2017 Base Year Emissions Inventory State Implementation Plan for VOC, NO_X, and CO

For Areas of Marginal Nonattainment of the 2015 Ozone NAAQS in Delaware

[~~P R O P O S A L~~][F I N A L]

Submitted to:

U.S. Environmental Protection Agency

Region 3 – Philadelphia, PA

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[~~August~~][November] 2020

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SECTION 1 - 2017 OZONE INVENTORY OVERVIEW AND SUMMARY

1.1 Introduction

This document contains Delaware's base year emissions inventory State Implementation Plan (SIP) revision under the 2015 8-hour ozone National Ambient Air Quality Standard (NAAQS) set forth by US Environmental Protection Agency (EPA).

1.2 Background and Requirements

Ground-level ozone, one of the principal components of "smog," is a serious air pollutant that harms human health and the environment. High levels of ozone can damage the respiratory system and cause breathing problems, throat irritation, coughing, chest pains, and greater susceptibility to respiratory infection. High levels of ozone also cause serious damage to forests and agricultural crops, resulting in economic losses to logging and farming operations. Ozone is generally not directly emitted to the atmosphere. It is formed in the atmosphere by photochemical reactions among volatile organic compounds (VOC), oxides of nitrogen (NO_X), and carbon monoxide (CO) in the presence of sunlight.

In October 2015, the EPA revised the 2008 8-hour ozone NAAQS of 0.075 parts per million (ppm) to 0.070 ppm (80 FR 65291). The 2015 ozone NAAQS of 0.070 ppm is expected to provide better protections of public health and environment. In a final rule dated June 4, 2018, the EPA designated 51 areas in the country as nonattainment for the 2015 ozone NAAQS.

New Castle County of Delaware was designated nonattainment as a part of the Philadelphia-Wilmington-Atlantic City Marginal Nonattainment Area (NAA) (83 FR 25776). Since this marginal NAA is centered by the City of Philadelphia, it is often referred to as "the Philadelphia NAA." In the same final rule, Kent and Sussex Counties were designated as attainment (83 FR 25776). The EPA made the designations of these three counties based on their 2014-2016 design values, and the effective date of the designations was August 3, 2018.

To facilitate planning, Sections 182(a)(1) and 172(c)(3) of the Clean Air Act (CAA) require all ozone NAAs to establish a comprehensive, accurate, and current inventory of actual emissions from all sources of the relevant pollutant or pollutants in the area by August 3, 2020 (i.e., two years after designation as nonattainment). This inventory is commonly referred to as a base year inventory. Delaware has previously been designated nonattainment for ozone under the 1979 1-hour, 1997 8-hour, and 2008 8-hour ozone NAAQSs, and has therefore been subject to this emission inventory requirement since the 1990 amendments to the CAA.

Delaware has developed emission inventories that meet the criterion of CAA 182(a)(1) and 172(c)(3) every three years since 1990. Delaware's latest comprehensive, accurate inventory of actual emissions from all sources of VOC, NO_X, and CO in the State covered calendar year 2017. The purpose of this SIP revision is to establish Delaware's calendar year 2017 emissions inventory, described in this document, as its base year emissions inventory under the 2015 8-hour ozone NAAQS.[1]

[1] Per 40 CFR 51.1315, a base year inventory only requires emissions from sources of VOC and NO_X. However, Delaware included sources of CO to be consistent with past base year inventory reports.

1.3 Responsibilities

The agency with direct responsibility for developing and submitting this SIP revision is Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Air Quality (DAQ), under the Division Director, David F. Fees, P.E. The working responsibility for Delaware's air quality SIP planning falls within DAQ's Planning Section, with Acting Section Manager, Valerie Gray, and Airshed Planning and Inventory Program Manager, Renae Held. Shane Cone, Jacquelyn Cuneo, and Jolyon Shelton, of DAQ's Planning Section are the authors of this document.

1.4 Project Management

The Airshed Planning and Inventory (API) Program and the Greenhouse Gas, Mobile, and Air Toxics Program within the Planning Section of DAQ were responsible for preparing the 2017 Periodic Emission Inventory (PEI) for criteria pollutants to include emissions of VOC, NO_X, and CO summarized in this report. Internal planning began in September 2017, with focus on the 2017 point source inventory reporting cycle taking place in March and April of 2018.

The project manager was responsible for identifying overall inventory goals, objectives, and deadlines, initiating inventory planning, approving estimation methodologies recommended by staff, reviewing emissions development work, and preparing inventory reports and documentation.

1.4.1 Point Sources

Point sources staff was responsible for the following:

- Identifying point source inventory goals, objectives, and deadlines;
- Establishing the universe of facilities to inventory;
- Providing training and guidance to industry representatives;
- Performing a technical review of emissions data submitted by facilities;
- Working with facility representatives to correct errors;
- Managing the point source inventory database; and
- Overseeing quality control of point sources data.

1.4.2 Nonpoint and Nonroad Sources

Nonpoint and nonroad sources staff was responsible for the following:

- Researching and recommending emission estimation methodologies;
- Defining all simplifying assumptions;
- Obtaining 2017 activity data, current emission factors, and applicable control information;
- Using spreadsheets to calculate emissions;
- Providing data to the EPA for developing aircraft emissions;
- Reviewing emission calculations for accuracy and completeness;
- Preparing report documents; and
- Compiling supporting documentation.

1.4.3 Onroad Mobile Sources

Onroad mobile sources staff was responsible for the following:

- Downloading EPA's Motor Vehicle Emission Simulator (MOVES) MOVES2014b model;
- Obtaining 2017 vehicle miles traveled (VMT), vehicle registration, and other mobile input data from the Delaware Department of Transportation (DelDOT);
- Obtaining other data for inclusion in the model inputs;
- Preparing the input files for running MOVES;
- Running MOVES and summarizing the model outputs;
- Reviewing emissions for accuracy and completeness;
- Preparing report documents; and
- Compiling supporting documentation.

As is noted in Section 5 of this report, DAQ is utilizing output from EPA's 2017 National Emission Inventory (NEI) run of the MOVES model.

1.5 Inventory Planning

Calendar year 2017 is a PEI year as defined by the Air Emissions Reporting Requirements (AERR). The AERR specifies the emissions data for criteria pollutants that are required to be reported to EPA's NEI. A PEI requires the development of emissions estimates from all sources within a state or local area for all criteria pollutants and their precursors. As such, the 2017 emissions inventory can provide the necessary data for the 2015 8-hour ozone NAAQS base year inventory.

1.5.1 Inventory Parameters

The inventory parameters defined by the base year emissions inventory requirements for the 2015 8-hour ozone NAAQS include the following:

- **Inventory year** – 2017
- **Pollutants** – VOC, NO_X, and CO as precursors to ozone
- **Source coverage** – All sources, including point, nonpoint, nonroad, and onroad mobile sources
- **Spatial resolution** – County level emissions
- **Geographic coverage** – New Castle County
- **Temporal resolution** – Annual and summer season weekday (SSWD) daily emissions. The summer season is defined as the months June, July, and August. Weekday is defined as the days Monday, Tuesday, Wednesday, Thursday, and Friday.

1.5.2 Data Collection and Management

For all source categories, the gathering of local activity data represented a major task spread over many months. For point sources, all facilities reported their emissions through the use of the State and Local Emissions Inventory System (SLEIS) on-line reporting application. Data entered into the on-line application was transferred to a DAQ database for review and correction.

Microsoft Excel® spreadsheets were employed for managing activity data and calculating emissions from stationary nonpoint sources and some nonroad categories. A consistent set of tabs within each source category spreadsheet included activity data, point source data (if applicable, for back outs), emission factors, controls, emission calculations, NEI input formats, and notes on QA/QC procedures.

Emissions for most of the nonroad vehicles and equipment categories were calculated using the MOVES Nonroad model. Aircraft engine emissions for landing and take-offs at airports in Delaware were calculated by the EPA after a review of this data by DAQ.

Emissions data were transferred from SLEIS (point sources), from the nonpoint and nonroad spreadsheets, and from the model outputs to staging tables in Microsoft Access® databases. These databases were then converted to XML files via the Emissions Inventory System (EIS) bridge tool, and then transmitted to the EIS via the Central Data Exchange (CDX) web client to meet EPA NEI deadlines.

1.6 Inventory Development

For point sources, DAQ developed a set of criteria to use in establishing the universe of facilities required to report. These criteria are presented in the point source section of this report (Section 2). A reporting structure was created within SLEIS for each facility meeting one or more of the reporting criteria. An extensive amount of review and follow up was performed on the point source data submitted by facilities.

For nonpoint sources, the first task involved gathering activity data for each source category. In many cases, these data were obtained from Delaware-specific sources. In some cases, the activity data were developed through the allocation of a portion of a national activity dataset (*i.e.*, national off-road equipment populations) to Delaware. Basic demographic data were also used for some source categories and are presented in Table 1-1. Once activity data were obtained, spreadsheets were developed to manage the data and combine the activity data with the selected emission factors to obtain uncontrolled emissions. Finally, for those sources where controls were applied, emissions were adjusted to account for control efficiency, rule effectiveness, and rule penetration.

Table 1-1. 2017 Demographic Data for New Castle County

Demographic Parameter	New Castle County
Population[2]	564,193
Households[2]	207,325
Land Area (square miles)	439
Annual VMT (million miles)	6,095

For onroad mobile and nonroad equipment, the MOVES model was used to develop emissions from these sources. In the use of the model, activity data was included in the model input files. For any type of data used by the model for which Delaware-specific data did not exist, the model used the system defaults. Details about Delaware-specific and default parameters are discussed in the nonroad and onroad and sections of this report (Sections 4 and 5, respectively).

[2] Delaware Population Consortium, 2017 estimate: https://stateplanning.delaware.gov/demography/dpc.shtml

1.7 Emissions Summary

The following emission summaries present the 2017 emissions inventory for VOC, NO_X, and CO for New Castle County by source sector. Throughout this document, annual emissions are reported in tons per year (tpy) and SSWD daily emissions in tons per day (tpd). The totals may not match the sum of the individual values due to independent rounding.

Table 1-2. 2017 New Castle County Emissions by Source Sector

Source Sector	Annual (tpy)			SSWD (tpd)		
	VOC	NO_X	CO	VOC	NO_X	CO
Point	747	2,504	1,766	3.11	14.53	10.42
Nonpoint	3,387	1,444	3,527	10.63	2.76	6.76
Nonroad	2,245	3,152	23,844	7.68	9.27	92.89
Onroad	2,213	5,184	28,807	6.23	15.70	87.23
All Sectors	**8,592**	**12,284**	**57,944**	**27.65**	**42.26**	**197.30**

SECTION 2 - STATIONARY POINT SOURCES

The point source inventory represents facility-specific data for larger stationary sources. Emissions data for all other source categories are reported at the county level. Point sources typically include large industrial, commercial, and institutional facilities. Manufacturing facilities, within the industrial sector, comprise the majority of all reporting point sources. The institutional sector includes hospitals, universities, prisons, military bases, landfills, and wastewater treatment plants.

