Delaware Statewide Toxic and Criteria Air Pollutant Emissions Inventories for 2002 and Projected Toxic Air Pollutant Emissions Inventory for 2003

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Abstract

The Delaware Air Quality Management Section (AQMS) embarked on the Delaware Air Toxics Assessment Study (DATAS) project in 2002 to gain a better understanding of ambient concentrations of toxic air pollutants (TAPs) throughout Delaware, exposure to those TAPs, and the health risks associated with that exposure based on nationally-accepted health benchmarks. The DATAS project is the first step in the process of assessing and controlling TAPs that pose an unacceptable risk to the citizens of Delaware. The DATAS project involves monitoring of TAPs at five locations throughout the state during 2003, and the use of air dispersion models to predict ambient air concentrations based on a comprehensive emission inventory.

In support of the modeling effort, E.H. Pechan & Associates, Inc. (Pechan) assisted AQMS in the development of a comprehensive statewide 2002 TAP inventory for 85 TAP species associated with point, stationary area, on-road mobile, and non-road sources. The inventory was then projected to 2003 to coincide with the monitored data to be used as input for the modeling of ambient air concentrations. In addition to the TAP inventory, Pechan also developed a 2002 criteria pollutant and precursor inventory for DE. This inventory will serve a number of purposes, including Delaware's emissions reporting requirements under the Consolidated Emissions Reporting Rule (CERR).

This paper provides an overview of the emissions inventory, and then focuses on efforts to obtain activity data needed to refine emissions estimates, spatial allocation (e.g., spatial surrogates, geo-

coded source locations) and temporal allocation in support of exposure modeling within five DE communities.

Introduction

The Delaware Air Toxics Assessment Study (DATAS)

The Air Quality Management Section (AQMS) within the Delaware Department of Natural Resources and Environmental Control (DNREC) embarked on the Delaware Air Toxics Assessment Study (DATAS) project in 2002 to develop a risk-based approach to understanding ambient concentrations of certain toxic air pollutants (TAPs) throughout Delaware. The DATAS project will continue through early 2005 and is the first step in the process of assessing and controlling TAPs that pose an unacceptable risk to the citizens of Delaware. The list of DATAS TAPs is shown in Table 1.

The U.S. EPA brought attention to TAPs through its own nationwide study known as the National Air Toxics Assessment (NATA). The NATA study identified certain TAPs that pose the greatest risk on a national or regional level. However, in many cases, EPA was unable to develop local estimates of TAP emissions, and thus relied on national default values to generate much of the emissions data that went into the NATA modeling effort. AQMS recognizes the limitations of NATA to accurately identify risks at the county and local level and seeks to improve upon that effort.

The DATAS project consists of three technical components: an ambient air monitoring network, a comprehensive emissions inventory, and air dispersion modeling/health risk assessment. Ambient air monitoring was completed at five locations throughout the State during 2003. The monitors measured several pollutant groups including volatile organic compounds (VOCs), metals, polycyclic aromatic hydrocarbons (PAHs), dioxins/furans, and carbonyls. In 2004, the project will involve the use of air dispersion models to predict ambient air concentrations based on a comprehensive 2003 emissions inventory. The observed monitoring data will be used to validate model performance. Sample monitoring data for select volatile organic TAP species is shown in Figure 2.

The modeling effort will quantify regional-scale and local-scale ambient concentrations of TAPs. The regional-scale model will consider sources of TAPs beyond Delaware's borders. Inventory data for other states within the regional domain will be obtained from EPA's National Emissions Inventory (NEI). The local-scale modeling will focus on ambient concentrations within five 10-kilometer (km) by 10-km inventory domains ("local areas"; see Figure 1), most of which are centered on each monitoring station. Additional spatial allocation of emissions to the sub-county level will be performed to obtain emissions data for each local area.

The Emissions Inventory Component

In support of the modeling effort, AQMS is preparing a statewide 2002 inventory of 87 TAPs (see Table 1) for all sources, including point, stationary area, on-road mobile, and non-road sources. While the year of interest for the DATAS project is 2003, AQMS determined it would be most efficient to develop a TAP inventory in conjunction with the 2002 criteria air pollutant (CAP) inventory necessary for meeting the requirements of the Consolidated Emissions Reporting Rule (CERR). The TAP inventory will then be projected to 2003, accounting for changes in activity and controls, to coincide with the observed monitoring data (note that for some source categories, 2003 activity data were acquired and used in developing the inventory).

The DATAS project, coupled with the new CERR requirements, required AQMS to seek assistance in preparing the TAP and CAP inventories. AQMS used penalty funds and a U.S. EPA grant to contract with E.H. Pechan & Associates (Pechan) for that assistance. Pechan was tasked with developing a 2002 CAP and TAP inventory for non-point sources, assisting AQMS staff in developing a point source 2002 CAP and TAP inventory, and projecting the entire 2002 TAP inventory to 2003. The combining of the CAP and TAP inventories allowed for consistent method development and the use of one set of activity data.

