Technical Memorandum: MANE-VU 2002 Ammonia Emissions Inventory for Miscellaneous Sources

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PECHAN

P.O. Box 1345
6245 Pleasant Valley Road
El Dorado, CA 95623

530-295-2995 telephone
530-295-2999 facsimile

3622 Lyckan Parkway
Suite 2002
Durham, NC 27707

919-493-3144 telephone
919-493-3182 facsimile

5528-B Hempstead Way
Springfield, VA 22151

703-813-6700 telephone
703-813-6729 facsimile

Prepared for:

MARAMA
Mid-Atlantic Regional Air Management Association
711 W. 40th Street, Suite 318
Baltimore, MD 21211-2109

Prepared by:

Stephen M. Roe
Ying K. Hsu
Holly C. Lindquist
E.H. Pechan & Associates, Inc.
P.O. Box 1345
6245 Pleasant Valley Road
El Dorado, CA 95623

March 31, 2004

A. INTRODUCTION

E.H. Pechan & Associates, Inc. (Pechan) developed 2002 ammonia (NH_3) emission estimates for several miscellaneous source categories for the Mid-Atlantic – Northeast Visibility Union (MANE-VU) Regional Planning Organization (RPO). The source categories are a part of four different source sectors: industrial refrigeration (Section B); cement plants (Section C); and publicly-owned treatment works (POTWs) and composting (Section D). For composting, Pechan developed 2002 emission estimates for volatile organic compounds (VOC) in addition to NH_3. Methods and data sources for developing the 2002 inventory are described in the first three sections of this technical memorandum. Section E provides the results of this project.

B. INDUSTRIAL REFRIGERATION

In order to estimate NH_3 emissions from industrial refrigeration sources for the 2002 MANE-VU Ammonia Inventory, Pechan attempted both top-down and bottom-up approaches as described in the work plan (Pechan, 2003a). The top-down approach was based on methods used to construct the South Coast Air Quality Management District's (SCAQMD) inventory. For this inventory, NH_3 suppliers were surveyed to gather information on annual sales and end use (including refrigeration). Part of what made this a successful method in the SCAQMD is that the researchers had determined that only three companies supplied nearly all of the NH_3 (Chitjian et al, 2000).

Pechan attempted to obtain data on NH_3 purchases and the amount of NH_3 lost by facilities using NH_3 refrigeration systems. Pechan first tried to collect data from NH_3 suppliers. This attempt was unsuccessful for two reasons. First, finding a comprehensive list of NH_3 suppliers was difficult. Many of the companies listed as supplying NH_3 in chemical supplier databases either did not sell NH_3, sold NH_3 in another form, or only sold small amounts of $NH_3$for laboratory use. Second, few of the companies contacted responded to our request for sales data.

Once it was determined that surveying suppliers would not yield sufficient data for inventory development, Pechan began collecting data directly from facilities operating NH_3 refrigeration systems. Pechan's starting point was EPA's Risk Management Program (RMP) database (EPA, 2003a). This information included data on the location of 188 RPO facilities that submitted RMPs to EPA with NH_3 refrigeration systems. The threshold for RMP reporting is 10,000 pounds (lbs) of storage. These RMP data did not include any facilities in Delaware (DE), Rhode Island (RI), or the District of Columbia (DC). The basic content of the RMP data was facility contact information and an indication of an NH_3 refrigeration process at the facility (in a process field). Pechan attempted to obtain information from the Offsite Consequence Analysis (OCA) portion of the RMP, which is likely to include information on the capacity of the system. However, these data are currently considered sensitive (due to terrorism), and Pechan was not able to obtain them.

Pechan gathered the following data from 30 RMP facilities covering a wide range of industries:

- The amount of NH_3 typically lost by the refrigeration system in one year or the amount of NH_3 purchases over the past few years to recharge the system; and

- The operating capacity of the system (in lbs of NH_3).

In addition to the RMP database, Pechan obtained survey data from the Delaware Department of Natural Resources and Environmental Control (DNREC) for an additional 22 facilities in DE (Fees, 2004). These data included 2002 charges to the refrigeration system and system capacity. Pechan added the DE data to the RMP data for facilities with capacities near or above the 10,000 lb RMP threshold. This resulted in 43 facilities. An analysis of the data from these facilities showed an average system capacity of about 32,000 lb of NH_3 (±7,000 lb at 95% confidence) and an annual loss rate of approximately 8% (±3% at 95% confidence). Note that not all facilities recharge their systems every year. Approximately one-third of the RMP/DNREC facilities reported zero recharges during the previous year(s).

For all of the surveyed facilities, Pechan estimated annual NH_3 losses by multiplying the capacity by the 8% loss factor. This was done instead of using the values supplied directly by the facilities, since: a) some facilities reported zero recharges during the survey period, and b) facilities that did report losses during the survey period likely did not emit that amount of NH_3 during a single year. For the remaining RMP facilities that were not surveyed, Pechan assigned the average 32,000 lb capacity and the 8% loss rate. To these data, Pechan also added system capacity data for six facilities supplied by the New Jersey Department of Environmental Protection that could be matched to the RMP database (Papalski, 2004).

After compiling the RMP data, it was noted that there were a few instances where potential duplicate facilities appeared. With the available data, Pechan could not determine if these were indeed duplicate records or if a facility had more than one refrigeration system. Therefore, these potential duplicates were left in the database. The overall effect on the inventory estimates is small.

The information described above should cover facilities with large NH_3 refrigeration systems (>10,000 lb) based on the assumption that facilities required to report under the RMP program have done so. For facilities that have smaller refrigeration systems, Pechan requested data from the MANE-VU states from the Superfund Amendments and Reauthorization Act of 1986 (SARA) Tier II reporting requirements. Under these requirements, facilities subject to Section 311 of SARA must supply information on the type and amount of hazardous substances at their facilities each year. For NH_3, the threshold quantity is 500 lb.

Pechan again had difficulty obtaining data on these Tier II facilities. There were two reasons for this. First, as with the RMP data, much of the SARA reporting data are now considered sensitive. Second, many states do not have these data in an electronic format (only hard copy reporting forms). Pechan was able to obtain data on nine Tier II facilities from RI. Of these nine facilities, one was larger than the 10,000 RMP reporting threshold. Pechan also received Tier II data from NJ. Pennsylvania refused to provide Tier II data for this project and no other states provided data. After extracting data for facilities within the SIC codes of interest (see Table 1), there were less than 30 facilities (some of which were already in the RMP data). Even with the addition of several more smaller facilities from DE, the available information for smaller capacity facilities was not sufficient to develop estimates that could be extrapolated to the RPO. The data from RI and NJ were added to the database for larger facilities described above.