The planning and execution of the point source inventory was accomplished in the following chronological order:

- Establish the reporting criteria and list of facilities to survey;
- Obtain inventory data from facilities;
- Perform administrative and technical review of data received from facilities;
- Seek resubmissions/corrections from facilities based on data review;
- Perform internal data manipulation (*i.e.*, apply rule effectiveness, remove non-reactive VOCs, create SSWD daily emission values); and
- Prepare inventory data files, report, and supporting documentation.

A final activity is to provide point source back out data, if there is overlap between point sources and stationary nonpoint source categories. Point source back out data includes emissions, throughput, and/or employees, depending on the nonpoint source category methodology.

The following criteria were established for defining the universe of facilities to be surveyed for 2017:

- Facilities that held a Title V permit in 2017; and
- Facilities that held a Synthetic Minor permit in 2017.

Based on these criteria, 126 facilities statewide reported air emissions data for 2017. Only New Castle County has been designated as marginal nonattainment in Delaware for the 2015 8-hour ozone NAAQS. Therefore, only 82 facilities that are located within New Castle County will be presented in this report.

2.1 Emissions Estimation and Methodology

Unlike other source sector emissions which are estimated by DAQ, point source emissions data are submitted to DAQ by the facilities. Emissions are reported at the process level and include both confined (stack) emission points as well as unconfined (fugitive) emission sources. A key aspect of point source data is the inclusion of facility coordinates to accurately allocate emissions spatially within a county for purposes of performing air dispersion modeling.

The summer months of June, July, and August were used to calculate point source SSWD emissions. The first step in calculating SSWD emissions was to calculate the number of weekdays

that each process operated during summer months, *Summer Season Weekdays*. The following parameters were utilized to calculate *Summer Season Weekdays*:

- *Summer Season Days*: Facilities reported the total number of days (including weekdays and weekends) that each process operated during the summer months (June, July, and August) in SLEIS.
- *Average Days / Week*: Facilities reported the average process operating schedule in days per week in SLEIS.

Summer Season Weekdays were calculated using the following assumptions:

- If *Average Days / Week* is less than or equal to 5 days, then *Summer Season Weekdays* = *Summer Season Days*.
- If *Average Days / Week* is greater than 5, but less than or equal to 6 days, then *Summer Season Weekdays* = (*Summer Season Days* * 5/6).
- If *Average Days / Week* is greater than 6, but less than or equal to 7 days, then *Summer Season Weekdays* = (*Summer Season Days* * 5/7).

To calculate SSWD emissions per process, the following equation was used:

$$\frac{\left(\frac{(June + July + August\ Throughput)}{Annual\ Throughput}\right) \quad x \quad Total\ Emissions}{Summer\ Season\ Weekdays}$$

where: June + July + August Throughput = A facility's reported monthly throughput for each process in SLEIS.
Annual Throughput = SLEIS calculated annual throughput for each process as the sum of reported monthly throughput.
Total Emissions = A facility's reported total emissions per pollutant for each process in SLEIS.
Summer Season Weekdays = Value calculated as described above.

The SSWD emissions per facility is the sum of the SSWD emissions for each process at that facility.

2.2 Emissions Summary

Annual and SSWD emissions for the 82 facilities located within New Castle County are summarized in Table 2-1 and provided in Appendix A.

Table 2-1. 2017 Facility-Level Emissions for New Castle County

Facility Name	Annual (tpy)			SSWD (tpd)		
	VOC	NO_X	CO	VOC	NOx	CO
1007 Market Condominium Association	<1	6	5	<0.01	0.03	0.03
Aearo Technologies LLC	5	<1	<1	0.02	<0.01	<0.01
Alfred I. duPont Hospital for Children	<1	18	11	0.03	0.59	0.19
Allan Myers Delaware, Inc. - Wilmington	1	2	5	<0.01	0.01	0.03
American Air Liquide - Glasgow	<1	<1	<1	<0.01	<0.01	<0.01
Amtrak Wilmington Maintenance Facility	1			<0.01		
AstraZeneca Pharmaceuticals, LLC - Fairfax	<1	2	<1	<0.01	0.03	<0.01
AstraZeneca Pharmaceuticals, LLC - Newark	<1	6	5	<0.01	0.02	0.02
Bank of America - Bracebridge	<1	2	1	<0.01	0.03	<0.01
Bank of America - Christiana Complex	<1	<1	<1	<0.01	0.02	<0.01
Bank of America - Deerfield	<1	1	<1	<0.01	0.02	<0.01
BASF Colors & Effects, Newport	22	17	31	0.07	0.08	0.11
Bilcare Research, Inc	2	2	2	<0.01	<0.01	<0.01
Boxwood Industrial Park, LLC	<1	2	1	0.00	0.00	0.00
Calpine - Christiana Energy Center	<1	<1	<1	<0.01	0.12	<0.01
Calpine - Delaware City Energy Center	<1	<1	<1	<0.01	0.05	<0.01
Calpine - Edge Moor Energy Center	8	97	76	0.16	1.81	1.53
Calpine - Hay Road Energy Center	30	498	120	0.14	2.33	0.56
Calpine - West Energy Center	<1	<1	<1	<0.01	0.05	<0.01
Christiana Care - Christiana Hospital	4	15	24	0.02	0.10	0.10
Christiana Care - Wilmington Hospital	<1	7	5	<0.01	0.06	0.02
Christiana Materials	2	4	14	0.01	0.03	0.09
Clean Earth of New Castle	<1	6	3	<0.01	0.06	0.03
Contractor's Materials	3	2	11	0.01	<0.01	0.05
Corrado Construction	0	0	0	0.00	0.00	0.00
Croda, Inc.	9	18	13	0.04	0.10	0.05
Dana Railcare	<1	<1	<1	0.02	<0.01	<0.01
Dassault Falcon Jet - Wilmington Corp.	11	1	<1	0.05	<0.01	<0.01
DE Solid Waste Authority - Cherry Island	4	13	44	0.02	0.05	0.15
Delaware City Refining Company - Delaware City	341	1,456	1,067	1.47	5.99	5.75
Delaware City Refining Company - Marketing Terminal	23	<1	<1	0.10	<0.01	<0.01
Delaware Park Horse Racing Track	<1	<1	<1	<0.01	0.02	0.03
Delaware Recyclable Products, Inc.	4	5	22	0.01	0.02	0.07
Department of Veterans Affairs Medical Center	<1	2	2	<0.01	0.02	0.02
Diamond Materials, LLC	1	2	13	<0.01	0.01	0.07
Diamond State Port Corporation - Port of Wilmington	52	52	11	0.08	0.45	0.07
DuPont Chestnut Run	<1	9	11	<0.01	0.03	0.04
DuPont Experimental Station	9	55	36	0.05	0.49	0.21
DuPont Nutrition USA, Inc.	3	21	90	0.01	0.12	0.44
Eastern Shore Natural Gas - Delaware City	3	6	<1	0.01	0.03	<0.01
First State Investors 5200	<1	<1	<1	<0.01	0.03	<0.01
FMC Stine Research Center	3	9	9	0.01	0.05	0.05
Formosa Plastics Corporation	47	29	20	0.17	0.14	0.08
GE Aviation - Newark, DE	3	<1	<1	0.02	<0.01	<0.01
Hercules Inc., Research Center	<1	2	4	0.02	<0.01	0.01
Honeywell / City of Wilmington (REBF)	4	2	4	0.03	0.02	0.03

	Annual (tpy)			SSWD (tpd)		
Facility Name	**VOC**	**NO_X**	**CO**	**VOC**	**NOx**	**CO**
Howard R. Young Correctional Institution	<1	1	<1	<0.01	0.01	<0.01
IKO Production Wilmington Inc.	5	4	3	0.02	0.03	0.02
James T. Vaughn Correctional Center	1	5	4	<0.01	<0.01	<0.01
JP Morgan Chase - 4001 Gov Printz Blvd.	1	6	1	0.02	0.08	0.02
JP Morgan Chase - Bear Christiana Road	<1	7	1	<0.01	0.03	<0.01
JP Morgan Chase - Morgan Christiana Center	<1	6	1	0.01	0.63	0.11
Kuehne Chemical Company	<1	2	<1	<0.01	<0.01	<0.01
Linde LLC	<1	<1	<1	<0.01	<0.01	<0.01
Magco Inc.	<1	2	3	<0.01	<0.01	0.01
Magellan Midstream Partners	48	4	2	0.06	0.03	<0.01
McConnell Johnson	<1	<1	<1	<0.01	0.05	0.01
Medal L.P., Air Liquide	16	3	3	0.05	<0.01	<0.01
Micropore, Inc.	4			0.01		
Middletown Materials	<1	5	1	<0.01	0.05	0.01
New Haven Packaging, LLC	<1	<1	<1	<0.01	<0.01	<0.01
Newark Data Center	<1	<1	<1	<0.01	0.06	0.01
News Journal Company	1			<0.01		
Noramco Inc.	<1	1	2	<0.01	<0.01	<0.01
PGR Holdings, LLC	<1	3	<1	<0.01	<0.01	<0.01
Polymer Technologies, Inc.	1	<1	<1	0.01	<0.01	<0.01
Prince Minerals, Inc.	<1	<1	<1	<0.01	<0.01	<0.01
Printpack, Inc.	9	2	2	0.03	<0.01	<0.01
PS-5 LLC (Community Education Building)	<1	13	11	<0.01	0.05	0.04
R & M Recycling	<1	<1	<1	<0.01	0.02	<0.01
Rogers Corporation - Bear Facility	4	2	2	0.02	<0.01	<0.01
Rohm and Haas Electronic Materials, Cmp, Inc.	6	3	4	0.05	0.05	0.02
Siemens Healthcare Diagnostics - Glasgow	<1	8	6	<0.01	0.08	0.03
St. Francis Hospital	<1	3	3	<0.01	0.02	<0.01
Stratis Visuals, LLC	2			<0.01		
Sunoco Partners & Marketing Terminal	39	4	18	0.12	0.01	0.06
Transflo Terminal Services, Inc.	<1			<0.01		
University of Delaware - Newark	4	20	27	0.01	0.08	0.07
Veolia - Red Lion Plant	<1	19	<1	<0.01	0.10	<0.01
Verisign	<1	<1	<1	<0.01	0.02	0.02
WDK Energy Partners	<1	<1	<1	<0.01	<0.01	<0.01
Wilmington Wastewater Treatment Plant	<1	5	4	<0.01	0.02	0.01
New Castle County Total	**747**	**2,504**	**1,766**	**3.11**	**14.53**	**10.42**

SECTION 3 - STATIONARY NONPOINT SOURCES

Stationary nonpoint sources represent a large and diverse set of individual emission source categories. A nonpoint source category is either: 1) represented by small facilities too numerous to individually inventory, such as commercial cooking at restaurants and fuel combustion at a variety of small businesses; or 2) a common activity, such as residential open burning. Emissions from the nonpoint source categories were estimated at the county level.