The DATAS project's local-scale modeling requires a finer spatial resolution than the county level emission estimates normally prepared for the NEI. Emission estimates are being developed for the five local areas, through a variety of allocation factors developed by Pechan or through geo-coding point and area sources. Small chrome plating operations, dry cleaners, and gasoline retail stations are just a few of the area source categories that were geo-coded for greater spatial resolution.

Temporal resolution was also improved for these inventories to enhance the air dispersion model performance and for the development of summer season weekday (SSWD) emission estimates required by the CERR. Where possible, activity and meteorological data were collected for each month of the year to develop the temporal allocation profiles.

Methods

For each of the four inventory sectors (point, area, onroad, and nonroad), an Inventory Preparation Plan (IPP) was developed which detailed the methods and data sources to be used in constructing the inventory, data quality objectives, quality assurance/quality control (QA/QC) procedures, and inventory coding procedures. The project team felt that detailed IPPs were essential to the development of an inventory that would fit Delaware's needs for CERR inventory submittal, as well as modeling to be conducted under the DATAS project. For example, the coding procedures included a listing of all SCCs to be used, spatial allocation methods (e.g. point coordinates, spatial surrogate), temporal allocation methods (e.g. temporal profiles), and control parameters (control efficiencies, rule penetration, rule effectiveness). The more details that were provided in the IPP, the less room for error or misinterpretation during the follow-up 2002/2003 inventory development phases. Also, a carefully developed set of IPPs would promote an efficient use of time during EI development.

Point Sources

The universe of facilities surveyed as point sources included any facility statewide that: (1) held a current Title V permit; or (2) reported, in the past 3 years, five tons per year or greater of VOCs; or (3) is a hot-mix asphalt plant, a hospital using ethylene oxide sterilization, an electricity generating unit, or a facility using anhydrous ammonia as a refrigerant. These criteria were selected to meet the several needs of the 2002 inventory, including as a periodic emission inventory, a baseline inventory for the new Federal standards, to meet CERR requirements, and to support the DATAS project.

Facilities reported through the Internet using an on-line reporting system developed specifically for Delaware. Smaller, one-process facilities were provided short two- or three-page reporting forms, which were transmitted in hard copy. Facilities were required to report the following data at the process level: monthly throughputs, operating schedule, control equipment information,

stack parameters, coordinates, and emissions estimation methodologies. The data were entered into Delaware's database management system which was then used to calculate emissions.

Facilities were required to report all 188 Clean Air Act hazardous air pollutants (HAPs) for all non-combustion processes. Combustion HAPs were calculated by AQMS using fuel throughputs and the latest published emission factors. With a few exceptions, the DATAS pollutants are a subset of the 188 HAPs. In addition to HAPs, facilities were required to report emissions of VOCs, nitrogen oxides (NOx), sulfur dioxide, carbon monoxide, particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}) and ammonia. PM with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) was calculated by AQMS using the latest emission factors or size fractioning of PM_{10}. The PM data was further divided into filterable and condensable components, where data permitted.

Extensive QA was conducted on the point source inventories. For example, the reasonableness of emission estimates were evaluated by comparing the 2002 CAP emissions to the 1999 inventory and the TAP emissions to the 2002 Toxics Release Inventory (TRI). Due to the modeling needs for accurate spatial resolution and accurate stack information, all facility coordinates were verified through the use of high-resolution aerial photographs. For certain processes, stack level coordinates were also obtained from the aerial photographs.

Area Sources

For the 2002 and 2003 EI efforts, emission estimates were developed for 37 area source subsectors. These are shown in Table 2. Also, shown are the primary pollutants of interest for each subsector (these were not the only pollutants estimated by sector, however). Many of the area source subsectors are standard area sources included in most criteria pollutant EIs. Certain subsectors were added due to their potential importance as sources of TAPs. These included the following:

- *Catastrophic/Accidental Releases* – information from the National Response Center of the U.S. Coast Guard was used to develop CAP and TAP emission estimates from accidental releases reported during 2002 and 2003;
- *Dover Speedway* – racing vehicle exhaust CAP and TAP emissions were estimated for several races occurring at the Dover Speedway during 2002 and 2003. This was a modest effort aimed at estimating "ball park" estimates to determine the potential significance of racing vehicle TAP emissions;
- *Heavy-Duty Diesel Vehicle (HDDV) Idling Hotspots* - these include warehouses, distribution centers, bus terminals, and truck stops. For the 2003 DATAS modeling, the project team is interested in assessing the significance of these sources as hotspots of diesel PM emissions and potential health risk; and
- *Landfills (inactive)* - active landfills are contained in DE's point source inventory. Emissions for several closed landfills were also estimated and included in the area source inventory, primarily to assess local TAP impacts.

