = Percentage of VOC pollutants in natural gas (25%, for gas only)[60]
HOURS = Hours of operation (8,760 hrs/yr)

Step 5: Calculate Compressor Emissions
Production from casing head and gas wells will be used to estimate compressor engine emissions. ERG estimated that 83% of the compressor engines have a maximum rating less than 500 hp. Furthermore, these engines represent 38% of the total horsepower capacity.[61] Engines greater then 500 hp should be included in the point source emission inventory. Compressors for the San Antonio region will be divided into 4-stroke rich, 2-stroke lean, and 4-

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[57] *Ibid*.
[58] *Ibid*.
[59] U.S. Environmental Protection Agency, November 1995. “Protocol for Equipment Leak Emission Estimates”. Office of Air Quality Planning and Standards, Research Triangle Park, NC, p. 2-15. Available online: http://www.epa.gov/ttnchie1/efdocs/equiplks.pdf. Accessed 08/19/10.
[60] ENVIRON International Corporation. August 2001. “Area and Mobile Source Emissions Inventory Technical Support Project: 1999-2010 Emission Inventory Trends and Projections”. Novato, CA. p 2-10. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/ei_trends_1990_2010-environ.pdf. Accessed 07/01/10.
[61] Clinton E. Burklin and Michael Heaney, August 31, 2005. “Natural Gas Compressor Engine Survey and Engine NOx Emissions at Gas Production Facilities”. Eastern Research Group, Inc. Morrisville, North Carolina. p. 4-3. Available online: http://files.harc.edu/Projects/AirQuality/Projects/H040.T121.2004/H40T121FinalReport.pdf. Accessed 07/01/10.

stroke rich with non-selective catalytic reduction (NSCR). The natural gas compressor count will be multiplied by the fraction of wells older than 1 year[62] (table 10), compression requirements (3.5 hp-hr/Mscf),[63] fraction of total engine capacity, fuel consumption, and emission factors (table 11).

Table 10: Compressors by Total Horsepower Capacity % and Fuel Consumption Rates[64]

Engine Type	Fraction of Wells older than 1 year[65]	Fuel Consumption $(MMBtu/hp\text{-}hr)_{HHV}$	Percentage of total horsepower capacity
4 stroke, rich	88%	0.008769	25%
2 stroke, lean	88%	0.009324	12%
4 stroke, rich w/ NSCR	88%	0.008769	1%

Table 11: Emission Factors for Compressors <500 HP (lb/MMBtu, HHV)[66]

Pollutant	4 stroke rich	2 stroke lean	4 stroke rich, w/ NSCR
NO_x	2.27	1.94	0.23
CO	3.51	0.35	0.35
VOC	0.0296	0.12	0.0029

The equation that will be used to calculate emissions from compressors is presented below:

Equation (5)

$$E_{COM} = (CH_A + NGW_A) \times FW \times R \text{ X } PEC \times FCR \times EF / 2{,}000 \text{ lbs/ton}$$

Where,

E_{COM} = Compressor emissions (tons) [by type: 4 stroke rich (FSR), 2 stroke lean (TSL), and 4 stroke rich w/ NSCR (FSN)]

CH_A = Casing head for natural gas wells for County A (Mscf), (from table 7)

NGW_A = Natural gas from gas well for County A (Mscf), (from table 7)

FW = Fraction of wells > 1 year old, (from table 10)

R = Compression requirements (3.5 hp-hr/Mscf)[67]

PEC = Percentage of total engine capacity, (from table 10)

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62 *Ibid*.

63 *Ibid*.

64 Clinton E. Burklin and Michael Heaney, October 5, 2006. "Natural Gas Compressor Engine Survey for Gas Production and Processing Facilities". Eastern Research Group, Inc. Morrisville, North Carolina. Available online: http://www.utexas.edu/research/ceer/GHG/files/ConfCallSupp/H068FinalReport.pdf. Accessed 06/05/10.

65 Clinton E. Burklin and Michael Heaney, August 31, 2005. "Natural Gas Compressor Engine Survey and Engine NOx Emissions at Gas Production Facilities". Eastern Research Group, Inc. Morrisville, North Carolina. p. 4-2. Available online: http://files.harc.edu/Projects/AirQuality/Projects/H040.T121.2004/H40T121FinalReport.pdf. Accessed 07/01/10.