3.1 Source Categories

There are a number of nonpoint source categories which contribute emissions of ozone precursors. These categories can be grouped into several category types. These include:

- **Solvent Use** – Many products used by homeowners and businesses contain VOC solvents to achieve the intended purpose of the product. Paints, cleaners, pesticides, personal care products, and inks are a few examples of products that contain VOC solvents.

- **Gasoline Usage** – The distribution and use of gasoline in vehicles and other gasoline-powered engines result in emissions of VOCs whenever the volatile gasoline vapors are allowed to escape.

- **Fuel Combustion** – The combustion of fuels in industrial, commercial, institutional, and residential furnaces, engines, boilers, wood stoves, and fireplaces create emissions of VOCs, NO_X, and CO.

- **Open Burning** – Open burning creates emissions of VOCs, NO_X, and CO. Open burning categories include trash burning, prescribed burning, burning of land clearing debris, wildfires, building fires, and vehicle fires.

Individual facilities are typically grouped with other like sources into a source category. Source categories are grouped in such a way that emissions are estimated collectively using one methodology. For the 2017 inventory, the distinction between point and nonpoint was defined by an annual emission threshold based on recent point source data (see Section 2 for point source criteria). Table 3-1 lists the source categories for which VOCs, NO_X, and CO for New Castle County were estimated.

3.2 Emission Estimation Methodologies and Activity Data

The 2014 Delaware PEI served as the starting point for nonpoint source category selection and methodology development. New methods were applied to some existing source categories, and emission factors were updated where available. New methods and emission factors came primarily from current *Emission Inventory Improvement Program, Volume III* documents and documented projects performed by the California Air Resource Board (CARB).

Other sources of information included the *Compilation of Air Pollutant Emission Factors, Volume I* (AP-42), the *Factor Information Retrieval System* (FIRE), and several projects performed by the Mid-Atlantic Regional Air Management Association (MARAMA), the Eastern Regional Technical Advisory Committee (ERTAC), and EPA. Also, a number of categories used the most recent emission factors listed in Nonpoint Method Advisory (NOMAD) committee Nonpoint Emissions Methodology and Operator Instructions (NEMO) documents, and emission factors as listed in the most recent version of the EPA Wagon Wheel Tool.

Table 3-1. Nonpoint Source Categories Inventoried

VOC Emissions Only	Emissions of VOC, NO_X, and CO
Agricultural Pesticides	Agricultural Burning
AIM Coatings	Commercial Cooking - EPA
Asphalt Paving	Commercial Fuel Combustion
Autobody Refinishing	Industrial Fuel Combustion
Commercial & Consumer Products	Land Clearing Debris Burning
Degreasing	Prescribed Burning
Dry Cleaning	Residential Fuel Combustion
Gasoline (Petroleum) Marketing	Residential Open Burning
Graphic Arts	Residential Wood Combustion
Industrial Adhesives	Structure Fires
Industrial Surface Coatings	Vehicle Fires
Traffic Markings	Wildfires - EPA

A major portion of the work involved in creating the 2017 nonpoint source inventory was in collecting activity data for each source category. The activity data gathered was related to the type of emission factors available and, in many cases, obtained from local sources. Surveys, letters, e-mails, and phone calls to individual businesses to obtain representative data for a source category was a technique used for several source categories. The type of activity data and the data source for each category is provided in Table 3-2.

Emissions from most nonpoint source categories were estimated by multiplying an indicator of collective activity by a corresponding emission factor. An indicator is any parameter associated with the activity level of a source, such as production, employment, fuel usage, or population that can be correlated with the emissions from that source. The corresponding emission factors are per unit of production, per employee, per unit of commodity consumed, or per capita, respectively. The basic equation that was applied to emission development for most nonpoint source categories is as follows:

$$Emissions\ (E) = Activity\ Data\ (Q) \times Emission\ Factor\ (EF)$$

If a source category had a regulatory control placed on it at the Federal or State level, the equation expands to the following:

$$E = Q \times EF \times [1 - (CE)(RE)(RP)]$$

where: CE = control efficiency
RE = rule effectiveness
RP = rule penetration

The control efficiency (CE) represents the typical emissions reduction achieved as compared to the otherwise uncontrolled emissions. A control may be a piece of equipment, such as a condenser used to recover vaporized solvent, or it may be an operational control, such as the use of only low VOC content paints.

Rule effectiveness (RE) reflects the ability of the regulatory program to achieve all emissions reductions that could have been achieved by full compliance with the applicable regulations at all sources at all times. If a rule is not being followed by all of the regulated community, then emissions will be higher than would otherwise be if there was 100% compliance. As an example, while the burning of trash is illegal under any circumstances in Delaware, the practice of burning household trash in backyard burn barrels still takes place in many rural areas of the State.

Rule penetration (RP) represents the percent of sources within a source category that are subject to the rule that requires control. As an example, gas stations that dispense more than 10,000 gallons of gasoline in a month are required by Delaware regulations to place vapor recovery systems on their gas pumps.[3] Those dispensing less than 10,000 gallons are not required to install controls. Therefore, RP is less than 100%. In the case of the burning of trash or leaves, no person or business is exempt, and thus RP is 100%.

An alternative to the use of an emission factor is the mass balance approach. The mass balance approach is applicable to VOC source categories where all of the VOC content in the products used evaporates and is emitted as a result of the normal use of the product. Delaware used the mass balance approach for several source categories, such as adhesives, asphalt paving, and painting (commercial, consumer, autobody, and traffic markings). Raw material or product purchase records were used to quantify emissions. Emissions were then equated to the VOC content of the material usage minus amounts leaving the site as or in waste.

To avoid double counting of emissions between point and nonpoint sources, point source back out was performed for the industrial and commercial fuel combustion categories and many of the solvent usage categories. Point source fuel usage was backed out from fuel consumption data obtained from the U.S. Department of Energy's (DOE) Energy Information Administration (EIA).[4] Point source employment was backed out from employment data obtained from the Delaware Department of Labor.

Non-reactive VOCs were excluded from emission estimates. Emission factors specified as non-methane organic carbon (NMOC) in *AP-42* were used when available. In some instances, the *AP-42* emission factor was in terms of total organic carbon (TOC) and the percentage of the methane component was indicated in a footnote. In these cases, the emission factor was reduced by the

[3] DAQ is in the process of amending its vapor recovery regulations to phase out Stage II vapor recovery systems at Delaware gasoline dispensing facilities, and to set up effective controls on vapor emission from gasoline underground storage tanks after phasing out Stage II systems (7 DE Admin. Code 1124).
[4] The primary EIA data that is used is from the State Energy Data System, SEDS: https://www.eia.gov/state/seds/?sid=DE. Other reports and forms from EIA are also used.

percentage of methane to remove the non-reactive methane component in the emission total. For example, for evaporative emissions from crude oil, the methane component was 15 percent. The emission factor was reduced by 15 percent to remove methane from the calculation.

Source activity may fluctuate significantly on a seasonal basis. As an example, residential wood combustion is primarily performed outside the summer season. Paint usage, on the other hand, is used more often in the warmer months of the year. Because nonpoint source emissions are generally a direct function of source activity, seasonal changes in activity levels were examined closely.

Delaware's 2017 inventory includes annual and SSWD emission calculations. SSWD daily emissions were developed through the use of a temporal allocation factor (TAF) applied to the annual emissions. Monthly and weekly profiles were used to develop the TAF. The monthly profile for each source category was developed through the use of monthly activity data, when available, or through EPA guidance (*Procedures, Volume I* and EIIP documents[5]). Most weekly profiles were developed through EPA guidance which defines activity taking place five, six, or seven days per week. Through EPA guidance, all TAFs include the work week. A few TAFs were developed based on the exact dates of episodic activity, such as firefighting training burns and prescribed fires. A full table of DNREC TAF is available in Appendix B.

[5] Air emissions inventory improvement program documents: https://www.epa.gov/air-emissions-inventories/air-emissions-inventory-improvement-program-eiip

Table 3-2. Summary of 2017 Nonpoint Source Activity Data

Source Category	Activity Data	Source of Activity Data
Agricultural Burning	Acreage and vegetation type	DAQ Area Source Compliance Program
Agricultural Pesticides	Planted crop acreage	Delaware Department of Agriculture
AIM Coatings	Solvents in U.S. paint shipments; U.S. Population	U.S. Census Bureau
Asphalt Paving	Cutback and emulsified asphalt usage	Delaware Department of Transportation
Autobody Refinishing	Employment data; Autobody shop usage reports	Delaware Department of Labor; Autobody shops
Commercial & Consumer Products	Population	Delaware Population Consortium
Commercial Cooking	Population	Delaware Population Consortium
Commercial Fuel Combustion	Fuel consumption	DOE Energy Information Admin.
Degreasing	Employment data	Delaware Department of Labor
Dry Cleaning	Facility-level solvent usage	DAQ Area Source Compliance Program
Gasoline (Petroleum) Marketing	Gasoline fuel sales; VMT through use of MOVES (Stage 2); employment data (comm. portable fuel containers)	FHWA Motor Fuel Tax Administration; DelDOT (VMT); Delaware Department of Labor (employment data)
Graphic Arts	Employment data	Delaware Department of Labor
Industrial Adhesives	Population	Delaware Population Consortium
Industrial Fuel Combustion	Fuel consumption	DOE Energy Information Admin.
Industrial Surface Coatings	Employment data	Delaware Department of Labor
Land Clearing Debris Burning	Acreage disturbed during road, commercial, and residential construction	DAQ data calculated for the construction dust categories
Prescribed Burning	Acreage and vegetation type	DAQ Area Source Compliance Program
Residential Fuel Combustion	Fuel consumption	DOE Energy Information Admin.
Residential Open Burning	Rural households	U.S. Census Bureau
Residential Wood Combustion	Occupied households	Delaware Population Consortium
Structure Fires	Number of structures fires	Delaware Fire Marshal and DAQ Area Source Compliance Program
Traffic Markings	U.S. paint shipments; U.S. and State public road miles	U.S. Census Bureau; FHWA highway statistics publication
Vehicle Fires	Number of vehicle fires	Delaware Fire Marshal
Wildfires	Acreage and vegetation type	Delaware Division of Forestry

3.3 Emissions Summary

Table 3-3 provides a summary of the 2017 annual (tpy) and SSWD daily (tpd) emissions for each nonpoint source category for New Castle County.