For the agricultural crop subsectors (including wind-blown dust), activity and emissions data were tied to a crop calendar developed for Delaware counties. This crop calendar included information on the timing of land preparation, cultivation and harvesting activities, as well as fertilizer and pesticides application. Wind-blown dust emissions were estimated for agricultural

crops for periods where the crops were not present and land preparation activities were occurring.

The 2002 and 2003 inventory development included survey work of affected sources to gather activity data for dry cleaning, HDDV idling, and sand and gravel facilities. A large amount of additional survey and other data gathering activity was conducted to gather the necessary information for most of the other subsectors. Most of this work involved contacts to other DE State and county agencies (e.g. Departments of Transportation and Agriculture) and other departments within DNREC.

Nonroad Sources

For the majority of nonroad engines, Pechan used EPA OTAQ's draft NONROAD2002a model to generate 2002 and 2003 CAP emissions and fuel consumption estimates (EPA, 2003). These emissions/fuel estimates then formed the basis of NH_3 and TAP emission estimates. To improve the accuracy of the model runs, default seasonal inputs were replaced for select parameters, including Reid vapor pressure (RVP), temperature, oxygenated fuel weight percent, Stage II control factors, and fuel sulfur levels. Emissions due to refueling at the gasoline pump (Stage II) and portable container use were subtracted from the NONROAD model estimates, since refueling emissions were developed as part of the area source inventory using alternate methods deemed to be more comprehensive and spatially representative.

Pechan researched and compiled available State and county-specific data to improve upon the default equipment populations and geographic allocation factors incorporated in the model. Equipment categories for which more representative State and/or county-specific data were collected included residential lawn and garden, land-based recreational vehicles (including golf carts), recreational marine, logging equipment, and aircraft ground support equipment. All other categories relied on default data included in the model for population and allocation factors.

Offroad categories not included in NONROAD include aircraft, commercial marine vessels (CMV), and locomotives. 2002 commercial and military landing and take-off operations (LTOs) were compiled for New Castle County Airport and Dover Air Force Base. Commercial and military aircraft emissions were then estimated using airport-specific data and FAA's Emission Dispersion Modeling System (EDMS) Version 4.12. General aviation and air taxi LTO activity data for several smaller airports were multiplied by EPA fleet-average emission factors to estimate CAP emissions. All aircraft TAP emissions were estimated by applying available speciation profiles to VOC, total organic gas (TOG), or PM_{10} emission estimates. Monthly LTO operations reported by airports were used to develop monthly allocation profiles for use in emissions modeling. Pechan also developed the necessary association between each local community and the airports that it contains, based on latitude/longitude coordinates.

For the locomotive category, Pechan contacted the Class I railways operating in Delaware (Norfolk Southern and CSX Transportation) to obtain both line haul and switchyard activity. For line haul emissions, Pechan obtained traffic density estimates of gross ton-miles [GTM] by county and multiplied this by a fuel consumption index (i.e., gallons of fuel consumed per GTM), to estimate fuel use by county. The number of yard locomotives was multiplied by an assumed annual fuel use to estimate total fuel consumption at Class I switchyards. For small Class II/III railways, Pechan estimated statewide and county fuel consumption by multiplying total system-wide consumption of each railroad by the proportion of track each railroad has in Delaware. The location of rail tracks and switchyards was established for spatially resolving the emission estimates to counties and to local areas.

For the CMV sector, Pechan developed emissions using several activity data variables including vessel calls, time-in-mode, rated engine power, and engine load factor. Pechan contacted the Marine Exchange for the Delaware River Area to obtain the number and type of ocean-going vessels (OGV) passing through Delaware waters. Activity for vessel-assists (tugboats) was based on the OGV call data. The U.S. Army Corps of Engineers (USACE) supplied towboat traffic passing through the Chesapeake and Delaware Canal, the Port of Wilmington, and the Delaware River. The ferry operators supplied schedules and engine data as well. The data were used to estimate the activity of both propulsion and auxiliary commercial marine engines in kilowatt-hours by engine category and type of activity (i.e., cruising, hotelling). For dredging, emissions were based on estimates of the emissions per volume of material dredged for maintenance of the Delaware River rather than engine activity (USACE, 2003). Pechan developed county allocation factors based on the length of waterway segments in each county. EPA emission factors were used to estimate CAP emissions. Speciation profiles of PM and VOC emissions and the estimated fuel consumption by engine type were used to develop TAP emission estimates. Pechan also estimated evaporative emissions, including benzene and xylenes, from the loading and transit of petroleum products on CMV, based on reports of the amount of product loaded at the Port of Wilmington and transported on Delaware waters.