66 EPA, July 2000. "AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Chapter 3.2 Natural Gas-fired Reciprocating Engines", p. 7. Available online: http://www.epa.gov/ttn/chief/ap42/ch03/index.html. Accessed 07/30/10.

67 Clinton E. Burklin and Michael Heaney, August 31, 2005. "Natural Gas Compressor Engine Survey and Engine NOx Emissions at Gas Production Facilities". Eastern Research Group, Inc. Morrisville, North Carolina. p. 2-10. Available online: http://files.harc.edu/Projects/AirQuality/Projects/H040.T121.2004/H40T121FinalReport.pdf. Accessed 07/01/10.

FCR = Fuel consumption (from table 10) (MMBtu, HHV/hp-hr)
EF = Emission factors for compressors (lb./MMBtu, HHV), (from table 11)

Step 6: Calculate Dehydrator Emissions

Dehydrator emissions will be calculated based on total natural gas production. Dehydrator emissions will be determined by multiplying the amount of gas extracted by the amount of VOC lost in dehydration (1.2163 lbs/MMscf).[68] The equation that will be used to calculate emissions from dehydrators is presented below:

Equation (6)

AE_A = (CH_A + NGW_A) / (1000 Mscf/MMscf) x LOST / (2,000 lbs/ton) / (1,000 MMBtu/MMcf)

Where,

AE_A = Emissions from dehydration (tons)
CH_A = Casing head for natural gas wells for County A (Mcf), (from table 7)
NGW_A = Natural gas from gas well for County A (Mcf), (from table 7)
LOST = Amount of VOC lost in dehydration (1.2163 lbs/MMscf)[69]

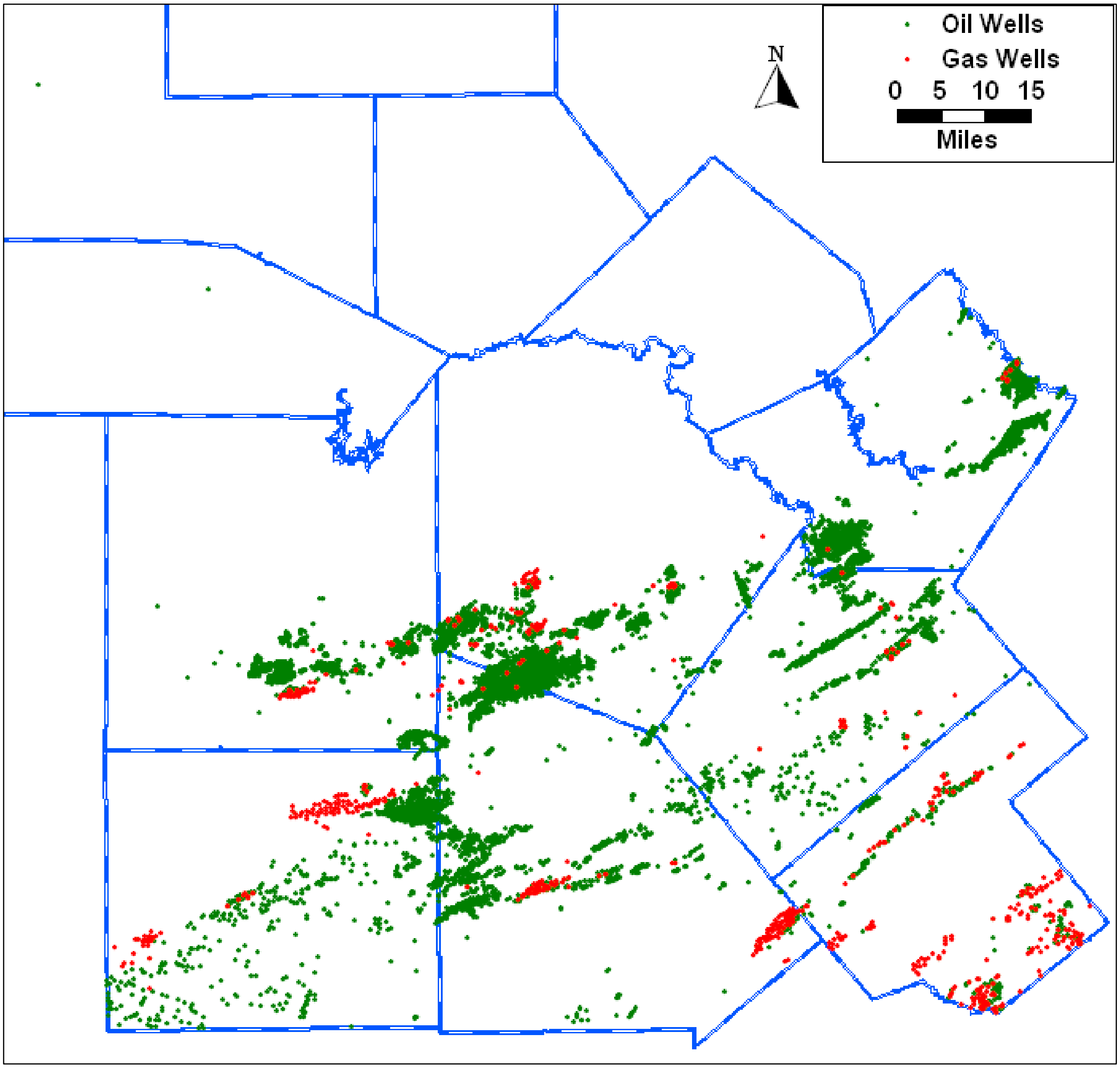
Step 7: Spatially Allocate Ozone Precursor Emissions