Table 3-3. Summary of 2017 Nonpoint Emissions for New Castle County

Source Categories	Annual (tpy)			SSWD (tpd)		
	VOC	NO_X	CO	VOC	NO_X	CO
SOLVENT USE						
Agricultural Pesticides	117	---	---	0.32*	---	---
AIM Coatings	403	---	---	1.45	---	---
Asphalt Paving	<1	---	---	<0.01	---	---
Auto Refinishing	29	---	---	0.08	---	---
Commercial & Consumer Products	1,118	---	---	3.17	---	---
Dry Cleaning	1	---	---	0.01	---	---
Graphic Arts	257	---	---	0.99	---	---
Industrial Adhesives & Sealants	107	---	---	0.41	---	---
Industrial Surface Coating	79	---	---	0.30	---	---
Solvent Cleaning	91	---	---	0.29	---	---
Traffic Markings	2	---	---	0.01	---	---
Solvent Use Total	**2,205**	---	---	**7.04**	---	---
GASOLINE MARKETING						
Retail Gasoline Stations	402	---	---	1.91	---	---
Other Gasoline Marketing Activities						
Aircraft Refueling	3	---	---	<0.01	---	---
Marinas	0	---	---	0	---	---
Portable Fuel Containers	120	---	---	0.33	---	---
CMV Loading and Transport	117	---	---	0.32	---	---
Gasoline Marketing Total	**642**	---	---	**2.57**	---	---
FUEL COMBUSTION						
Commercial/Institutional	21	384	289	0.04	0.73	0.43
Industrial	36	585	268	0.10	1.66	0.80
Residential Fossil Fuel	23	426	175	0.02	0.28	0.12
Residential Wood	353	40	2,385	0.76*	0.09*	5.15*
Fuel Combustion Total	**433**	**1,435**	**3,117**	**0.92**	**2.76**	**6.50**
OPEN BURNING						
Agricultural Burning	1	<1	8	<0.01	<0.01	<0.01
Residential Open Burning	2	<1	15	<0.01	<0.01	<0.01
Land Clearing Debris Burning	0	0	0	0	0	0
Prescribed Burning	65	5	273	<0.01	<0.01	<0.01
Structure Fires	3	<1	15	<0.01	<0.01	<0.01
Vehicle Fires	1	<1	3	<0.01	<0.01	<0.01
Wildfires	0	0	0	0	0	0
Open Burning Total	**72**	**9**	**314**	**<0.01**	**<0.01**	**<0.01**
MISCELLANEOUS SOURCES						
Commercial Cooking	35	0	96	0.10*	0	0.26*
NONPOINT SECTOR TOTAL	**3,387**	**1,444**	**3,527**	**10.63***	**2.76***	**6.76***

* These figures include EPA annual totals with Delaware-specific temporal profiles for SSWD calculation.

SECTION 4 - NONROAD MOBILE SOURCES

Nonroad mobile sources represent a large and diverse set of off-road vehicles and non-stationary equipment. Emission estimates of VOCs, NO_X, and CO for this source sector account for exhaust emissions from engine fuel combustion.

Nonroad vehicles and equipment are grouped into four source category types for the purpose of developing emission estimates. These include:

- **Aircraft** – Commercial, military, and private aircraft.

- **Locomotives** – Commercial line haul and yard locomotives.

- **Commercial Marine Vessels (CMVs)** – Various types of vessels that navigate the Delaware Bay and River and the Chesapeake and Delaware Canal are included under this source category. Recreational boats are included in the next category.

- **Other Off-road Vehicles and Equipment** – All other off-road emission sources are accounted for through the use of EPA's MOVES2014b model in Nonroad mode. The model compiles off-road equipment pertinent to Delaware into the following subcategories:

    - Recreational (land-based);
    - Construction;
    - Industrial;
    - Lawn and Garden;
    - Agricultural;
    - Commercial;
    - Logging;
    - Airport Ground Support;
    - Recreational Marine; and
    - Railway Maintenance.

Individual equipment Source Classification Codes (SCCs) covered in the MOVES Nonroad model are further broken down by the fuel type, including 2-stroke gasoline, 4-stroke gasoline, diesel, liquefied petroleum gas (LPG), and compressed natural gas (CNG).

4.1 Emission Estimation Methodologies

The 2014 Delaware PEI served as the starting point for nonroad source category selection and methodology development. No new sources were added to Delaware's off-road mobile source inventory. However, EPA ran the Federal Aviation Administration's (FAA) new Aviation Environmental Design Tool (AEDT) in 2017, and Delaware is adopting these emission estimates.

Similar to the estimation of stationary nonpoint emissions, off-road equipment emissions were estimated by multiplying an indicator of collective activity within the inventory area for a source category by a corresponding emission factor. The indicators of activity for off-road sources include landing and take-offs (LTOs), vessel port-of-calls, time-in-mode (TIMs, which are pertinent to aircraft and CMVs), gross ton miles (locomotives), equipment populations, and economic activity (both pertinent to nonroad equipment) that can be correlated with the emissions from that source. The corresponding emission factors are amount of pollutant (either grams or pounds) per unit of fuel used (locomotives and military/commercial aircraft), per LTO (air taxi and general aviation), or per unit of power output in brake horsepower or kilowatt-hours (nonroad equipment and CMVs, respectively).

A major portion of the work involved in creating the 2017 nonroad source inventory was in collecting activity data for each source category. The activity data gathered was related to the type of emission factors available and, in many cases, obtained from local sources. More information about gathering activity data for each source category is presented below.

There are no point source data that must be backed out of the nonroad mobile source sector. Even though larger airports may report as a point source, their reported point source emissions do not include ground support equipment or aircraft engine emissions. Also, aircraft emissions are estimated only for LTOs that take place at a Delaware airport. Emissions from aircraft that transit Delaware airspace are not included in Delaware's inventory.

4.2 Emissions Summary

Table 4-1 provides the summary of the 2017 annual (tpy) and SSWD daily (tpd) emissions for New Castle County for aircraft, locomotives, commercial marine vessels, and all equipment emissions estimated using EPA's MOVES Nonroad model. The nonroad sector is a significant contributor to ozone precursors in Delaware.

Table 4-1. Summary of 2017 Nonroad Emissions for New Castle County

	Annual (tpy)			SSWD (tpd)		
Source Categories	**VOC**	**NO_X**	**CO**	**VOC**	**NO_X**	**CO**
MOVES Nonroad Equipment	2,090	1,110	23,112	7.25	3.68	90.89
Aircraft	47	78	463	0.13	0.21	1.27
Locomotives	28	432	70	0.08*	1.18*	0.19*
Commercial Marine Vessels	80	1,532	199	0.22*	4.20*	0.54*
TOTAL	2,245	3,152	23,844	7.68	9.27	92.89

* These figures include EPA annual totals with Delaware-specific temporal profiles for SSWD calculation.

4.3 MOVES 2014b Nonroad Model Equipment

DAQ used MOVES2014b to develop 2017 annual and SSWD daily emission estimates for New Castle County. Most equipment covered by the MOVES Nonroad model is powered by diesel-fueled compression-ignition engines or gasoline-fueled spark-ignition engines. Engines fueled by compressed natural gas (CNG) and liquefied petroleum gas (LPG) are also included in the Nonroad model. Table 4-2 lists general SCCs addressed by the model. Equipment categories are defined

at the 7-digit SCC level (with recreational marine and railway maintenance being exceptions) and specific equipment are defined at the 10-digit SCC level.

To estimate pollutant emissions, the MOVES Nonroad model multiplies equipment populations and their associated activity by the appropriate emission factors. Geographic allocation factors (GAFs) are used to distribute national equipment populations to states/counties. These factors are based on surrogate indicators of equipment populations. For example, harvested cropland is the surrogate indicator used in allocating agricultural equipment. A national average engine activity (*i.e.*, load factor times annual hours of use) is used in the MOVES Nonroad model.

Table 4-2. SCCs Addressed by the Nonroad Model

Nonroad SCCs	SCC Descriptions	Nonroad SCCs	SCC Descriptions
2260xxxxxx	2-stroke gasoline engines	2268xxxxxx	CNG engines
2260001xxx	- recreational vehicles	2268002xxx	- construction equipment
2260002xxx	- construction equipment	2268003xxx	- industrial equipment
2260003xxx	- industrial equipment	2268005xxx	- agricultural equipment
2260004xxx	- lawn & garden equipment	2268006xxx	- light commercial equipment
2260005xxx	- agricultural equipment	226801xxxx	- oil field equipment
2260006xxx	- light commercial equipment	2270xxxxxx	Diesel engines
2260007xxx	- logging equipment	2270001xxx	- recreational vehicles
2265xxxxxx	4-stroke gasoline engines	2270002xxx	- construction equipment
2265001xxx	- recreational vehicles	2270003xxx	- industrial equipment
2265002xxx	- construction equipment	2270004xxx	- lawn & garden equipment
2265003xxx	- industrial equipment	2270005xxx	- farm equipment
2265004xxx	- lawn & garden equipment	2270006xxx	- light commercial equipment
2265005xxx	- agricultural equipment	2270007xxx	- logging equipment
2265006xxx	- light commercial equipment	2270008xxx	- airport service equipment
2265007xxx	- logging equipment	2270009xxx	- underground mining equipment
2265008xxx	- airport service equipment	227001xxxx	- oil field equipment
226501xxxx	- oil field equipment	2282xxxxxx	Recreational marine equipment
2267xxxxxx	LPG engines	2285xxx015	Railway maintenance equipment
2267001xxx	- recreational vehicles		
2267002xxx	- construction equipment		
2267003xxx	- industrial equipment		
2267004xxx	- lawn & garden equipment		
2267005xxx	- agricultural equipment		
2267006xxx	- light commercial equipment		
2267008xxx	- airport service equipment		

MOVES Nonroad model option files were prepared to account for temperatures and fuel characteristics representative for each of the four seasons (winter, spring, summer, and fall). Temperature and fuel input values for each three-month period (December-February, March-May, June-August, and September-November) were averaged to estimate seasonal values. Minimum, maximum, and average temperatures per month were obtained from the National Weather Service for the New Castle County Airport. Table 4-3 presents a summary of county temperature and gasoline fuel characteristics data used for each season. A sulfur content of 15 ppm for nonroad diesel fuel was used for 2017 based on EPA requirements.

Table 4-3. 2017 MOVES Nonroad Model Temperature and Fuel Characteristic Input Values by Season for New Castle County

Season	Reid Vapor Pressure (RVP)	Gasoline Sulfur ppm	Daily Average Temperature, ºF		
			Minimum	Maximum	Average
Summer	6.9	10	65	83	75
Autumn	9.75	10	42	77	60
Winter	11.31	10	31	51	39
Spring	9.75	10	36	60	54

A single MOVES Nonroad model run was used to compute both the SSWD emissions and the annual emissions. To achieve this, MOVES Nonroad was run by selecting all months, both day types, all hours, and the output time aggregation of "24-hour day". An Excel pivot table was created from the MOVES Output Table (provided in Appendix C, Tab 1. Pivot_SSWD & Annual) to select the summer months of June, July, and August and just the weekdays. The pivot table results were averaged to calculate average SSWD emissions for each pollutant.

The first step in calculating annual emissions was to calculate *Daily Emissions* from the MOVES Output Table. A new column was added to the same MOVES Output Table to calculate *Daily Emissions* using the following equation:

$$emissionQuant \times (DayID / 7) \times DaysInMonth$$

where: emissionQuant = MOVES model output, quantity of emissions (tons/day)
DayID = MOVES model output, representing weekend (2) or weekday (5)
DaysInMonth = number of days in a particular month

Then, an Excel pivot table was created from the MOVES Output table (provided in Appendix C, Tab 1. Pivot_SSWD & Annual), selecting all months and both DayID types. Table 4.4 summarizes the fields that were utilized in the pivot tables to calculate SSWD and annual emissions.