Onroad Sources

Onroad sources were modeled using EPA's MOBILE6.2 emission factor model with as many local inputs as possible, combined with 2002 link-level vehicle miles traveled (VMT) data. The MOBILE6.2 inputs used are discussed below.

Fuel -- Monthly fuel parameters, including those parameters needed to model the TAPs were obtained from the data used for Delaware in EPA's preliminary 2002 NEI. The fuel data used were based on fuel survey data from the Philadelphia area and from Sussex County. The gasoline data included Reid vapor pressure; sulfur, aromatics, olefins, and benzene content; vapor percentage at 200 and 300 degrees Fahrenheit; and the market share and volume percentage of oxygenates. Reformulated gasoline was used throughout Delaware in 2002. These fuel inputs reflect reformulated gasoline properties. Diesel fuel sulfur content data were also obtained from summer and winter survey data provided by EPA, based on survey data from the Philadelphia area.
Temperature -- County-specific actual temperature data for 2002 were provided by AQMS. Average daily maximum and minimum temperatures were calculated for each month of the year, and for summer and winter.
Registration Data -- July 2002 vehicle registration data from the Delaware Division of Motor Vehicles were used to develop the MOBILE6 registration distributions by county. The data collected by Delaware included two light-duty truck (LDT). Default data from MOBILE6 were used to allocate these LDT registration data to the four separate LDT categories. The heavy duty vehicle data provided by the Division of Motor Vehicles already included the breakdowns for the MOBILE6 heavy-duty vehicle categories.
VMT Mix by Vehicle Type -- Actual data were not available to specify the VMT fractions by vehicle type. Instead, county-specific VMT mix fractions were calculated using the Delaware county-specific registration counts by model year and the default MOBILE6 mileage accumulation rates and diesel sales fractions.
Speed Distributions -- Speed distributions were calculated by functional roadway class and county at the daily level of detail. (Hourly data were not available). The data used in calculating the speed distributions were based on the speeds included in the link-level VMT data provided by the Delaware Department of Transportation (DOT).
Control Programs – AQMS provided county-specific information on the inspection and maintenance (I/M) programs and anti-tampering programs in place in Delaware in 2002.

MOBILE6.2 input files were developed for each county including the inputs described above. Scenarios within each input file were developed to represent the temperature and fuel conditions present in each month or season and the speed distribution for each functional roadway class. TAP and CAP emission factors were calculated using the same input files. Emission factors for a total of 33 TAPs were estimated using MOBILE6.2.

Both TAP and CAP emissions were calculated at the link-level of detail by vehicle type using link-level data for 2002 provided by Delaware DOT and the corresponding MOBILE6.2 emission factors. Emissions from an additional 17 congeners of dioxin were calculated using fuel-specific emission factors multiplied by VMT. Onroad emissions of mercury and arsenic were not included in the Delaware TAP inventory, based on EPA guidance to defer inventory development of these pollutants at this time due to the lack of credible onroad emission factor data for these two pollutants.

Conclusions

By combining the TAP inventory development effort with the development of a criteria pollutant emissions inventory, DNREC was able to fill two different inventory needs with only a marginal increase in the resources (time and manpower) needed to complete just one of the inventories. The authors believe that other state and local agencies could achieve similar benefits by considering all of the needs for emissions inventories when projects are planned. In addition to TAP and CAP inventories, greenhouse gas inventories can also be developed with marginal increases in resources above what is needed to prepare an inventory of just one of the other pollutant categories. The inventories described in this paper were prepared in less than nine months; however the authors recommend that similar efforts allow for at least twelve months. The additional time will make it easier to conduct all of the data gathering needed to support a comprehensive inventory effort.

Table 3 provides a summary of 2002 emissions estimated for selected TAPs for the area source sector. For the selected TAPs in this table, many of the important area subsectors are also important criteria pollutant contributors (e.g. gasoline marketing VOC, residential wood combustion PM). Area source subsectors for which only CAP emissions were estimated included: agricultural production, agricultural fertilizer application, animal husbandry, bakeries, commercial and residential construction, miscellaneous ammonia source categories, road construction, sand and gravel operations, and windblown dust.

From the standpoint of the DATAS project, it will be important to adequately characterize the spatial and temporal aspects of the 2003 TAP inventory for important area subsectors. These include gasoline marketing (due to the contribution of benzene and other TAPs), dry cleaning (perchloroethylene), diesel combustion sources (diesel PM), residential wood combustion (important contributions for a number of TAPs), and smaller industrial sources (e.g. auto refinishers). Note that some potentially important health risk contributors are being handled in the point source inventory (e.g. active landfills, ethylene oxide sterilizers, chromium platers).