The location of the oil and gas wells will be used to allocate ozone precursor emissions to the 4 km photochemical model grid (figure 4).

[68] ENVIRON International Corporation. August 2001. "Area and Mobile Source Emissions Inventory Technical Support Project: 1999-2010 Emission Inventory Trends and Projections". Novato, CA. p 2-11. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/ei_trends_1990_2010-environ.pdf. Accessed 07/01/10.

[69] *Ibid*.

Figure 4: Location of Oil and Gas Wells in the AACOG region



Plot Date: August 3, 2010
Map Compilation: August 3, 2010
Source: Railroad Commission Of Texas, June 1, 2006. “Information Technology Services Division User's Guide: Digital Map Information”. Publication Number: OGA094. Austin, Texas.

Stationary Diesel Generators

This category consists of ozone precursor emissions emitted from emergency and baseload stationary generator usage.

> "Stationary diesel internal combustion (IC) engines constitute a significant component of the nation's electricity generating infrastructure…Historically, the vast majority of these engines has been used primarily or exclusively to provide back-up power in emergency (i.e. outage) situations and in some cases to reduce reliance on grid-supplied electricity during periods of peak demand. Consequently, most diesel generators have been operated infrequently and have not been subject to the kinds of environmental regulation applicable to large central station power plants."[70]

The methodology used to estimate emissions from generators will be based on local data, Eastern Research Group (ERG study),[71] ENVIRON,[72] and AP-42 emission factors.[73] The methodology will follow these steps:

1. Determine the number of emergency and baseload generators by kilowatt (kW) range in the AACOG region.
2. Determine hourly usage of generators.
3. Calculate ozone precursor emissions.

Raw local input data such as population size and local activity profiles will be provided to TCEQ.

Step 1: Determine Population by Kilowatt Range for Generators in the AACOG Region.
Generators will be divided into usage types and kW bins to determine the population of generators in the AACOG region. Emergency generators are only used in case of a power interruption or for testing/maintenance of the generator. Emergency generators are permitted by rule and do not have to report NO_x/VOC emissions under the Texas Administrative Code. The Code states "Internal combustion engine and gas turbine driven compressors, electric generator sets, and water pumps, used only for portable, emergency, and/or standby services are permitted by rule, provided that the maximum annual operating hours shall not exceed 10% of the normal annual operating schedule".[74] There are a number of emergency generators in

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[70] Northeast States for Coordinated Air Use Management (NESCAUM), June 2003. "Stationary Diesel Engines in the Northeast: An Initial Assessment of the Regional Population, Control Technology Options and Air Quality Policy Issues". Boston, MA. p. ES 1. Available online: www.nescaum.org/documents/rpt030612dieselgenerators.pdf/. Accessed 08/13/10.