Table 4.4. Calculation of SSWD and Annual Emissions Pivot Table Details

Pivot Table Fields	Emission Tally Type	
	SSWD	Annual
Columns	Pollutant	Pollutant
Rows	MonthID (Select 6,7,8)	MonthID (Select All)
	DayID (Select 5)	DayID (Select Both)
∑ values	Sum of Emission Quant	Sum of Daily Emissions
Post Processing	Calculate Average	Use Grand Total Columns

Table 4-5 provides the summary of the 2017 annual (tpy) and SSWD daily (tpd) emissions for New Castle County for all equipment emissions estimated using EPA's MOVES Nonroad model by fuel type.

Table 4-5. 2017 New Castle County Emissions for Nonroad Equipment

		Annual (tpy)			SSWD (tpd)		
Fuel Type	**Equipment Category**	**VOC**	**NO_X**	**CO**	**VOC**	**NO_X**	**CO**
Gasoline	All Equipment	2,024.4	471.4	22,412.5	7.01	1.40	88.53
Diesel	All Equipment	50.7	559.4	247.4	0.19	2.03	0.92
LPG	All Equipment	10.9	71.9	413.1	0.03	0.23	1.32
CNG	All Equipment	4.2	7.7	39.3	0.01	0.02	0.13
All Fuels	**Total**	**2,090**	**1,110**	**23,112**	**7.25**	**3.68**	**90.89**

4.4 Aircraft

The aircraft source category includes emissions from commercial, air taxi, general aviation, and military aircraft. These sub-categories are described as follows:

- Military aircraft – used by the U.S. military in a wide range of missions;
- Commercial aircraft – used for scheduled service transporting passengers, freight, or both;
- General aviation – includes other non-military aircraft used for recreational flying, business, personal transportation, and various other activities; and
- Air taxis – used for scheduled service carrying passengers and/or freight, but are smaller aircraft that operate on a more limited basis than the commercial carriers.

Airport-specific emissions for all aircraft sub-categories were allocated to the county in which each airport is located. Where there are multiple airports in a given county, the emissions were summed to provide a county-level emissions estimate. Aircraft emissions are reported under the following SCCs:

Table 4-6. SCCs for Aircraft

SCC	Descriptor 1	Descriptor 3	Descriptor 6	Descriptor 8
2275001000	Mobile Sources	Aircraft	Military Aircraft	Total
2275020000	Mobile Sources	Aircraft	Commercial Aircraft	Total: All Types
2275050000	Mobile Sources	Aircraft	General Aviation	Total
2275060000	Mobile Sources	Aircraft	Air Taxi	Total

EPA estimated annual aircraft emissions using a combination of airport-specific activity data and FAA/EPA emission factors. Estimating aircraft emissions focuses on the "mixing zone," which has a height (mixing height) equal to the thickness of the inversion layer. Air emissions within this zone are trapped by the inversion layer and ultimately affect ground-level pollutant concentrations. When aircraft are above the mixing zone, emissions tend to disperse and have no ground-level effects. The aircraft operations within the mixing zone are defined by the LTO cycle. Each LTO cycle consists of five specific operating modes:

- Approach – when the aircraft approaches the airport on its descent from the mixing height to when it lands on the runway.
- Taxi/idle-in – when the aircraft taxis from the runway to the gate and turns its engines off.
- Taxi/idle-out – from engine start-up to take-off as the aircraft taxis from the gate back out to the runway.
- Take-off – this mode is characterized primarily by full-throttle operation that typically lasts until the aircraft reaches between 500 and 1,000 feet above ground, which is when engine power is reduced.
- Climb-out – this mode begins right after the take-off mode and lasts until the aircraft passes out of the mixing height.

The operation time in each of these modes is dependent on the aircraft category, local meteorological conditions, and operational considerations at a given airport. The TIM for the take-off operating mode is the least variable.

The following are the general steps to be used to estimate aircraft emissions:

- Determine the mixing height to be used to define the LTO cycle;
- Define the fleet make-up for each airport;
- Determine airport activity in terms of the number of LTOs by aircraft/engine type;
- Select emission factors for each engine model associated with the aircraft fleet;
- Estimate the TIM for the aircraft fleet at each airport;
- Calculate emissions based on aircraft LTOs, emission factors for each aircraft engine model, and estimated aircraft TIM; and
- Aggregate the emissions across aircraft.

LTO data were obtained from DelDOT for all airports in New Castle County. Table 4-7 provides the LTO data by the four aircraft types for airports in New Castle County. Delaware reviewed LTO data and airport data that EPA provided. DAQ made changes to include the LTO counts in Table 4-7 in the EPA run of the FAA model and also verified the county location of each airport. The activity data for this category is not provided in a way that indicates the time the LTOs occurred. Therefore, DAQ final SSWD values are simple daily values, calculated from the annual total.

Table 4-7. 2017 LTO Data for New Castle County

Airport	Aircraft Type	LTOs
A.I. Dupont Children's Hospital	General Aviation, Piston	18
	General Aviation, Turbine	33
Bracebridge III	General Aviation, Piston	18
	General Aviation, Turbine	33
Christina Hospital	General Aviation, Piston	18
	General Aviation, Turbine	33
Duffy's	General Aviation, Piston	110
Full Throttle Farm	General Aviation, Piston	114
Greenville	General Aviation, Piston	18
	General Aviation, Turbine	33
Mckeown	General Aviation, Piston	83
New Castle County	Air Taxi, Piston	653
	Air Taxi, Turbine	2,342
	Commercial Aircraft, Total: All Types	40
	General Aviation, Piston	22,945
	General Aviation, Turbine	8,901
	Military Aircraft, Total	6,372
Okolona Plantation	General Aviation, Piston	79
Rollins Bldg	General Aviation, Piston	18
	General Aviation, Turbine	33
Scotty's Place	General Aviation, Piston	83
Spirit Airpark	General Aviation, Piston	131
Summit	General Aviation, Piston	22,665
	General Aviation, Turbine	8,771
	Military Aircraft, Total	100
Townsend A	General Aviation, Piston	114

DAQ provided these data to EPA for their run of the most updated FAA model. The values in Table 4-7 were different from the EPA-supplied data, and were compiled with state-specific data from the airports in the state. The results for the 2017 annual emissions by aircraft category are presented in Table 4-8.

Table 4-8. 2017 Annual Emissions of Aircraft in New Castle County

SCC	Aircraft Category	Annual (tpy)			SSWD (tpd)		
		VOC	NO_X	CO	VOC	NO_X	CO
2275001000	Military	35	72	84	0.10*	0.20*	0.23*
2275020000	Commercial	<1	<1	<1	<0.01*	<0.01*	<0.01*
2275050011	General Aviation - Piston	3	2	279	0.01*	<0.01*	0.76*
2275050012	General Aviation - Turbine	6	3	86	0.02*	0.01*	0.24*
2275060011	Air Taxi - Piston	<1	<1	9	<0.01*	<0.01*	0.03*
2275060012	Air Taxi - Turbine	1	<1	4	<0.01*	<0.01*	0.01*
22750xxxxx	**Total: Aircraft**	**47**	**78**	**463**	**0.13**	**0.21**	**1.27**

* = These figures are using EPA annual totals with Delaware-specific temporal profiles for SSWD calculation.

4.5 Locomotives

Railroad locomotives are a combustion source of emissions with most significant emissions occurring where there is a concentration of railroad activity (such as a large switch yard). The primary fuel consumed by railroad locomotives is distillate oil (diesel fuel). Locomotives can perform two different types of operations: line haul and yard (or switch). Line haul locomotives generally travel between distant locations, such as from one city to another. Yard locomotives are primarily responsible for moving railcars within a particular railway yard. Locomotive emissions are reported under the SCCs provided in Table 4-9.

For 2017, DAQ coordinated efforts with the ERTAC Rail group to develop locomotive emission estimates. The ERTAC Rail line haul estimates represent the highest quality data available, as no fuel use information was provided to the State from Norfolk Southern (NS) or CSX Transportation (CSX). For line haul locomotives, ERTAC and DAQ calculated Class I operation emissions separately from Class II/III operations. Line haul locomotive emissions for passenger trains and commuter lines were estimated to be zero since rail service in Delaware (Amtrak and SEPTA) is electric powered. Fuel consumption was used to estimate locomotive engine emissions. Fuel consumption rates are usually known only for the entire interstate operating region, therefore, it is necessary to allocate the total amount of fuel consumed "system-wide" to Delaware and its counties.

Table 4-9. SCCs for Locomotives

SCC	Descriptor 1	Descriptor 3	Descriptor 6	Descriptor 8
2285002006	Mobile Sources	Railroad Equipment	Diesel	Line Haul Locomotives: Class I Operations
2285002007	Mobile Sources	Railroad Equipment	Diesel	Line Haul Locomotives: Class II/Class III Operations
2285002010	Mobile Sources	Railroad Equipment	Diesel	Yard Locomotives

4.5.1 Line Haul Locomotives – Class I Operations

CSX operates Class I locomotives within New Castle County, while NS operates throughout the State. DAQ contacted these companies to obtain estimates of fuel consumption or data to calculate fuel consumption (*e.g.*, gross ton-miles (GTM) and gallons of fuel consumed per GTM). These companies did not provide fuel use to the DAQ. Therefore, ERTAC estimates were used for these categories. The ERTAC rail workgroup was able to obtain two high quality sets of data: national Class I fuel use and link-level rail activity density. Using these two datasets, they were able to estimate emissions for all counties in the US at a higher resolution than the DAQ previously achieved. However, because of the sensitive nature of the data, the DAQ does not have access to the raw data, and so only totals are provided in this document.

4.5.2 Line Haul Locomotives – Class II/III Operations

Five railroads operate Class II/III locomotives within the State:

- Maryland & Delaware (MDDE) Railroad – New Castle County and Sussex County;

- Delaware Coast Line Railroad – Sussex County;
- Delmarva Central Railroad – All three counties of the State;
- East Penn Railroad – New Castle County (company did not provide data for 2017); and
- Wilmington and Western – New Castle County.

Each of these companies, with the exception of East Penn, provided DAQ with fuel used in each county of the State. The system-wide reported fuel use and track miles of each railroad is presented in Table 4-10.

Table 4-10. 2017 Locomotive Fuel Consumption Data by County for Line Haul Operations

Railroad Company	Class	County	Track Miles	Fuel Consumed, gallons/year
Maryland & Delaware	II/III	New Castle	11.25	0
Delaware Coast Line	II/III	Sussex	13	9,000
Delmarva Central	II/III	New Castle	122.3*	52,202
Delmarva Central	II/III	Kent	122.3*	99,731
Delmarva Central	II/III	Sussex	122.3*	118,933
East Penn	II/III	New Castle	No Data Provided	No Data Provided
Wilmington and Western	II/III	New Castle	10	410

*Note: Track miles are system/state-wide

4.5.3 Yard Locomotives

Table 4-11 provides a summary of switchyard operations and fuel consumption by rail company and county. MDDE and Delaware Central Railroad both provided fuel used at switchyard by county for 2017. No data was received from the Class I railroads for the 2017 inventory year. Therefore, a count of switchyard locomotives was done for each known switchyard in Delaware via Google Earth satellite imagery. Fuel consumed for these yard locomotives was calculated from the annual R-1 report provided by each respective Class I railroad company. The total US switcher fuel was apportioned to Delaware based on the proportion of the number of switcher locomotives counted in Delaware to the total number of US switchyard locomotives.