The 2002 off-road emission estimates were based on surveys of locomotive and aircraft activity, published commercial marine vessel call data for the Delaware River Area, and Delaware-specific estimates of equipment populations or activity for other select nonroad engines. 2003 estimates were projected from 2002 using the appropriate growth and control factors, with the exception of the NONROAD model categories, which were developed using 2003 model runs. County level TAP emissions were allocated to the five local areas using information known to correlate with the activity (e.g., residential/commercial building square footage for lawn and garden equipment). The physical location of airports or switchyards was used to geocode aircraft and locomotive emissions. This allowed for improved resolution and characterization of emission sources for important nonroad-related TAPs, including diesel PM, formaldehyde, and toluene.

The quality of the TAP onroad emission inventory benefited from being calculated simultaneously with the CAP inventory. The CAP inventory is easier to check for errors of magnitude due to the smaller number of pollutants and knowledge gained over years of experience in reviewing CAP inventories. Thus, by reviewing the CAP emission inventory first, several errors were identified and corrected that may not have been noted if only the TAP inventory had been prepared. For example, the source of some discrepancies that were noted in the draft CAP inventory was eventually determined to be due to an error in the registration

distribution for one of the counties. Correcting this error improved both the TAP and CAP onroad inventories. Review of the inventories and cross-county comparisons has shown that the VMT mixes used in this analysis are having a significant effect on the resultant emissions. Therefore, it is important for Delaware to consider collecting actual data that could be used in the future to improve the accuracy of the VMT mix by vehicle type.

References

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USACE, 2003: "Delaware River Main Channel Deepening Project, Preliminary Emissions Reduction Strategy Report," U.S. Army Corps of Engineers, Philadelphia District, Prepared by Moffatt and Nichol Engineers. July 2003.

Key Words

Toxic air pollutants, criteria air pollutants, emission inventory

Table 1. List of DATAS TAPs.

Chemical Name	Chemical Abstract Service No.
Volatile Organic Compounds (VOCs)	
Acrylonitrile	107131
Benzene	71432
Bis(2-ethylhexyl)phthalate	117817
1,3-Butadiene	106990
Carbon Tetrachloride	56235
Chlorobenzene	108907
Chloroethane (Ethyl Chloride)	75003
Chloroform	67663
Chloromethylbenzene (Benzyl Chloride)	100447
1,4-Dichlorobenzene	106467
3,3-Dichlorobenzidine	91941
1,1-Dichloroethane (Ethylidenedichloride)	75343
1,3-Dichloropropene	542756
Ethylbenzene	100414
Ethylene Dibromide	106934
Ethylene Dichloride (1,2-Dichloroethane)	107062
Ethylene Oxide	75218
Hexachlorobenzene (perchlorobenzene)	118741
Hexachloroethane	67721
Hydrazine	302012
Isophorone	78591
Methylene Chloride (dichloromethane)	75092
2-Methylphenol (o-cresol)	95487
Nitrobenzene	98953
Pentachlorophenol	87865
Perchloroethylene	127184
Phenol	108952
Propylene Dichloride	78875
Quinoline	91225
Styrene	100425
1,1,2,2-Tetrachloroethane	79345
Toluene	108883
1,1,2-Trichloroethane	79005
Trichloroethylene (trichloroethene)	79016
2,4,6-Trichlorophenol	88062
Vinyl Chloride	75014
m-Xylene	108383
o-Xylene	95476
p-Xylene	106423
Xylenes (mixed isomers)	1330207
Carbonyls	
Acetaldehyde	75070
Acetone	67641
Acrolein	107028
Formaldehyde	50000
Polycyclic Aromatic Hydrocarbons (PAHs)	
Acenaphthene	83329
Acenapthylene	208968
Anthracene	120127
Benzo(a)anthracene	56553

Table 1. List of 87 DATAS TAPs (continued).

Chemical Name	Chemical Abstract Service No.
Benzo(a)pyrene	50328
Benzo(b)fluoranthene	205992
Benzo(g,h,i)perylene	191242
Benzo(k)fluoranthene	207089
Chrysene	218019
Dibenz(a,h)anthracene	53703
Fluoranthene	206440
Fluorene	86737
Indeno(1,2,3-cd)pyrene	193395
Naphthalene	91203
Phenanthrene	85018
Pyrene	129000
Dioxins/Furans	
2,3,7,8-TCDD	1746016
1,2,3,7,8-PeCDD	40321764
1,2,3,4,7,8-HxCDD	39227286
1,2,3,6,7,8-HxCDD	57653857
1,2,3,7,8,9-HxCDD	19408743
1,2,3,4,6,7,8-HpCDD	35822469
OCDD	3268879
2,3,7,8-TCDF	51207319
1,2,3,7,8-PeCDF	57117416
2,3,4,7,8-PeCDF	57117314
1,2,3,4,7,8-HxCDF	70648269
1,2,3,6,7,8-HxCDF	57117449
1,2,3,7,8,9-HxCDF	72918219
2,3,4,6,7,8-HxCDF	60851345
1,2,3,4,6,7,8-HpCDF	67562394
1,2,3,4,7,8,9-HpCDF	55673897
OCDF	39001020
2,3,7,8-TCDD TEQ	600
Metals	
Arsenic Compounds	7440382
Beryllium Compounds	7440417
Cadmium Compounds	7440439
Chromium Compounds (Chromium VI)	18540299
Lead Compounds	7439921
Manganese Compounds	7439965
Mercury Compounds	7439976
Nickel Compounds	7440020
Other	
Coke Oven Emissions	8007452
Diesel Particulate Matter	Not applicable
PCBs	1336363