[71] Rick Baker and Sam Wells, August 31, 2005. "Data Collection, Sampling and Emissions Inventory Preparation Plan for Selected Commercial and Industrial Equipment: Phase II". Eastern Research Group, Inc. Morrisville, North Carolina. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/erg-data_collection_plan_phase2_final.pdf. Accessed 06/28/10.

[72] ENVIRON, January 17, 2005, "Estimates of Emissions for Small-Scale, Stationary Diesel Generator Engines in the Dallas-Fort Worth Area". Novato, CA. Available online: http://files.harc.edu/Projects/AirQuality/Projects/H010/DFW/H10.DFWFinalReport.pdf. Accessed 08/13/10.

[73] EPA, October 1996. "AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Chapter 3 Stationary Internal Combustion Sources". Available online: http://www.epa.gov/ttn/chief/ap42/ch03/index.html. Accessed 08/13/10.

[74] Texas Administrative Code, Title 30, Part 1, Chapter 106, Subchapter W, Rule 511. Available online. http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC. Accessed 08/13/10.

the San Antonio region because there are at least 50 emergency generators greater than 1,500 hp at just the USAA office complex and Microsoft Corp data center in San Antonio.

Although ERG found only one base load generator in the Dallas region,[75] a quick survey of operation permits in the AACOG region found that there was a number of large baseload generators located at quarry and batch plants in the AACOG region. These permits included baseload generators with engines over 1,000 hp. Some baseload generators operate in one location, while other baseload generators were moved frequently to different sites.

The first step in estimating emissions for generators is to determine the population of local diesel generators. To calculate the number of generators for each county in the AACOG region, a generator to population ratio (from the ERG study in Dallas) will be used. Table 12 shows the allocation of generators by kW bin for each AACOG county in 2008, based on the per capita generator distribution calculated using ERG data.[76] The proposed equation to calculate the number of generators by kW bin for each county is presented below:

Equation (1)

$$GEN_{XA} = POP_x / POP_{Dallas} \times GEN_{DallasA}$$

Where,

GEN_{XA} = Number of generators in AACOG county X for kW bin A (provided in table 12)
POP_x = Population of AACOG county X (from US Census)[77]
POP_{Dallas} = Population of 9-county Dallas area (from US Census)[78]
$GEN_{DallasA}$ = Number of generators in 9-county Dallas area of kW bin A (from ENVIRON)[79]

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[75] Rick Baker and Sam Wells, August 31, 2005. "Data Collection, Sampling and Emissions Inventory Preparation Plan for Selected Commercial and Industrial Equipment: Phase II". Eastern Research Group, Inc. Morrisville, North Carolina. p. 3-32. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/erg-data_collection_plan_phase2_final.pdf. Accessed 06/28/10.
[76] *Ibid*. p 3-33.
[77] U.S. Census Bureau. March, 2010. "Annual Estimates of the Resident Population for Counties: April 1, 2000 to July 1, 2009". Available online: http://www.census.gov/popest/counties/counties.html. Accessed 07/30/10.
[78] *Ibid.*
[79] ENVIRON, January 17, 2005, "Estimates of Emissions for Small-Scale, Stationary Diesel Generator Engines in the Dallas-Fort Worth Area". Novato, CA., p. 40. Available online: http://files.harc.edu/Projects/AirQuality/Projects/H010/DFW/H10.DFWFinalReport.pdf. Accessed 08/13/10.