Table 4-11. 2017 Switchyard Activity and Estimated Fuel Consumption

Switchyard	No. of Yard Locomotives	Fuel Consumed, gallons/year
MDDE	2	1090
Delaware Central	No Data Provided	2610
Norfolk Southern	14	922,077
CSX	7	461,038

4.5.4 Locomotive age/Engine build

Delaware Central Railroad and MDDE both provided the make and model of their locomotives. These are found in the table below.

Table 4-12. Delaware Central Railroad and MDDE Locomotive Make and Model

Company	Tier	Locomotive Type	APU or Auto start/stop
DCR	0	No data Provided	ZTR AESS
DCR	0+	No data Provided	ZTR AESS
DCR	0	No data Provided	ZTR AESS
DCR	0	No data Provided	ZTR AESS
DCR	0	No data Provided	ZTR AESS
DCR	Pre-1973	No data Provided	none
DCR	Pre-1973	No data Provided	ZTR AESS
DCR	Pre-1973	No data Provided	ZTR AESS
DCR	0+	No data Provided	APU
DCR	0+	No data Provided	APU
DCR	Pre-1973	No data Provided	APU
DCR	Pre-1973	No data Provided	APU
DCR	Pre-1973	No data Provided	APU
MDDE	No Data Provided	RS3M	Unknown
MDDE	No Data Provided	RS3M	Unknown
MDDE	No Data Provided	RS3M	Unknown
MDDE	No Data Provided	SW900	Unknown
MDDE	No Data Provided	CF7	Unknown

4.5.5 Sample Calculations and Results

Line Haul Locomotive

To determine the amount of pollutant ***p*** at the county level:

$$E_p = FC \times EF_p$$

where: E_p = amount of pollutant ***p*** emitted for the county in pounds
FC = fuel consumption for the county in gallons
EF_p = emission factor for pollutant ***p*** in pounds per gallon

Yard Locomotive

To determine the amount of pollutant ***p*** at the county-level:

$$E_p = Yd \times FC_{Yd} \times EF_{\boldsymbol{p}}$$

where: E_p = amount of pollutant ***p*** emitted for the county in pounds
Yd = number of yard locomotives in the county
FC_{Yd} = fuel consumption per yard locomotive in gallons per year
EF_p = emission factor for pollutant ***p*** in pounds per gallon

The results for the 2017 locomotive emissions by county are presented in Table 4-13. The activity data for this category is not provided in a way that indicates the time when activity occurred. Also, EPA has not provided seasonality in their estimations of line haul data. Therefore, DAQ final SSWD values are simple daily values, calculated from the annual total.

Table 4-13. 2017 Locomotives Emissions in New Castle County

SCC	Category Description	Annual (tpy)			SSWD (tpd)		
		VOC	NO_X	CO	VOC	NO_X	CO
2285002006	Class I Line Haul	6	127	25	0.02*	0.35*	0.07*
2285002007	Class II/III Line Haul	1	19	2	<0.01*	0.05*	0.01*
2285002010	Yard Locomotives	21	286	43	0.06	0.78	0.12
22850020xx		**28**	**432**	**70**	**0.08***	**1.18***	**0.19***

* = These figures are using EPA annual totals with Delaware-specific temporal profiles for SSWD calculation.

4.6 Commercial Marine Vessels

The CMV sector includes many types of vessels, such as large deep-draft vessels, barge towboats, harbor tugs, dredging vessels, ferries, excursion vessels, and commercial fishing vessels. In addition to the numerous vessel types, each vessel type engages in different activities such as hoteling, maneuvering within the port, and cruising.

In its 1999 final rule for commercial marine diesel engines, EPA defined three categories of marine diesel engines based on engine displacement, power and revolutions per minute (rpm). Table 4-14 presents the definitions for each category.

Table 4-14. U.S. EPA Marine Engine Category Definitions

Category	Displacement per cylinder	Power range (kW)	RPM range
1	disp. < 5 liters and power $\geq$ 37 kW	37 - 2,300	1,800 - 3,000
2	5 $\leq$ displacement < 30 liters	1,500 - 8,000	750 - 1,500
3	displacement $\geq$ 30 liters	2,500 - 80,000	60 - 900

The EPA classifies CMV emissions by fuel type (residual and diesel) and by mode of operation (port and underway). CMVs often burn multiple types of fuel and may burn different fuels for different operating modes or locations (*i.e.*, near ports). DAQ used the port and underway SCCs to characterize the CMV emissions as listed in Table 4-15. The SCC classification is based on the most common type of fuel utilized by the vessel category. Beginning in 2015, International Maritime Organization (IMO) regulations required ships in emission control areas (ECAs) to limit sulfur content to 0.1%S.

Table 4-15. SCCs for Commercial Marine Vessels

SCC	Descriptor 1	Descriptor 3	Descriptor 4
2280002101	Mobile Sources	Diesel	C1C2 Port emissions: Main Engine
2280002102	Mobile Sources	Diesel	C1C2 Port emissions: Auxiliary Engine
2280002201	Mobile Sources	Diesel	C1C2 Underway emissions: Main Engine
2280002202	Mobile Sources	Diesel	C1C2 Underway emissions: Auxiliary Engine
2280002103	Mobile Sources	Diesel	C3 Port emissions: Main Engine
2280002104	Mobile Sources	Diesel	C3 Port emissions: Auxiliary Engine
2280002203	Mobile Sources	Diesel	C3 Underway emissions: Main Engine
2280002204	Mobile Sources	Diesel	C3 Underway emissions: Auxiliary Engine
2280003103	Mobile Sources	Residual	C3 Port emissions: Main Engine
2280003104	Mobile Sources	Residual	C3 Port emissions: Auxiliary Engine
2280003203	Mobile Sources	Residual	C3 Underway emissions: Main Engine
2280003204	Mobile Sources	Residual	C3 Underway emissions: Auxiliary Engine

There are four activity modes for CMV: cruise, reduced speed zone (RSZ), maneuver, and hotel. Underway emissions are estimated as the combined activity of cruise and RSZ modes. Port emissions are estimated as the combined activity of maneuvering and hoteling modes. Emissions from ferries and dredging are considered port emissions since these vessels operate primarily within the port area.

DAQ calculated emissions for ocean-going vessels, towboats, tug-assist vessels, ferries and vessels associated with dredging operations. CMV engine emissions are assumed to be a function of the following:

- Mode of operation;
- Vessel type (bulk carrier, tanker, towboat, etc.);
- Vessel dead weight tonnage (DWT);
- Type of engine (2-stroke, 4-stroke, or steam); and
- Length of waterway segment.

Therefore, DAQ accounted for these variations when estimating CMV activity. The four modes of operation that are performed by vessels are defined below:

Cruise – Assumed to begin 25 miles out from the port breakwater until the vessel reaches the breakwater. The breakwater is located at the mouth of the Delaware Bay. Cruise mode is only applicable to Sussex County.

Reduced Speed Zone (RSZ) – Begins at the breakwater and continues until the vessel is one to two nautical miles from the berth or anchorage. The vessel is assumed to have a speed of twelve knots during this mode. This mode is also referred to as transit, and escort for towboats and tug-assist vessels.

Maneuvering – Time the vessel slows to below four knots until the dock lines are secure. This mode is also referred to as assist mode for tug-assist vessels.

Hoteling – Time the vessel is at dock. During this mode, the vessel operates auxiliary engines for electrical power.

The waterway segment distances used to estimate activity and to allocate the activity to each county were estimated from the Google Earth website in 2017 by tracing the shipping channel. Segment distances are shown in Table 4-16. The distance South is given to the breakwater at the mouth of the Delaware Bay. The distance North is given to the Delaware-Pennsylvania border. The distance for the C&D Canal East is given from the Delaware-Maryland border to the entrance of the Delaware River (Reedy Point).

Table 4-16. Waterway Segment Distances for the Delaware River Area

Waterway Segment	Distance (mi.)
Point	**South**
DE/PA Border	83.8
Oceanport	83.3
Port of Wilmington	76.1
Magellan Terminal	75.6
Delaware City Refinery	66.0
C&D Canal	62.6
Latitude 39°30'	57.7
New Castle Co/Kent Co	48.5
Kent Co/Sussex Co	15.9
Point	**North**
Port of Wilmington	7.7
C&D Canal	21.2
Point	**East**
C&D Canal	13.0

The engine activity for each mode is calculated using the following equation:

$$Activity_{mode} = Power \times Load\ Factor \times Time_{mode} \times Calls$$

where:
- $Activity_{mode}$ = activity by mode (kilowatt-hours)
- Power = rated engine power by vessel and engine type (kilowatts)
- Load Factor = load factor of the engine by vessel type and mode
- $Time_{mode}$ = time in mode per call by vessel type (hours)
- Calls = number of calls by vessel and engine type

This calculation must be performed for both propulsion and auxiliary engines and for each mode. Both propulsion engines and auxiliary engines are operating during cruise, RSZ, and maneuvering modes. Only auxiliary engines operate during hoteling. Once the activity is calculated, it is allocated to the county level using county allocation factors.

This approach to calculating activity of CMVs was used for all vessel types except vessels involved in dredging activity. For dredging, the activity data used for emissions calculations was the volume of material dredged. Details on the sources and development of activity data are provided in the following subsections.

4.6.1 Ocean-Going Vessels

DAQ obtained vessel call data for ocean-going vessels (OGVs) during calendar year 2017 from the Maritime Exchange for the Delaware River and Bay. Data were obtained for vessels that traveled anywhere into or through the Delaware River. The data for the entire port area is required since the majority of vessels pass through Delaware waters en route to other ports. The vessel call data included the vessel name, ship type, DWT, pier, and the date of the call. The ship types calling on the Delaware River Area ports in 2017 are shown in Table 4-17.

Vessels may shift between piers during the same call on the Delaware River area. DAQ adjusted the vessel call data to remove shifts between piers, where possible, to avoid double counting using a methodology recommended by the staff of the Marine Exchange. Data on the engine power and engine type (2-stroke, 4-stroke, and steam) used on OGVs were not available through the Marine Exchange. Therefore, DAQ assigned engine power and engine type based on average engine data obtained from other sources.

For propulsion engines, the average engine power and the engine type were obtained from the EPA report *Commercial Marine Activity for Deep Sea Ports in the United States* (*Deep Sea Ports*). This report presents data for vessels that called on the Delaware River area ports during calendar year 1996. Note that the Delaware River area includes ports in Delaware, New Jersey and Pennsylvania, which are located on the Delaware River. The number of calls by vessel and engine type is presented for specific DWT ranges. The average engine power is also given.