Figure 1. DATAS Local Areas.

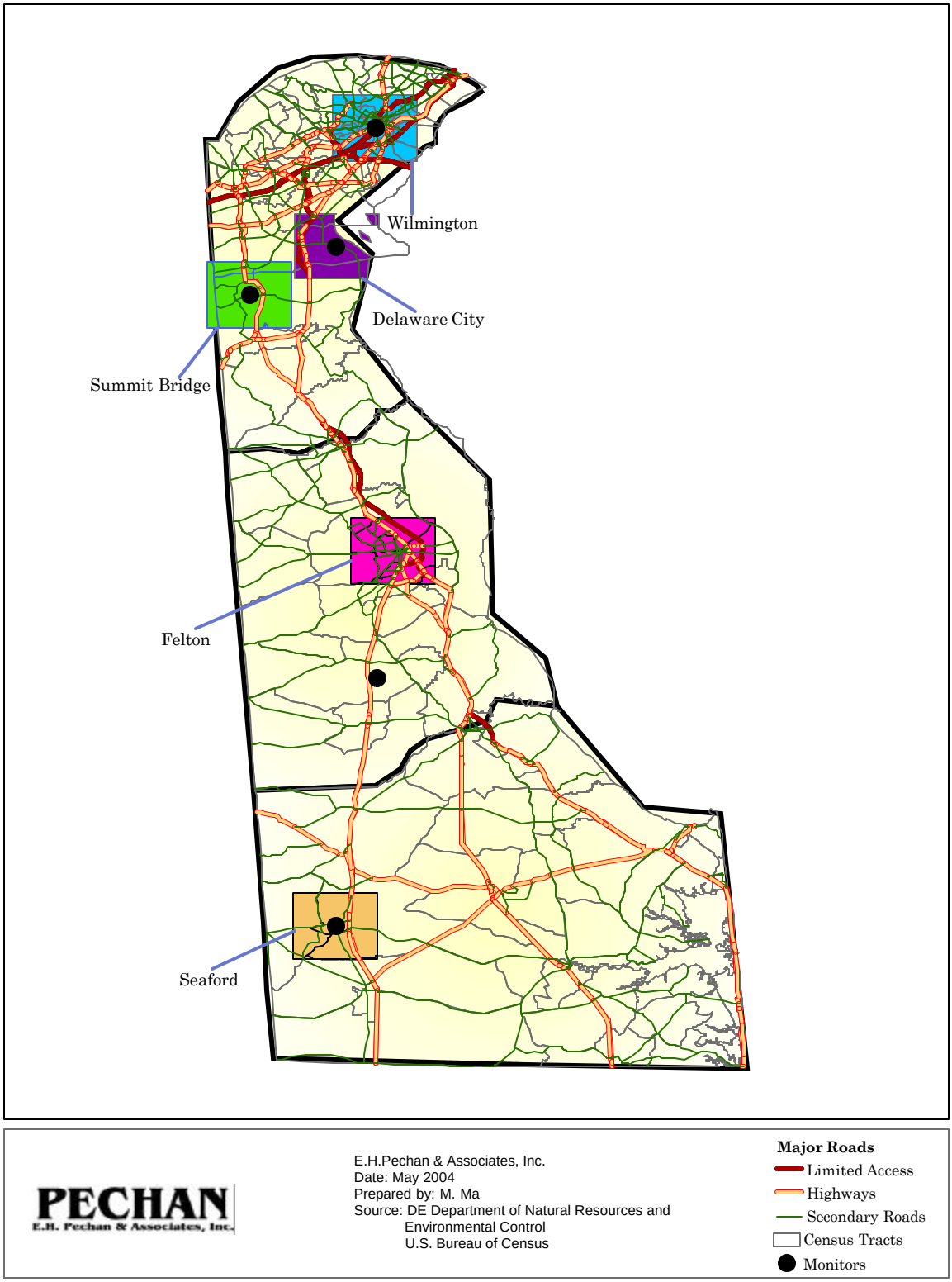

Figure 2. 2003 Ambient Monitoring Data for Selected TAPs.