Table 12: Estimated Capacity of Emergency and Baseload Diesel Generators in the AACOG region, 2008

Type of Generator	County	kW bins									Total
		0-25	25-50	50-100	100-250	250-500	500-750	750-1,000	1,000-1,500	1,500 +	
Emergency Generators	Atascosa	585	1,545	1,854	5,344	8,518	6,251	4,703	9,307	4,149	42,255
	Bandera	326	862	1,035	2,983	4,754	3,488	2,625	5,194	2,315	23,582
	Bexar	20,994	55,451	66,556	191,849	305,774	224,383	168,822	334,102	148,934	1,516,865
	Comal	1,354	3,577	4,293	12,375	19,723	14,473	10,889	21,550	9,607	97,840
	Frio	236	622	747	2,153	3,432	2,518	1,895	3,750	1,671	17,023
	Gillespie	311	820	985	2,838	4,523	3,319	2,497	4,942	2,203	22,439
	Guadalupe	1,454	3,840	4,609	13,286	21,176	15,539	11,692	23,138	10,314	105,048
	Karnes	221	584	701	2,021	3,222	2,364	1,779	3,520	1,569	15,981
	Kendall	442	1,167	1,400	4,036	6,432	4,720	3,551	7,028	3,133	31,909
	Kerr	638	1,685	2,022	5,829	9,290	6,817	5,129	10,151	4,525	46,087
	Medina	599	1,582	1,899	5,474	8,725	6,402	4,817	9,533	4,250	43,281
	Wilson	553	1,461	1,754	5,055	8,058	5,913	4,449	8,804	3,925	39,971
Baseload Generators	Atascosa	75	205	192	607	400	283	537	472	108	2,879
	Bandera	42	114	107	339	223	158	300	264	60	1,607
	Bexar	2,691	7,358	6,883	21,807	14,350	10,173	19,274	16,954	3,879	103,368
	Comal	174	475	444	1,407	926	656	1,243	1,094	250	6,667
	Frio	30	83	77	245	161	114	216	190	44	1,160
	Gillespie	40	109	102	323	212	150	285	251	57	1,529
	Guadalupe	186	510	477	1,510	994	704	1,335	1,174	269	7,159
	Karnes	28	78	73	230	151	107	203	179	41	1,089
	Kendall	57	155	145	459	302	214	405	357	82	2,174
	Kerr	82	224	209	663	436	309	586	515	118	3,141
	Medina	77	210	196	622	409	290	550	484	111	2,949
	Wilson	71	194	181	575	378	268	508	447	102	2,724
Total		31,265	82,909	96,940	282,030	422,567	309,617	248,290	463,398	201,715	2,138,730

Some of the data used to calculate emissions in the ERG study is based on the intensive survey work conducted in Houston by the Houston Advanced Research Center (HARC) report on "Estimates of Emissions for Small-Scale Diesel Engines".[80] ERG deemed the previous population and hp distributions from the local ENVIRON study to be reasonable and applicable to Dallas. However, the adjustments to national activity rates (developed from local survey results) in the ENVIRON study were not consistent with the corresponding duty-cycle descriptions, leading ERG to believe that most units were actually being used in emergency/stand-by applications. Specifically, ERG found no instances of peak shaving during its limited phone surveys in the Dallas area and concluded that the current high cost of diesel makes peak shaving generation with small engines non-competitive with current electric rates, and the number of such applications is quite small. Peak shaving generators will not be included in AACOG's emission estimates because emissions are expected to be insignificant.

Step 2: Determine Hourly Usage of Generators

As a result of their survey work, ERG found that almost all the existing emergency generators provide power during storm related power outages, which did not occur during typical ozone season meteorology. ERG determined that these emissions should not be included in estimating ozone season weekday emissions. The survey found testing and maintenance use estimates between 1 and 4 hours per month, corresponding well with the values reported by ENVIRON of 20 – 32 hours per year for emergency generators <500 hp[81] and those reported by CARB[82] of 30 hours per year for emergency generators. However, these units are generally tested in an *unloaded* condition, resulting in a lower load factor on the generators than was used in the previous study.[83] ERG applied an effective load factor of 0.11 for emergency generators. Due to similarities in the electrical supply and meteorology between the San Antonio and Dallas areas, the same usage rates and load factors will be applied in calculating diesel generator emissions in the AACOG region.

The load factors from the report published by ENVIRON in the Dallas region will be used for baseline generators in the AACOG region.