Table 4-17. Vessel Types Calling on Delaware River Area Ports in 2017

Codes	Main Vessel Type	Additional Vessel Types Included w/ Main Type
BU	Bulk	Bulk Cargo (BG), Chemical (CH), Bulk (HR)
CC	Container	Container/Bulk (CB), Part Container (PC)
GC	General Cargo	
MS	Miscellaneous	Livestock (LV), Tall Ship (TS)
PR	Passenger	
RF	Refrigerated Cargo (Reefer)	Container Reefer (CR)
RR	Roll on-Roll off (RORO)	RORO Container (RC)
TA	Tanker	Tanker (AS), Bulk Oil (BO), Chemical Oil Tanker (CO), Gas Carrier (PG and NG)
VE	Vehicle Carrier	

In 2017, DAQ changed its methodology in calculating OGV emissions by ascertaining each ship trip segment between every location where an Automatic Identification System (AIS) "ping" occurs. There were 50 such locations. All other "ping" points in New Jersey and all ports in Pennsylvania are located north of the Delaware/Pennsylvania state line. Vessels calling on New Jersey and Pennsylvania ports must be included in underway emission calculations for Delaware since the vessels travel through the Delaware portion of the bay and river.

Table 4-18 presents the assigned propulsion engine power and the number of "pings" by vessel type, DWT range and engine type for calls on the Delaware River area in 2017. In addition to

vessels traveling in the Delaware River Bay and River, 256 OGVs traversed the C&D Canal to or from the Chesapeake Bay.

Table 4-18. Average Propulsion Engine Power and the 2017 ship "pings" for OGVs traversing the Delaware River Area (DE, NJ and PA)

Main Vessel Type	Rig Type Included	Average Propulsion Engine Power	Number of Ship "Pings"
BU	BU, BG, OR	<25K	226
BU	BU, BG, OR	25K-35K	156
BU	BU, BG, OR	35K-45K	731
BU	BU, BG, OR	>45K	2
CC	CC, CB, PC	<25K	791
CC	CC, CB, PC	25K-35K	921
CC	CC, CB, PC	35K-45K	137
CC	CC, CB, PC	>45K	64
GC	GC	<15K	13
GC	GC	15K-30K	14
GC	GC	30K-45K	9
MS	CL, HL, LV	<10K	190
PR	PR	<5K	2
PR	PR	5K-10K	3
RF	RF, CR	5K-10K	168
RF	RF, CR	10K-15K	136
RF	RF, CR	15K-25K	49
RR	RR, RC	<15K	37
RR	RR, RC	15K-30K	92
RR	RR, RC	>30K	285
TA	TA, AS, BO, CH, CO, NP, PD, PG	<30K	283
TA	TA, AS, BO, CH, CO, NP, PD, PG	30K-60K	716
TA	TA, AS, BO, CH, CO, NP, PD, PG	60K-90K	15
TA	TA, AS, BO, CH, CO, NP, PD, PG	90K-120K	365
TA	TA, AS, BO, CH, CO, NP, PD, PG	120K-150K	5
TA	TA, AS, BO, CH, CO, NP, PD, PG	>150K	21
VE	VE	<12.5K	27
VE	VE	12.5K-15K	84
VE	VE	15K-17.5K	666
VE	VE	>17.5K	2
ALL		**TOTAL**	**6,210**

4.6.2 Towboats and Tug Assists

Towboats are used to transport non-self-propelled vessels, either dry cargo or tanker barges, throughout the Delaware River area, including the C&D Canal. DAQ obtained data on the number of towboat trips during calendar year 2017 from *Waterborne Commerce of the United States*. DAQ subtracted the number of towboat trips for the Port of Wilmington (POW) and the C&D Canal from the number of trips on the Delaware River (PA to the Sea). For towboats traveling to and from the POW and traveling through the C&D Canal, DAQ assumed that half the vessels travel north and the other half travel south to/from the POW and the canal.

In 2017, 5,911 towboat trips transited Delaware waters on the Delaware River, with a trip defined as a one-way passage. 347 towboat trips entered or exited the POW, and 1,479 towboat trips transited the C&D Canal.

Tugs assist OGVs from the shipping channel to its intended berth and then back to the channel when the vessel leaves port. This activity is considered the maneuvering mode for OGVs. Two tugs are typically required to assist an OGV with a DWT greater than 20,000 tons; for smaller OGVs, one tug suffices. The number of tug assists (982 in 2017) is directly related to the number of OGVs calling to a Delaware port. Note that a tug assisting a vessel to Bermuda International in New Jersey and the piers at the oil refineries in Marcus Hook, PA will require a tug to pick up the OGV in Delaware waters, thus tug assists are included for these docks. The tug meeting time to the docking time is usually within one hour.

In addition to assisting OGVs to maneuver into port, tugboats escort gas carriers through the Delaware Bay and River. Other vessels typically do not utilize an escort. Tug escort trips are included in the number of towboat trips transiting Delaware waters presented above. DAQ did not estimate emissions from hoteling of towboats and tugs due to lack of activity data.

Vessel speeds, average maneuvering and hoteling time, propulsion and auxiliary engine horsepower ratings, and engine load factors for OGVs, towboats, and tugs were obtained from EPA's *Deep Sea Ports* and *Preparing Port Emission Inventories*. For RSZ mode, time-in-mode for each vessel was calculated based on vessel speeds and waterway segment distances provided in Table 4-15.

4.6.3 Dredging

Maintenance dredging is performed routinely on the Delaware River to keep the channels to their required depths. Dredging involves multiple vessels, including dredges, assist tugs, and generator barges that provide additional power. Estimating emissions from dredging vessel engine activity is time-consuming. Therefore, DAQ developed emissions based on the volume of material dredged during calendar year 2017 rather than engine activity in kilowatt-hours.

DAQ obtained the dredging activity data from both the United States Army Corps of Engineers (USACE) and from within DNREC. The amount of material dredged by USACE contractors was obtained from the USACE report on dredging contracts awarded for the year 2017. DAQ also contacted the Delaware Division of Soil and Water Conservation to obtain the amount of material dredged by the Division. Table 4-19 presents the estimated amount of material dredged and the

type of dredge used. DAQ assumed all the dredging activity is maintenance dredging. New cut dredging results in higher emissions, therefore this assumption may result in lower emission estimates than are actually occurring in the area.

Table 4-19. Material Dredged in Delaware Waters during 2017

County	Type of Equipment	Total Material Dredged (cubic yards)
Kent	Hydraulic	558,201
New Castle	Hydraulic	297,000
Sussex	Hydraulic	2,252,379
Kent	Bucket/Clamshell	558,201
New Castle	Bucket/Clamshell	297,000
Sussex	Bucket/Clamshell	909,879

4.6.4 Ferries

The only ferry in Delaware that operates in New Castle County is the Three Forts Ferry. This ferry travels from either Delaware City, DE or Fort Mott, NJ to Fort Delaware located on Pea Patch Island in the Delaware River. Monthly trip count data for the ferry was obtained by contacting the Delaware River & Bay Authority (DRBA). The Three Forts Ferry made 2,862 one-way trips in 2017. The DRBA also provided the engine and time-in-mode data for the Three Forts Ferry.

4.6.5 Spatial Allocation

DAQ developed county allocation factors for CMV activity data based on the location of the activity on the various waterways and length of the waterway segment. In developing county allocation factors, DAQ assumed that from latitude 39°30' to 25 miles beyond the mouth of the Delaware Bay, the activity is split evenly between Delaware and New Jersey since the ship channel roughly corresponds to the boundary between the two states. Above latitude 39°30', all emissions are allocated to Delaware since the entire breadth of the river is under Delaware's jurisdiction. Allocations were developed for each activity mode, since the activity takes place in different areas depending on the mode.

For OGV maneuvering and hoteling modes, the activity is allocated to the county in which the port is located. All large Delaware ports are located in New Castle County. Much of the maneuvering and hoteling activity thus takes place to New Castle County. OGVs will also hotel at one of the several anchorages along the shipping channel. Emissions are estimated for hoteling that takes place at Delaware's anchorages.

For the RSZ mode, county allocation factors were developed for the four ports in Delaware (Port of Wilmington, Magellan Terminal, Oceanport, and Delaware City Refinery), Bermuda International in New Jersey, and from the Pennsylvania-Delaware border to the breakwater (PA/DE to the Sea).

Allocating dredging to each county was based on the river miles in each county, and split between Delaware and New Jersey below latitude 39°30'. While the Three Forts Ferry travels to Fort Mott

on the New Jersey side of the Delaware River, at that latitude, Delaware's jurisdictional waters extend the breadth of the river. Therefore, all activity for the Three Forts Ferry was allocated to New Castle County.

The results for the 2017 annual emissions by CMV category are presented in Table 4-20.

Table 4-20. 2017 Commercial Marine Vessel Emissions for New Castle County

		Annual (tpy)			SSWD (tpd)		
SCC	**Category Description**	**VOC**	**NO_X**	**CO**	**VOC**	**NO_X**	**CO**
2280002101	C1C2 Port emissions: Main Engine - Diesel	2	18	1	<0.01*	0.05*	<0.01*
2280002102	C1C2 Port emissions: Auxiliary Engine- Diesel	2	78	12	0.01*	0.21*	0.03*
2280002201	C1C2 Underway emissions: Main Engine – Diesel	11	286	42	0.03*	0.78*	0.12*
2280002202	C1C2 Underway emissions: Auxiliary Engine – Diesel	6	198	31	0.02*	0.54*	0.08*
2280002103	C3 Port emissions: Main Engine – Diesel	8	45	8	0.02*	0.12*	0.02*
2280002104	C3 Port emissions: Auxiliary Engine – Diesel	9	196	22	0.02*	0.54*	0.06*
2280002203	C3 Underway emissions: Main Engine – Diesel	35	543	63	0.10*	1.49*	0.17*
2280002204	C3 Underway emissions: Auxiliary Engine – Diesel	8	169	19	0.02*	0.46*	0.05*
2280003103	C3 Port emissions: Main Engine - Residual	0	0	0	0.00*	0.00*	0.00*
2280003104	C3 Port emissions: Auxiliary Engine – Residual	0	0	0	0.00*	0.00*	0.00*
2280003203	C3 Underway emissions: Main Engine – Residual	0	0	0	0.00*	0.00*	0.00*
2280003204	C3 Underway emissions: Auxiliary Engine - Residual	0	0	0	0.00*	0.00*	0.00*
228000xxxx		80	1,532	199	0.22*	4.20*	0.54*

* = These figures are using EPA annual totals with Delaware-specific temporal profiles for SSWD calculation.

SECTION 5 - ONROAD MOBILE SOURCES

The 2017 onroad mobile source inventory is an estimate of vehicle emissions based on actual VMT on Delaware roadways in 2017 using EPA's MOVES2014b model. DAQ used the input files submitted for the EPA's 2017 NEI run of the MOVES2014b model. These inputs files are organized in a county database (CDB), the details of which are outlined in Table 5-1. MOVES uses many more inputs; those not mentioned here would use the default tables from the MOVES database (movesdb20181022).