In order to fill out the rest of the inventory for this source category, Pechan used an employee-based emission factor to be included in the Emission Inventory Improvement Program (EIIP) guidance to estimate total county-level refrigeration loss emissions (30 lb/employee-yr). This emission factor was derived from data in the SCAQMD inventory (Chitjian et al, 2000). No data are available to estimate certainty bounds around this emission factor. The employment data were taken from the 2001 U.S. Bureau of Census County Business Patterns (BOC, 2003; 2002 data are not yet available). The Standard Industrial Classification (SIC) codes used to develop the county-level employment data are shown in Table 1 below (the North American Industrial Classification System codes are also shown).

The emission estimates in the NIF formatted file correspond to the total county-level estimates made with the EIIP emission factor. The only case where this does not apply is for the State of Delaware. The DNREC contact feels that their coverage of industrial refrigeration sources is complete (Fees, 2004). It is interesting to note that the use of the emission factor above yields an estimate for DE that is about an order of magnitude higher than that developed through the DE survey data. While some smaller industrial refrigeration systems could be missing in DE's survey data, the missing emissions are probably not significant. This comparison shows that the use of the EIIP emission factor probably provides order of magnitude emission estimates of industrial refrigeration losses.

Table 1. SIC Codes Associated with Ammonia (NH_3) Refrigeration Facilities

SIC Code	Description	NAICS Code
2011	Meat Packing Plants	311611
2013	Sausages/Other Prepared Meats	311612, 311613
2015	Poultry Slaughtering/Processing[a]	311615
2021-2026	Dairy Products	311512-311514, 31152
2032-2038	Dried, Canned, Frozen Fruits/Vegetables	311411, 311412, 311421-311423
2051-2053	Bread and Bakery Product Mfg.	31181
2064, 2066	Chocolate and Confectionery Mfg.	31132, 31133
2082-2086	Malt Beverages, Wines, Liquors, Soft Drinks	31211-31213
2091-2092	Canned, Fresh or Frozen Seafood	31171
2097	Ice Manufacturing	312113
2099	Food Preparations, not elsewhere classified	311991, 311999
2821	Plastics Material and Resin Mfg.	325211
4222, 4226	Refrigerated Warehousing & Storage	49312
514x	Various Food Wholesalers	4224, 311612
518x	Various Beverage Wholesalers	42281,42282

[a]Sometimes listed under 1123xx "Poultry & Egg Production".

Pechan also submitted a spreadsheet with the "point-source" data from the facility database described above. There were no instances where the total county-level estimate from the facility database was more than the employment-based estimate. State-level results are provided in Section E.

C. 2002 CEMENT PLANT EMISSION ESTIMATES

Pechan contacted Garth Hawkins of the Portland Cement Association (PCA) to request throughput data for cement production facilities. PCA did not have any facility level data on clinker throughput. Therefore, Mr. Hawkins sent an email to PCA member facilities requesting that they provide this information to Pechan directly. Pechan did not receive any responses from facilities, and because Mr. Hawkins did not feel comfortable releasing member contact information, Pechan was unable to contact facilities directly.

Since the attempt to collect activity data from facilities was not successful, Pechan turned to other sources of data. Actual 2002 throughput data for facilities in Maryland and New York were obtained from state agency contacts (Lang, 2004; King, 2004; Mancilla, 2004). For facilities in Pennsylvania and Maine, emissions were estimated using 2001 kiln clinker capacity, obtained from the PCA (Hawkins, 2003a).

An NH_3 emission factor of 0.145 lb/ton clinker based on data obtained from the PCA (Hawkins, 2003b) was used to estimate emissions for all plants, including the Glens Falls plant in NY. Based on comments from NYDEC, Pechan did not use an emission factor based on a source test conducted at this facility (Weston, 2001). From the source test, the emission factor for this plant was estimated to be 1.31 lb NH_3/ton clinker produced.

The emission factor based on PCA data will be the emission factor used in the EIIP guidance document being finalized by Pechan (Pechan, 2003b). (Please see the new EIIP guidance document (scheduled to be finalized April 2004) for a discussion on emissions uncertainties and for recommendations to improve emission factors from cement plants). This average emission factor (0.145lb/ton clinker) is not specific to kiln type (e.g., wet versus dry). Discussions with PCA indicate that the biggest driver in the magnitude of NH_3 emissions is the reduced nitrogen content of the raw materials fed to the kiln. The composition of these raw materials can vary considerably from site to site. As a result, the minimum, average, and maximum emission factors based on the PCA data vary over three orders of magnitude (0.002 to 1.29 lb NH_3/ton clinker). The average emission factor was applied to all of the kilns in the RPO. Results are provided in Section E of this memorandum. The data provided from PCA is included in the Appendix.

D. 2002 NH_3 EMISSIONS INVENTORY FOR POTWs AND COMPOSTING SOURCES IN THE MANE-VU REGION

1. Publicly-Owned Treatment Works (POTWs)

Pechan collected biosolids generation, wastewater flow rate, and other associated data from the EPA Office of Wastewater Management (OWM; EPA, 2003b), Envirofacts (EPA, 2003c), *BioCycle* (2000), the New England Biosolids & Residuals Association (NEBRA, 2003), and the States of New Jersey (Pilawski, 2003) and Delaware (Fees, 2003).

OWM conducted the Year 2000 Clean Watersheds Needs Survey (CWNS), which was a joint effort between States and EPA, in response to Section 205(a) and 516 of the Clean Water Act. The CWNS has information on publicly-owned wastewater collection and treatment facilities, facilities for control of sanitary sewer overflows (SSOs), combined sewer overflows (CSOs), storm water control activities, nonpoint sources, and programs designed to protect the nation's estuaries. Information obtained from the survey is maintained in the CWNS database. The collected data are used to produce a Report to Congress, which provides an estimate of clean water needs for the United States.

The CWNS 2000 Survey database was augmented with statewide biosolids generation data from sources including NEBRA (2003), *BioCycle* (2000), New Jersey (Pilawski, 2003) and Delaware (Fees, 2003). Facility geographic coordinates (latitude and longitude) were collected from the CWNS 2000 Survey (Harcum, 2003) and Envirofacts (EPA, 2003c).