- 100 – 150 kW = 0.48
- 150 – 300 kW = 0.46
- 300 – 500 kW = 0.47
- 500+ kW = 0.43[84]

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[80] ENVIRON, December 22, 2003, "Estimates of Emissions for Small-Scale Diesel Engines". Novato, CA. Available online: http://www.harc.edu/harc/Projects/AirQuality/Projects/ShowProject.aspx?projectID=22. Accessed 08/13/10.

[81] ENVIRON, January 17, 2005, "Estimates of Emissions for Small-Scale, Stationary Diesel Generator Engines in the Dallas-Fort Worth Area". Novato, CA., p. 24. Available online: http://files.harc.edu/Projects/AirQuality/Projects/H010/DFW/H10.DFWFinalReport.pdf. Accessed 08/13/10.

[82] CARB. September 2003. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking Airborne Toxic Control Measure for Stationary Compression-Ignition Engines". Appendix D. p. D-28. Available online: http://www.arb.ca.gov/regact/statde/appd.pdf. Accessed 08/13/10.

[83] Rick Baker and Sam Wells, August 31, 2005. "Data Collection, Sampling and Emissions Inventory Preparation Plan for Selected Commercial and Industrial Equipment: Phase II". Eastern Research Group, Inc. Morrisville, North Carolina. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/erg-data_collection_plan_phase2_final.pdf. Accessed 06/28/10.

[84] ENVIRON, January 17, 2005, "Estimates of Emissions for Small-Scale, Stationary Diesel Generator Engines in the Dallas-Fort Worth Area". Novato, CA., p. 25. Available online:

The load factors that will be used to calculate emissions for baseline generators below 100 kW will be the same as 100 – 150 kW generators: 0.48. Annual hour usage for baseline generators will be based on the survey results from the Dallas region.

- 0 – 150 kW = 48 hours
- 150 – 500 kW = 46 hours
- 500 – 700 kW = 93 hours
- 700 – 1200 kW = 115 hours
- 1200 + kW = 250 hours[85]

Step 3: Estimating Ozone Precursors Emissions

The emissions factors that will be used to calculate emissions from stationary generators (table 13) are from EPA AP-42 manual.[86]

Table 13: Emission Factors for Diesel Generators

HP	kW	NOx		VOC		CO	
		g/hp-hr	lb/MW-h	G/hp-hr	lb/MW-h	g/hp-hr	lb/MW-h
<600hp	<447	14.06	41.47	1.14	3.36	3.00	8.86
>600hp	>447	10.86	32.04	1.00	2.95	2.50	7.39

lbs/MW-h = pounds per megawatt-hour, g/hp-h = grams per horsepower-hour

Emissions from generators will be calculated using the following formula:

Equation (2)

$$E_A = HP_A \times HRS \times LF \times EF$$

Where

- E_A = Emissions from stationary diesel generators for kW bin A (grams/yr)
- HP_A = Power produced by generators for kW bin A (from table 12)
- HRS = Hours of use (from CARB for emergency generators[87] and ENVIRON for baseline generators)
- LF = Typical load factor (from ERG for emergency generators and ENVIRON for baseline generators)[88]
- EF = Pollutant specific emission factor for Type A equipment (from table 13)

Emission estimates will be aggregated for each kW bin to calculate county total emissions.

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http://files.harc.edu/Projects/AirQuality/Projects/H010/DFW/H10.DFWFinalReport.pdf. Accessed 08/13/10.

[85] *Ibid*.

[86] EPA, October 1996. "AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Chapter 3 Stationary Internal Combustion Sources". Available online: http://www.epa.gov/ttn/chief/ap42/ch03/index.html. Accessed 07/22/10.

[87] CARB. September 2003. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking Airborne Toxic Control Measure for Stationary Compression-Ignition Engines". Appendix D. p. D-28. Available online: http://www.arb.ca.gov/regact/statde/appd.pdf. Accessed 08/13/10.

[88] Rick Baker and Sam Wells, August 31, 2005. "Data Collection, Sampling and Emissions Inventory Preparation Plan for Selected Commercial and Industrial Equipment: Phase II". Eastern Research Group, Inc. Morrisville, North Carolina. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/erg-data_collection_plan_phase2_final.pdf. Accessed 06/28/10.