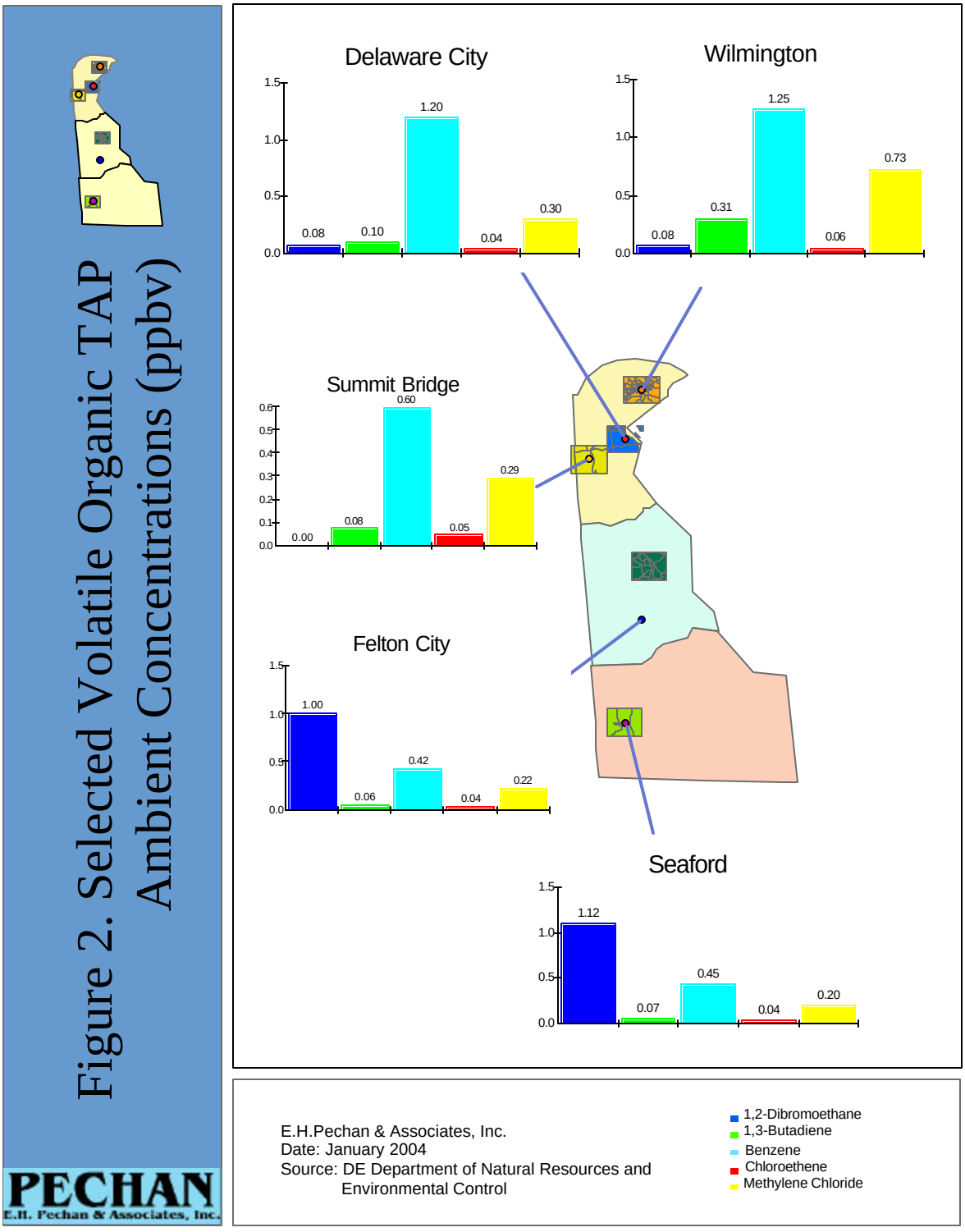

Table 2. List of 37 Area Source Subsectors Covered in This Project.