The contents of databases used by Pechan were as follows:

- *CWNS 2000 Survey* – Individual facility number, facility name, state, county, watershed, municipal and industrial flows, and geographic coordinates (latitude and longitude). This survey contributes most of the data in the MANE-VU database and is supplemented with the following data;

- *Envirofacts* – Multiple environmental databases for facility information, including toxic chemical releases, water discharge permit compliance, latitude and longitude, hazardous waste handling processes, Superfund status, and air emission estimates;

- *State of New Jersey* – Individual facility number, facility name, county, existing flow, biosolids generation, and breakdown of: incineration and landfill, out of state disposal, composting, and farmland beneficial uses. This data set is newer than CWNS 2000 Survey, and therefore replaced all CWNS data for New Jersey (NJ);

- *State of Delaware* – Individual facility number, facility name, county, existing flow, and farmland beneficial use. The updated flow rates substituted those provided in CWNS 2000 Survey;

- *BioCycle* – Year 2000 statewide biosolids generation, breakdown of land application, composting, lime stabilization, heat drying- pelletization, landfilling, incineration, surface disposal, lagoon storage and other; and

- *NEBRA* – Biosolids generation of six New England states in 2000, breakdown of land application, compost, landfilling, and incineration disposal. This data set replaced six New England states biosolids production data reported in the CWNS 2000 Survey.

For POTWs, Pechan developed emission estimates for wastewater treatment processes, biosolids processes at POTWs, and biosolids management practices (mainly at an off-site location). The emission factors were taken from draft EIIP guidance (Pechan, 2003b; estimated to be finalized in April 2004). The following sections describe the methods for assembling the activity data.

a. Wastewater Generation

Facility-level wastewater flows were taken from the CWNS 2000 Survey or State-supplied data for NJ and DE.

b. Biosolids Generation

Aggregated statewide biosolids generation data were taken from the *BioCycle* 2000 Survey and NEBRA. In addition, NJ provided detailed facility-level biosolids production data (Pilawski, 2003). In order to spatially-allocate NH_3 emissions, facility-level biosolids production was allocated based on wastewater flows. Biosolids generation per gallon of wastewater has remained approximately the same from 1988 to 1998 (EPA, 1999). As part of this task, Pechan found a good correlation ($R^2 = 0.90$) of wastewater flow rates and biosolids generation data in all 12 MANE-VU states. The POTWs operating in the United States generate about 0.16 pounds (dry weight basis) of sewage sludge each day for every person that the sewage system services (Stehouwer, 1999a). The state of New Jersey estimated 0.2 pounds per capita per day of biosolids production. Therefore, for states other than New Jersey in the MANE-VU region, facility-level biosolids production for the year 2000 was allocated based on the facilities' wastewater flow rates and annual statewide biosolids production reported in the *BioCycle* 2000 Survey and NEBRA. Biosolids production is not available for DC. It was estimated based on the wastewater flow from the regression equation mentioned previously.

Except for NJ, year 2002 biosolids generation was grown from Year 2000 to Year 2002 based on the population for each state. For New Jersey, 2002 biosolids generation data were available at individual facilities (Pilawski, 2003).

All reported biosolids production data are in units of dry tons per year. Since the available NH_3 emission factor for this sector is in units of pounds per wet ton biosolids, dry biosolids production data were adjusted according to an assumed average solids content of 5 percent (Stehouwer, 1999b).

c. Biosolids Management Practices

For NH_3 emission estimates, biosolids management practices are aggregated into: land application; composting; heat drying- pelletization; landfilling; and incineration. Ammonia emission factors are available for land application and composting (Pechan, 2003b). Landfilling emissions are assumed to be incorporated into the landfill emission factor contained in the upcoming EIIP guidance, and are not included in this inventory (estimates of landfill methane emissions are needed to estimate landfill NH_3 emissions). For biosolids sent to landfills for use as daily cover, this activity is included in the land application estimates. Ammonia emissions associated with incineration are assumed to be negligible. For heat-drying – pelletization, no emissions data are available. Therefore, Pechan developed emission estimates for two biosolids management practices: land application and composting.

Table 2 lists the fraction of biosolids applied to land including farm land application, lime stabilization, surface disposal, lagoon storage and "other" land application as summarized in the *BioCycle* Year 2000 Survey, NEBRA, and New Jersey reports.

New Jersey provided facility-level biosolids production and management methods, which are categorized somewhat differently from those listed in the *BioCycle* Year 2000 Survey. Land application fractions of biosolids were estimated by summing a portion of the beneficial use, disposal, and other categories. Incineration, beneficial use Class A (composting), and landfill cover biosolids were not included in this estimate.

Table 2. Fraction of Biosolids Applied to Land

State	Fraction Applied to Land
Connecticut	0.00
Delaware	0.98
Maine	0.31
Maryland	0.80
Massachusetts	0.61
New Hampshire	0.11
New Jersey	facility-specific[a]
New York	0.52
District of Columbia	1.00[b]
Rhode Island	0.00
Pennsylvania	0.55
Vermont	0.26

[a]Individual facility reported values used.
[b] 96% is land-applied to crop lands in Virginia and 4% to crop lands in MD.

Biosolids management activity was allocated to the county in which each POTW is located. This is an area requiring further study, since biosolids may be landfilled, composted, or land applied in different counties or states. The only instance where this allocation method changed was for DC-generated biosolids. Information from the District of Columbia Water and Sewer Authority (DCWASA, 2004) indicated that biosolids were land applied mainly to crop lands in Virginia and Maryland. DCWASA provided estimates that 96% of the biosolids were applied to Virginia crop lands with the remainder going to MD croplands. Pechan assumed that the counties in MD were those six MD counties surrounding DC. The fraction of biosolids applied to each MD county were derived based on harvested acreage in the 1997 Census of Agriculture (NASS, 2004). The fractions are as follows: Charles – 0.17; Prince Georges – 0.14; Calvert – 0.09; Anne Arundel – 0.12; Howard – 0.16; and Montgomery – 0.32.

Facility geographic coordinates (latitudes and longitudes) were acquired from the CWNS 2000 Survey and EPA Envirofacts (EPA, 2003c). For those facilities that did not have geographic coordinates, geocoded latitudes and longitudes were estimated based on the county centroids where the facilities were located. The facility identification numbers (ID) used by Pechan are consistent with the CWNS 2000 Survey, except for Delaware and New Jersey where National Pollutant Discharge Elimination System (NPDES) numbers were provided and used.

d. Estimates of NH_3 Emissions from POTWs

Ammonia emissions from POTWs were assigned to the three source classification codes (SCCs) as shown in Table 3 below. The emission factors used to estimate emissions were taken from the draft EIIP guidance (Pechan, 2003b). These emission factors are not expected to change in the final version of the guidance. The water treatment emission factor reflects recent testing in southern California that showed much lower NH_3 emission levels than had previous been used (e.g. previous EPA guidance). For water treatment, much of this difference is due to the fact that typical POTWs operate at a pH that does not favor ammonia emissions (e.g. less than 8).

Table 3. Ammonia (NH_3) Emission Factors for POTWs

SCC	Description	EF (lb/SCC unit)	SCC Units	EF Rating
2630020010	Waste Disposal, Treatment and Recovery; Wastewater Treatment; Public Owned; Wastewater Treatment Processes Total	0.027	10^6 gallons	D; range is 0.004 to 0.051.
2630020020	Waste Disposal, Treatment and Recovery; Wastewater Treatment; Public Owned; Biosolids Processes Total	0.142	10^6 gallons	D; estimated range is 0.10 to 0.57.
2630050000	Waste Disposal, Treatment and Recovery; Wastewater Treatment; Public Owned; Land Application - Digested Sludge	0.109	ton wet digested biosolids	E; no data available to estimate the EF range.

2. Composting

Composting refers to the use of both aerobic and anaerobic microbial processes to degrade waste materials for beneficial reuse. Compostable wastes include biosolids (sewage sludge), manure, green waste (e.g., landscape trimmings, grass clippings), and other biodegradable materials. Pechan has searched/contacted EPA, state agencies, *BioCycle*, and the internet for composting information. Of all the sources, *BioCycle* provided the most complete and detailed information.

For municipal solid waste (MSW) composting, *BioCycle* surveyed Year 2000 statewide MSW production activities (*BioCycle*, 2001). The survey included questions on the fraction of MSW recycled, including the amount composted. While recycle rates were reported by all states, only 20 states responded to composting. The tonnage of MSW composted was calculated based on reported solid waste production and composting fractions. For those states that did not report a composting fraction, an average of all reported 20 state fractions was assumed. This average MSW composting fraction (5.3%) is very close to the one reported (5.4%) by EPA (1998). However, using the average fraction of MSW composted, the estimates for DC, Maine and Pennsylvania exceeded the total amount of recycled MSW reported by these states. Therefore, for these states, the recycled yard trimmings quantities were used to represent total composting activity.

An NH_3 emission factor of 2.81 lb/ton of mixed waste composted was applied to estimate NH_3 emissions (see Table 4). This emission factor was derived from SCAQMD test data of a 50:50 mixture by weight of biosolids and green waste (Pechan, 2003b). Pechan believes that this emission factor represents the best match to the available data. The EIIP guidance will also contain a set of emission factors strictly for green waste (e.g., yard trimmings); however these emission factors should only be applied to green waste composting facilities. This is because NH_3 emissions are much lower and VOC estimates are higher during green waste composting as shown in Table 4 (due to a much lower nitrogen content of the waste compared to mixed waste composting). Green waste composting facilities exist in the MANE-VU states; however, the *BioCycle* data did not report throughput data for these facilities. The only place where Pechan applied a different composting emission factor was for DC. Information from *Biocycle* and DCWASA indicated that only green waste was composted. Therefore, the emission factors for green waste were used to estimate emissions for DC (the SCC associated with green waste composting was also used for reporting DC emissions).

For biosolids composting, the *BioCycle* biosolids composting survey for 1998 (*BioCycle*, 1999) has more complete data than the 1999 survey published in the November 2000 issue. The survey conducted in 1999 had only one third of the operating facilities returning questionnaires. In total, there were 115 biosolids composting facilities identified in MANE-VU region. The *BioCycle* data does not describe whether biosolids were mixed or partially mixed with other wastes. Therefore, 100% biosolids composting was assumed, and the emission factor of 3.28 lb NH_3/wet ton was applied (see Table 4). Solids content was assumed to be 10% when adjusting dry biosolids to the moisture content of composted biosolids (*BioCycle,* 2000). A few facilities reported biosolids in units of cubic yards. For these facilities, a biosolids density of 1000 wet lb/cubic yard was applied to convert biosolids volume into mass (EPA, 1993). Table 4 provides the SCCs and emission factors for composting operations (Pechan, 2003b). The emission factor for green waste composting is provided for information only (no data specific to green waste composting in the MANE-VU region was identified).

Table 4. Emission Factors for Composting Operations

SCC	Description	Emission Factor (lb/SCC unit)		SCC Units
		NH_3	VOC	
2680001000	Waste Disposal, Treatment and Recovery; Composting; Biosolids, All Processes	3.28	1.70	ton
2680002000	Waste Disposal, Treatment and Recovery; Composting; Mixed Waste, All Processes	2.81	3.12	ton
2680003000	Waste Disposal, Treatment and Recovery; Composting; Green Waste, All Processes	0.82	3.76	ton

The state-level composting activity data were grown from 1998 to 2002 using population data. The 2002 state-level composting activity was then allocated to the county-level using population data. As specified in the work plan, Pechan developed emission estimates for both NH_3 and VOC for composting.

E. RESULTS

Table 5 provides a summary of 2002 NH_3 emission estimates developed during this project. Table 6 provides facility-level emission estimates for cement plants in the MANE-VU region. Also, as specified in the work plan, Pechan developed VOC emission estimates for composting processes. These are provided in Table 7.

Figures 1 through 3 are county-level emission density maps showing the distribution of RPO emissions for industrial refrigeration losses, POTWs and biosolids management, and composting, respectively.

Figures 4 and 5 are pie charts showing NH_3 emission estimates for the entire RPO and the New York City metropolitan (NYC metro) area, respectively. For the purposes of this analysis, the NYC metro area is comprised of six New York and four New Jersey counties (Bronx, Kings, Nassau, New York, Queens, Richmond, Bergen, Essex, Hudson, and Union counties). Also, the emission estimates underlying these figures are taken from a variety of sources and are not based on a rigorous analysis of the emissions data. The area source data, including the estimates from this project, are for the year 2002 (Pechan, 2004). Point, nonroad, and onroad emissions data are taken from the 1999 NEI (EPA, 2003).

What these two charts show is a significant change in source contribution between large regional areas (e.g., RPO to national levels) and urban areas. At regional levels, primary contributors are from the agricultural sector, although onroad sources are also significant contributors at the regional level (see Figure 4). As shown in Figure 5, most of the primary contributors at the urban scale are relatively unimportant at the regional to national level. The onroad sector dominates in the NYC metro area and other source sectors become more significant contributors. This has important implications for understanding fine PM formation in urban areas.

Regarding cement plants, while these sources also do not appear to be large contributors at the regional level, they can be significant point sources of emissions. Depending on their proximity to Class I areas, cement plants could be important contributors to regional haze in these areas.