Area Source Sector	Primary Pollutants of Interest
Agricultural Fertilizer Application	NH_3
Agricultural Pesticides	VOC, TAPs
Agricultural Production	PM_{10}, $PM_{2.5}$
Animal Husbandry	NH_3
Architectural & Industrial Maintenance Coatings	VOC, TAPs
Asphalt Paving	VOC, TAPs
Auto Refinishing	VOC, TAPs
Bakeries	VOC
Catastrophic/Accidental Releases	NH_3, VOC, TAPs
Commercial Construction	PM_{10}, $PM_{2.5}$
Commercial Fuel Combustion	NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$, TAPs
Commercial Cooking	PM_{10}, $PM_{2.5}$, TAPs
Consumer Products	VOC, TAPs
Dover Speedway	PM_{10}, $PM_{2.5}$, CO, TAPs
Dry Cleaning	VOC, TAPs
Gasoline (Petroleum) Marketing	VOC, TAPs
Graphic Arts	VOC, TAPs
Heavy-Duty Diesel Vehicle Idling Hotspots	PM_{10}, $PM_{2.5}$, TAPs
Industrial Fuel Combustion	NO_x, CO, SO_2, TAPs
Industrial Surface Coating	VOC, TAPs
Landfills (Inactive)	VOC, TAPs
Miscellaneous NH_3 Sources	NH_3
Open Burning (Residential and Land Clearing)	PM_{10}, $PM_{2.5}$, TAPs
Paved and Unpaved Road Dust	PM_{10}, $PM_{2.5}$, TAPs
Prescribed Burning	PM_{10}, $PM_{2.5}$, TAPs
Publicly-Owned Treatment Works	VOC, NH_3, TAPs
Residential Construction	PM_{10}, $PM_{2.5}$
Residential Fuel Combustion	NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$, TAPs
Residential Wood Combustion	PM_{10}, $PM_{2.5}$, NO_x, CO, SO_2, NH_3, TAPs
Road Construction	PM_{10}, $PM_{2.5}$
Sand & Gravel Operations	PM_{10}, $PM_{2.5}$
Solvent Cleaning	VOC, TAPs
Structure Fires	PM_{10}, $PM_{2.5}$, TAPs
Traffic Markings	VOC, TAPs
Vehicle Fires	PM_{10}, $PM_{2.5}$, TAPs
Wildfires	PM_{10}, $PM_{2.5}$, TAPs
Windblown Dust	PM_{10}, $PM_{2.5}$

Table 3. Selected 2002 TAP Emission Estimates for the Area Source Sector (ton/yr).

Area Source Subsector[a]	Benzene 71432	Toluene 108883	Formaldehyde 50000	Naphthalene 91203	Benzo(a)pyrene 50328	Lead 7439921
Agricultural Pesticides	31.1	12.8	0.00	0.13	0.00	0.00
Architectural & Industrial Maintenance Coatings	0.00	000	0.024	1.44	0.00	0.00
Asphalt Paving	0.00	3.12	0.00	0.50	0.00	0.00
Auto Refinishing	0.00	19.3	0.00	0.087	0.00	0.00
Catastrophic/Accidental Releases	6.93E-04	5.00E-03	0.00	1.25E-04	0.00	0.00
Commercial Construction[a]	0.00	0.00	0.00	0.00	0.00	0.00
Commercial Fuel Combustion	6.00E-03	9.00E-03	0.64	2.00E-03	1.71E-06	1.00E-02
Commercial Cooking	3.17	1.26	2.53	0.21	1.48E-03	0.00
Consumer Products	7.97E-04	0.00	1.89E-03	1.58E-04	0.00	0.00
Dover Speedway	6.91E-03	3.00E-03	0.018	1.84E-04	0.00	1.96E-06
Dry Cleaning	0.00	0.16	0.00	1.00E-02	0.00	0.00
Gasoline Marketing	24.8	144	0.00	2.97	0.00	0.00
Graphic Arts	15.8	91.2	0.00	3.00E-02	0.00	0.00
Heavy-Duty Diesel Vehicle Idling Hotspots[b]	n/a	n/a	n/a	n/a	n/a	n/a
Industrial Fuel Combustion	0.22	0.06	0.73	6.00E-03	0.00	0.69
Industrial Surface Coating	0.00	54.0	0.00	0.00	0.00	0.00
Landfills (Inactive)	0.12	2.94	0.00	0.00	0.00	0.00
Open Burning – Residential	2.32	0.28	2.95	0.12	0.00	7.26E-04
Paved and Unpaved Road Dust	0.00	0.00	0.00	0.00	2.00E-03	0.68
POTWs	9.00E-03	4.70E-02	1.10E-02	0.00	0.00	0.00
Prescribed Burning	5.56	2.81	12.7	0.00	7.00E-03	0.00
Residential Fuel Combustion	0.01	0.02	1.45	0.003	2.93E-06	0.03
Residential Wood Combustion	34.4	30.8	40.4	11.9	0.181	0.00
Solvent Cleaning	0.00	48.6	0.00	2.93	0.00	0.00
Structure Fires	0.00	0.00	0.18	0.00	0.00	0.00
Traffic Markings	0.00	0.13	0.00	0.00	0.00	0.00
Wildfires	4.10	2.07	9.36	0.00	0.01	0.00
Totals	**122**	**413**	**71.0**	**20.3**	**0.20**	**1.41**

[a] Emission estimates for the remaining sectors shown in Table 2 were for criteria pollutants only.

[b] These emissions are being estimated for 2003 in Phase IV of this project only.