Table 5. Summary of 2002 Ammonia (NH_3) Emission Estimates

SCC	Description	Emissions (tons/year)[a]												
		CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	RPO
2399010000	Industrial Processes; Industrial Refrigeration; Refrigerant Losses; All Processes	371	46	20.1	756	524	241	124	1051	1817	1629	92	114	6,785
305006xx 305007xx	Industrial Processes; Mineral Products; Cement Manufacturing; Kilns	0.0	0.0	0.0	0.0	157	31.3	0.0	0.0	252	428	0.0	0.0	868
2630020010	Waste Disposal, Treatment and Recovery; Wastewater Treatment; Public Owned; Wastewater Treatment Processes Total	1.9	1.7	0.5	3.9	2.3	0.7	0.4	4.9	39.1	7.4	0.7	0.2	63.7
2630020020	Waste Disposal, Treatment and Recovery; Wastewater Treatment; Public Owned; Biosolids Processes Total	10.2	8.7	2.4	20.6	12.3	3.6	2.3	25.6	205	38.8	3.5	1.1	334
2630050000	Waste Disposal, Treatment and Recovery; Wastewater Treatment; Public Owned; Land Application – Digested Sludge	0.0	0.0	23.1	179	138	11.7	2.2	107	206	184	0.0	2.4	852
2680001000	Waste Disposal, Treatment and Recovery; Composting; Biosolids, All Processes	205	0.0	4.6	468	655	247	149	627	350	712	106	23.6	3,547
2680002000	Waste Disposal, Treatment and Recovery; Composting; Mixed Waste, All Processes	248	0.83[b]	163	1289	924	98.2	31.7	710	2365	607	137	25.0	6,599
Totals		**836**	**57.2**	**214**	**2,716**	**2,412**	**634**	**310**	**2,526**	**5,234**	**3,606**	**339**	**166**	**19,049**

[a] Totals do not always add exactly due to rounding.
[b] Reported under SCC 2680003000 (green waste composting).

Table 6. 2002 Cement Kiln Emissions

Facility	Kiln Type	State	Clinker (ton/yr)	EF (lb/ton clinker)	2002 Emissions (tons)	Source
Lehigh Portland Cement	preheater	MD	1,291,628	0.145	93.6	Steve Lang, MDE
Independent Cement/St. Lawrence	long dry	MD	569,993	0.145	41.3	Duane King, MDE
Essroc Cement Corp	long wet	MD	308,000	0.145	22.3	Duane King, MDE
Dragon Products Company	wet	ME	432,180	0.145	31.3	Garth Hawkins, PCA (2001 capacity)
Norlite Corp	dry	NY	240,942	0.145	17.5	Carlos Mancilla, NYSDEC
Northeast Solite Corporation	dry	NY	241,996	0.145	17.5	Carlos Mancilla, NYSDEC
Glens Falls Lehigh Cement Company	preheater	NY	563,618	0.145	40.9	Carlos Mancilla, NYSDEC
St Lawrence Cement Company	wet	NY	622,091	0.145	45.1	Carlos Mancilla, NYSDEC
Glens Falls Lehigh Cement Company	wet	NY	81,472	0.145	5.9	Carlos Mancilla, NYSDEC
Lafarge North America Inc.	wet	NY	1,727,241	0.145	125	Carlos Mancilla, NYSDEC
Allentown Cement Co /Evansville	dry	PA	853,335	0.145	61.9	Garth Hawkins, PCA (2001 capacity)
Essroc/Bessemer	wet	PA	621,810	0.145	45.1	Garth Hawkins, PCA (2001 capacity)
Cemex Inc/Wampum Cement Plt	dry	PA	837,900	0.145	60.8	Garth Hawkins, PCA (2001 capacity)
Lafarge Corp/Whitehall Plt	preheater	PA	793,800	0.145	57.6	Garth Hawkins, PCA (2001 capacity)
Essroc/Nazareth Lower Cement Plt	preheater	PA	1,230,390	0.145	89.2	Garth Hawkins, PCA (2001 capacity)
Essroc/Nazareth Cement Plt	long dry	PA	572,198	0.145	41.5	Garth Hawkins, PCA (2001 capacity)
Hercules Cement Co/Stockertown	preheater	PA	999,968	0.145	72.5	Garth Hawkins, PCA (2001 capacity)
		Totals	**11,988,562**		**869**	

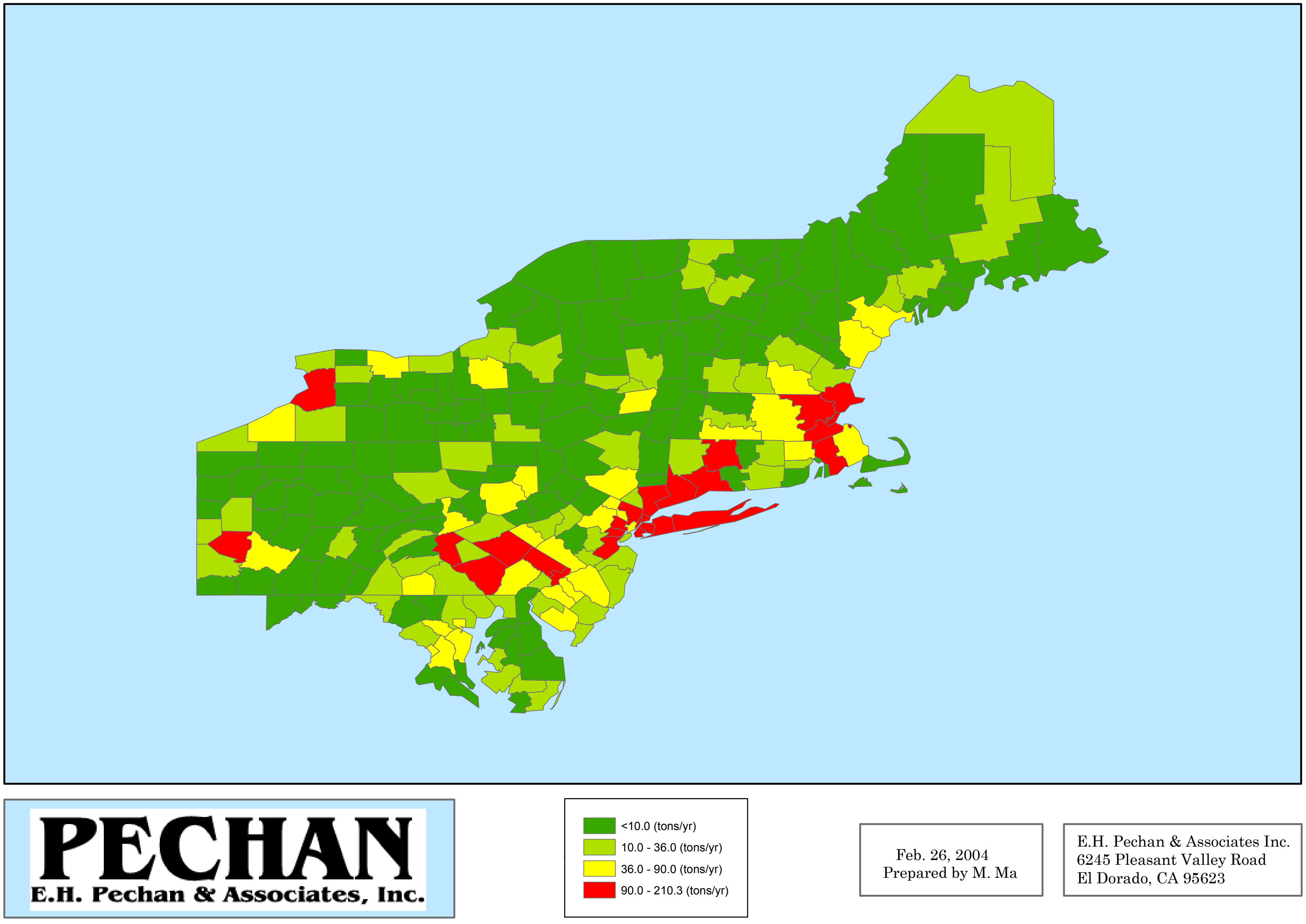
Table 7. Summary of 2002 VOC Emission Estimates

SCC	Description	Emissions (tons/year)												
		CT	**DC**	**DE**	**MA**	**MD**	**ME**	**NH**	**NJ**	**NY**	**PA**	**RI**	**VT**	**RPO**
2680010000	Waste Disposal, Treatment and Recovery; Composting; Biosolids, All Processes	106	0.0	2.4	243	339	128	77.4	325	181	369	55	12	1,838
2680020000	Waste Disposal, Treatment and Recovery; Composting; Mixed Waste, All Processes	275	3.8[a]	181	1432	1025	110	35.2	788	2626	674	152	27.8	7,330
	Totals	**381**	**3.8**	**183.4**	**1,675**	**1,364**	**238**	**112.6**	**1,113**	**2,807**	**1,043**	**207**	**39.8**	**9,168**

[a] Reported under SCC 2680030000 (green waste composting).

Figure 1. MANE-VU RPO 2002 NH3 Emissions

Industrial Refrigeration



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Prepared by M. Ma

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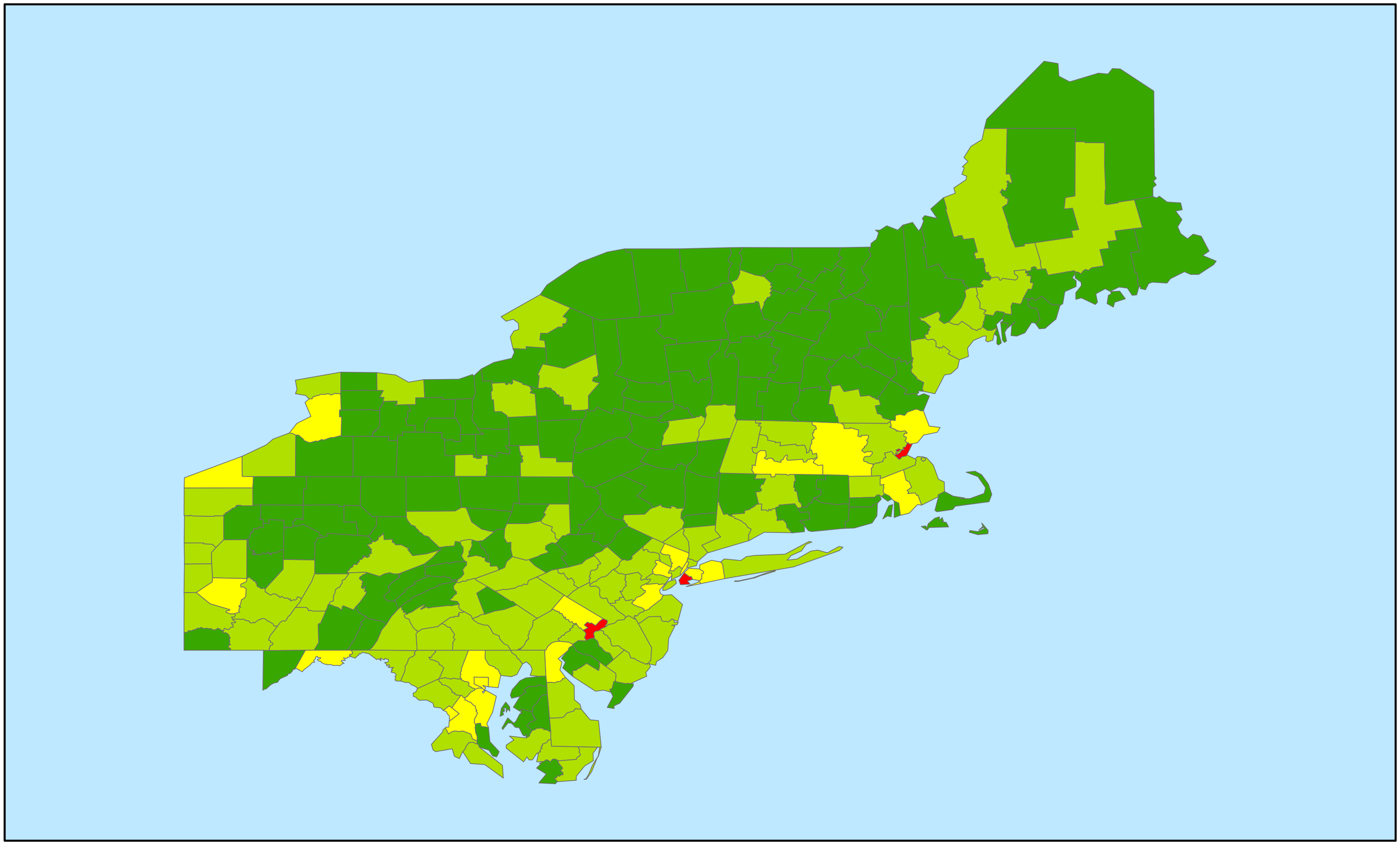
Figure 2. MANE-VU RPO 2002 NH3 Emissions

POTWs and Biosolids Management



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E.H. Pechan & Associates, Inc.

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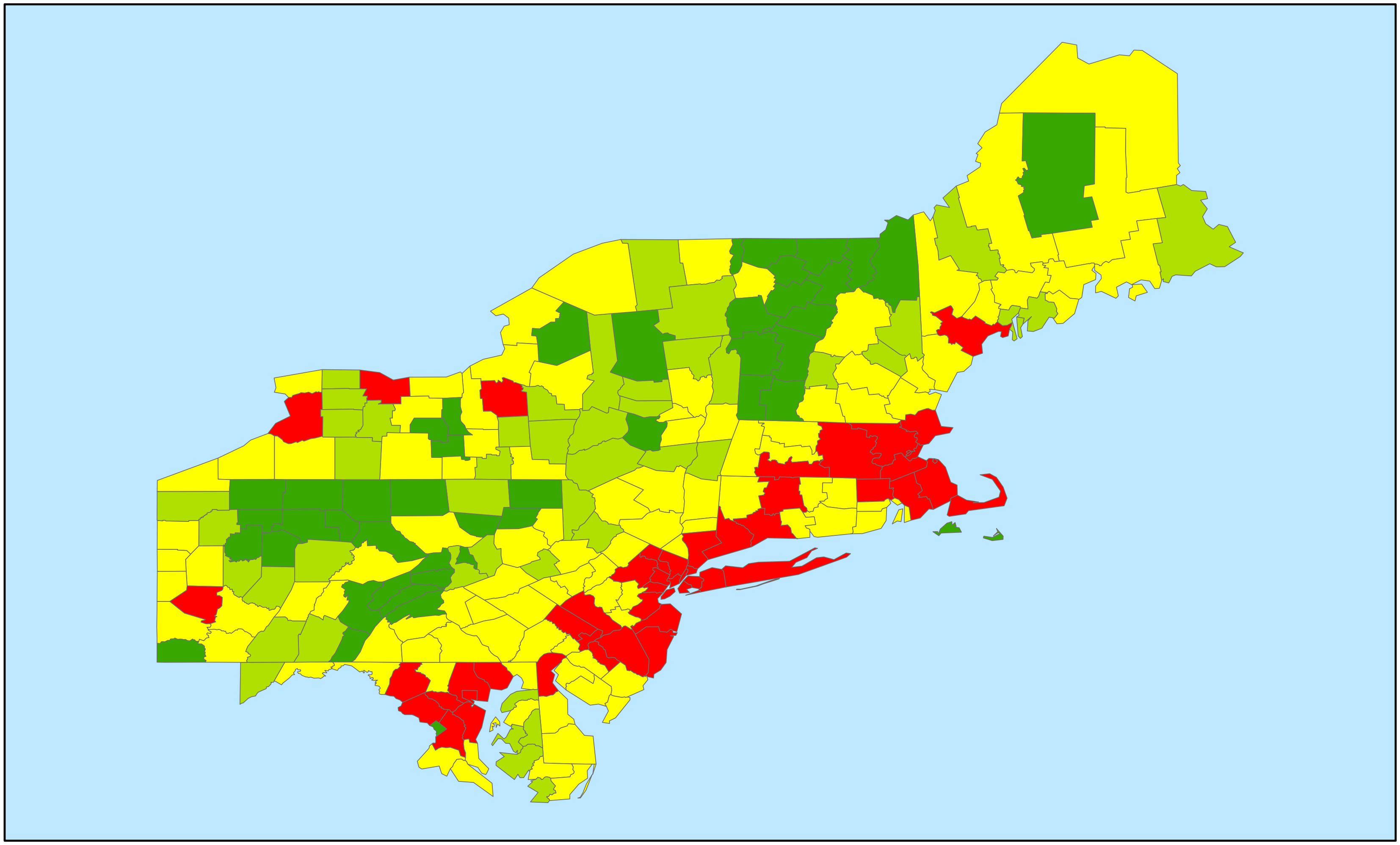
E.H. Pechan & Associates Inc.
6245 Pleasant Valley Road
El Dorado, CA 95623

Figure 3. MANE-VU RPO 2002 NH3 Emissions

Composting



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<5.0 (tons/yr)	
5.0 - 10.0 (tons/yr)	
10.0 - 60.0 (tons/yr)	
60.0 - 403.1 (tons/yr)	

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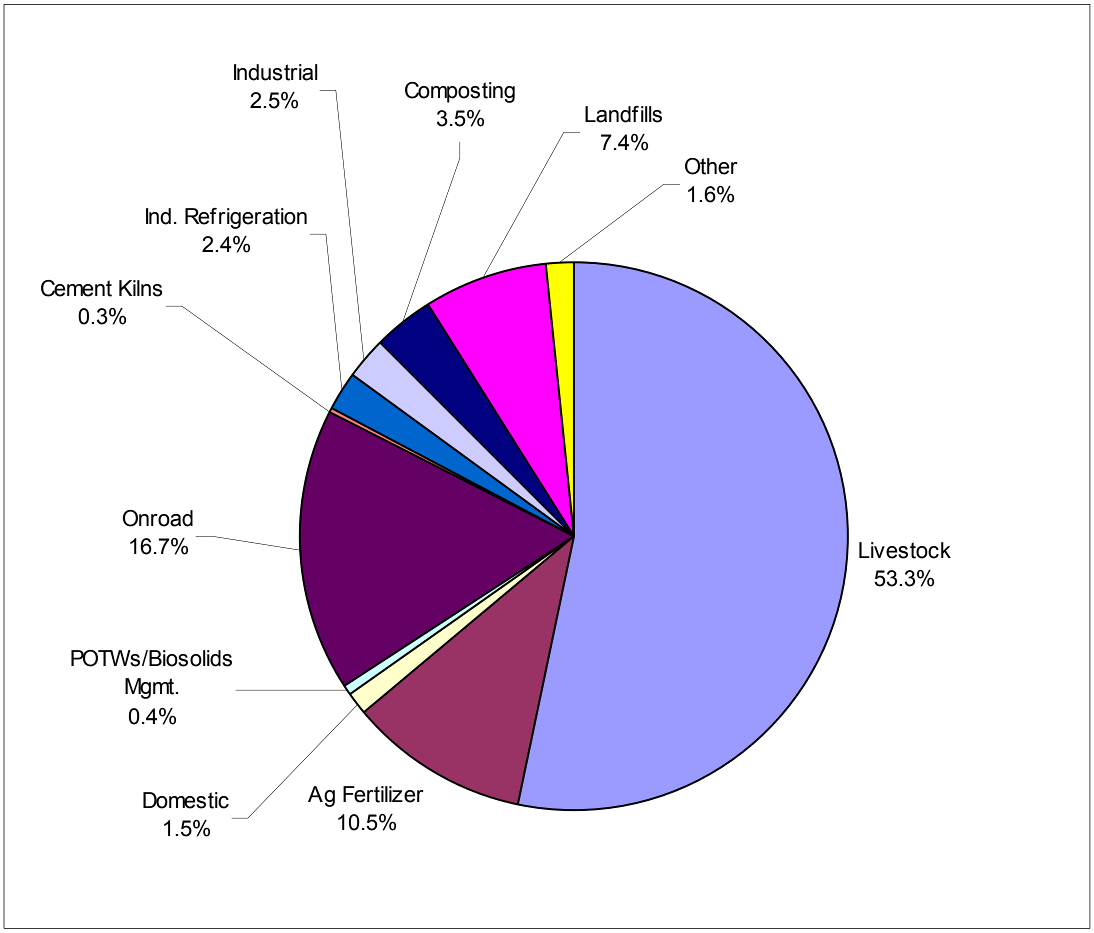
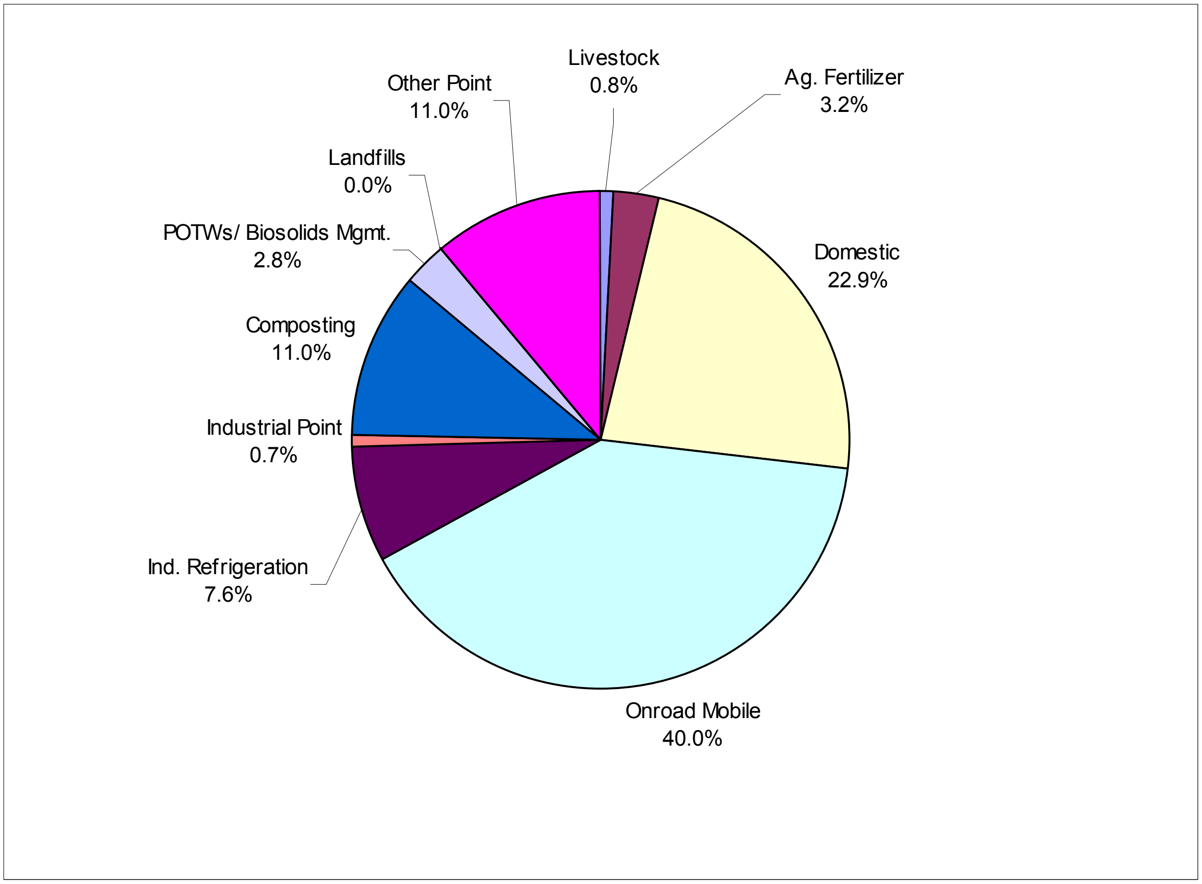
El Dorado, CA 95623

Figure 4. MANE-VU RPO NH_3 Emission Contributors



Note: "Domestic" includes human perspiration and respiration, cigarette smoke, household NH_3 use. "Other Point" includes non-industrial point sources. It is not clear the degree of overlap between the point source inventory and industrial refrigeration emission estimates. "Other" includes: nonroad mobile, commercial and residential fuel combustion, forest fires and prescribed burning, storage and transport, incineration, and industrial waste water treatment.

Figure 5. NYC Metro Area NH_3 Contributors



Note: "Domestic" includes human perspiration and respiration, cigarette smoke, household NH_3 use. "Other Point" includes non-industrial point sources. It is not clear the degree of overlap between the point source inventory and industrial refrigeration emission estimates. "Other" includes: nonroad mobile, commercial and residential fuel combustion, forest fires and prescribed burning, storage and transport, incineration, and industrial waste water treatment. Data were not identified to estimate NH_3 emission estimates from NYC metro area landfills (e.g., Fresh Kills).

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Appendix A. Supporting Documentation

PCA
Portland Cement Association

October 20, 2003

Mr. Stephen M. Roe
Senior Scientist
E.H. Pechan & Associates, Inc.
P.O. Box 1345
El Dorado, CA 95623

Ammonia Emissions from Portland Cement Manufacturing

Dear Mr. Roe:

I am writing in response to your inquiry concerning ammonia emissions from cement manufacturing facilities. These data should assist you in the development of an ammonia emission inventory guidance document for the USEPA and Mane-Vu. The table below provides a summary of ammonia emission data. These data were collected in conjunction with the development of a data set to address the National Emission Standard for Hazardous Air Pollutants (NESHAP) for portland cement manufacturing. The emission rates from the test reports and related plant production capacities were used to produce the following table:

Emissions factor	Parameter	Kiln type	Number of plants	Number of tests	Minimum, lb/ton clinker	Average, lb/ton clinker	Maximum, lb/ton clinker
Portland cement kilns	Ammonia / ammonium	Wet	4	5	0.0026	0.2705	1.2895
		Long dry	2	7	0.0000	0.0377	0.1199
		Preheater	6	9	0.0016	0.1279	0.3967
		Precalciner	4	8	0.0031	0.0992	0.3502

If you have questions, please contact me by telephone at 847.972.9180 or by electronic mail at ghawkins@cement.org.

Sincerely,

Garth J. Hawkins, PE
Program Manager, Environment, Health & Safety

cc: A. O'Hare, PCA

5420 Old Orchard Road
Skokie, Illinois 60077-1083
847.966.6200 Fax 847.966.8389

www.cement.org