Table 5-1. County Database

MOVES CDB Tab	Input datasource	Data Source Details
Road Type Distribution	RoadTypeDistribution	Analyzed the DMV's Road type VMT data which is collected by road type. This was converted to the appropriate MOVES road type.
Source Type Population	SourceTypeYear	The DMV's registration database was used.
Vehicle Type VMT	HpmsVtypeYear	Delaware 2017 VMT report together with the MOVES database. This is discussed in detail below.
	MonthVmtFraction	Used the data from the CRC-A100 dataset.
	DayVMTFraction	
	HourVMTFraction	
I/M Programs	IMCoverage	This is discussed in more detail below.
Generic	EmissionRateByAge	Delaware adopted the LEV-III standards in 2014, the following guidance was used to generate an appropriate "EmissionRateByAge" table: "Instructions for Using LEV and NLEV Inputs for MOVES2014" EPA-420-B-14-060a"
Age Distribution	SourceTypeAgeDistribution	The DMV's registration database was used.
Average Speed Distribution	AvgSpeedDistribution	Used the data from the CRC-A100 data set. This came from a study of massive amounts of Bluetooth data. This was used nationally for the 2014 NEI. Where the vehicle types were not available, the data from the Delaware Department of Transport's Travel Demand Model was used.
Fuel	FuelSupply	Used the MOVES default tables for New Castle County.
	FuelFormulation	
	FuelUsageFraction	
	AVFT	
Meteorology Data	ZoneMonthHour	Temperature and humidity data was downloaded from NOAA website for 2017.

5.1 Delaware-Specific Input Data for 2017

As outlined above, the MOVES model allows for a variety of model inputs. DAQ, with assistance from DelDOT, puts considerable effort in creating county-specific input data files. The county-specific input data types created for the 2017 inventory include VMT (by vehicle and roadway type), vehicle registration data (vehicle populations and age distributions), average speeds in the form of speed bin fractions (weekday versus weekend and by roadway type), and inspection and maintenance (I/M) program specifications. Each of these input data sets are discussed separately

below. DAQ relies on the MOVES model defaults for fuel parameters (formulations and supply), ramp fractions, and weekly and daily fractions.

5.1.1 Vehicle Miles Traveled (VMT) Data

The activity data used for developing the onroad emission inventory is VMT. DelDOT provided 2017 VMT data by roadway type for all counties in Delaware. DelDOT is required to submit calendar year VMT data annually to the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS). The VMT is estimated based on data from permanent traffic count stations throughout the county.

DelDOT's traffic count program provides daily and seasonal variation data. Additional temporary stations provide shorter-term counts that are expanded with factors derived from appropriate permanent count stations. Counting and expansion activities are consistent with FHWA guidelines. The traffic data submitted to HPMS are considered the most accurate VMT totals for Delaware.

Since the VMT provided by DelDOT is supplied by HPMS roadway type, the task of creating VMT by MOVES road type fractions requires mapping the twelve HPMS road types to the four MOVES road types. The road type allocations for New Castle County for 2017 are provided in Table 5-2.

Table 5-2. New Castle County VMT Fractions by Road Type

MOVES Road Type Code	Road Type Description	VMT Fraction by Road Type
2	Rural Restricted Access	0.0000
3	Rural Unrestricted Access	0.1550
4	Urban Restricted Access	0.5457
5	Urban Unrestricted Access	0.2993
Total		**1.0000**

5.1.2 VMT Fractions by Vehicle Type

MOVES requires VMT by HPMS vehicle types as an input, however, VMT by vehicle type data are not collected in Delaware, so an alternate method was used.

The output from a MOVES statewide run at the national level was analyzed for VMT distribution by vehicle type. These VMT proportions were then used to allocate the VMT as measured by DelDOT to the vehicle types, as can be seen in Table 5-3.

Table 5-3. New Castle County VMT by Vehicle Type

HPMSVtypeID	HPMSVtypeName	yearID	HPMSBaseYearVMT
10	Motorcycles	2017	37,567,788
25	Light Duty Vehicles	2017	5,525,977,280
40	Buses	2017	28,773,188
50	Single Unit Trucks	2017	217,394,603
60	Combination Trucks	2017	285,900,620

5.1.3 VMT Temporal Allocations

The MOVES model input files include allocations of VMT by month. Monthly allocation of VMT is accomplished through the use of permanent count station data provided by DelDOT. For 2017, DelDOT provided monthly VMT data from the permanent count stations throughout New Castle County. Each month's data for all count stations was summed and divided by the sum of the annual VMT recorded by the all count stations in a county. The monthly VMT fractions created in this way are provided in Table 5-4.

Table 5-4. Monthly VMT Allocation Fractions for New Castle County

Month	VMT Fraction
January	0.0700
February	0.0732
March	0.0782
April	0.0834
May	0.0874
June	0.0934
July	0.0907
August	0.0911
September	0.0855
October	0.0847
November	0.0818
December	0.0807

5.1.4 Vehicle Populations and Age Distributions

Vehicle registration data was obtained from the Delaware Division of Motor Vehicles (DMV) registration database on July 1, 2018. The data shows the number of vehicles registered by model year (MY) for each of the 16 MOBILE6.2 vehicle classes.

The data is first transformed to the 13 MOVES source types using the techniques outlined in the Vehicle Type Mapping sheet in the EPA's conversion tool:

"VMT-Converter-road-veh16-20100209.xls"

Then, the last storage bin (25 years and older) is reallocated across five years according to the proportions listed in the MOVES2014 default database for calendar year 2017.

5.1.5 Speed Bin Fractions

The MOVES model represents average vehicle speeds by roadway type through the use of speed bin fractions. There are 16 speed bins with the first representing speeds less than 2.5 miles per hour (mph), with each subsequent bin having a range of 5 mph (*i.e.*, 42.5 mph – 47.5 mph). The final bin represents speeds equal to or greater than 72.5 mph.

For 2017, DelDOT provided seasonal speed bin fractions for each of the four MOVES roadway types, for each hour of the day, and for weekday and weekend driving patterns. DelDOT estimated speeds using the Peninsula travel demand model. The model accounts for traffic volumes and variations in travel according to purpose, which impact average speeds.

However, the Speed Bin data that was used came from the telematics data that the CRC A-100 study[6] provided. Between September 2015 and August 2016 telematics data from millions of vehicles was taken nationally and compiled into MOVES ready tables. The CRC A-100 dataset covered the vehicle types as outlined in Table 5-5. These cover the vast majority of vehicles. Where CRC A-100 data was not available, the data came from the DelDOT Peninsula travel model. This is the same approach as used for the NEI2014v2 MOVES runs, and is being used again for the NEI 2017 runs.

Table 5-5. 2017 Vehicle Populations for New Castle County

Vehicle Code	Vehicle Type	Number of Vehicles	Include in CRC A-100 Telematics
11	Motorcycle	12,037	Yes
21	Passenger Vehicle	227,297	Yes
31	Passenger Truck	152,764	Yes
32	Light Commercial Truck	81,766	Yes
41	Intercity Bus	145	No
42	Transit Bus	435	No
43	School Bus	721	No
51	Refuse Truck	43	No
52	Single Unit Short-Haul Truck	3,719	Yes
53	Single Unit Long-Haul Truck	271	Yes
54	Motor Home	430	No
61	Combination Short-Haul Truck	696	Yes
62	Combination Long-Haul Truck	482	Yes

5.1.6 Inspection and Maintenance (I/M)

Table 5-6 outlines the I/M program as implemented in New Castle County.

The program includes a biennial onboard diagnostic testing program (OBD II) for 1996 and later model year (MY) vehicles. Vehicle emission computer systems are checked for any diagnostic trouble codes present, a symptom of excess emissions which results in the vehicle failing.

Older vehicles, starting with MY 1968, are given a curb idle test (MY 1968-1980) or a two-speed idle test (MY 1981-1995). A tailpipe probe is inserted for 60 seconds to determine exhaust concentrations of hydrocarbons and carbon monoxide. Depending on the MY, vehicles with an excess emission concentration of either pollutant will fail the test.

Older vehicles (MY 1975-1995) are also given a fuel system pressure test (FP) and a gas cap (GC) test. Air pressure is applied to the fuel system from the fuel inlet to the canister. After air pressure has been applied, pressure degradation is monitored. Vehicles fail the FP if it cannot maintain the equivalent pressure of eight inches of water for up to two minutes after being pressurized to 14.0 ± 0.5 inches of water. A similar pressure test is applied to the vehicle's GC.

[6] http://crcsite.wpengine.com/wp-content/uploads/2019/05/ERG_FinalReport_CRCA100_28Feb2017.pdf

Table 5-6. New Castle County I/M Program Parameters

Test Type	IDLE	2500/IDLE	FP & GC	OBD I/M
Test Frequency	Biennial	Biennial	Biennial	Biennial
Program Type	Test Only	Test Only	Test Only	Test Only
Model Years	1968-1980	1981-1995	1975-1995	1996-2010
Regulatory Class Coverage				
Passenger Vehicle	96.02	96.02	96.02	95.62
Passenger Truck	94.10	94.10	94.10	93.71
Light Comm. Truck	88.34	88.34	88.34	87.97
Vehicles Tested (gasoline only)				
Passenger Vehicle	Yes	Yes	Yes	Yes
Passenger Truck	Yes	Yes	Yes	Yes
Light Comm. Truck (up to 8,500 GVWR)	Yes	Yes	Yes	Yes
School Bus	No	No	No	No
Single Unit Short-Haul Truck	No	No	No	No
Single Unit Long-Haul Truck	No	No	No	No
Refuse Truck	No	No	No	No
Combination Short-Haul Truck	No	No	No	No
Combination Long-Haul Truck	No	No	No	No
Motor Home	No	No	No	No
Intercity Bus	No	No	No	No
Transit Bus	No	No	No	No
Motorcycle	No	No	No	No

5.1.7 Meteorology

The ZoneMonthHour table is a listing of the average hourly temperature and relative humidity data. This data is averaged for each hour for each month so that there are 288 (12 x 24) readings for both parameters.

Hourly data for every day of every month for 2017 was downloaded using the Local Climatological Data tool[7] provided by NOAA as presented in Table 5-7.

Table 5-7. New Castle County Local Climatological Data Station Details

County	Station Location
New Castle	NEW CASTLE COUNTY AIRPORT (13781)

[7] https://www.ncdc.noaa.gov/cdo-web/datatools/lcd?prior=N

This data was processed so as to produce the data in the format as defined in the ZoneMonthHour table.

5.2 Controls

All MOVES-recognized onroad control measures known to be in place in Delaware in 2017 were included in the MOVES emission inventory mode modeling. Local control programs include Delaware's I/M program, the Federal reformulated gasoline program, and the Northeast Ozone Transport Region LEV program. The MOVES model internally includes all national control programs, such as the Tier 1, Tier 2 and Tier 3 gasoline fuel and light duty engine emission standards as well as the ultra-low sulfur diesel fuel and heavy duty engine standards.

Two Delaware control programs, the anti-tampering procedures (ATP) performed at the inspections lanes and the anti-idling regulation, were not accounted for in the MOVES runs since the model does not provide for inputting these programs. For the ATP control program, vehicles that are tested are also checked to see if the catalytic converter, GC, and fuel inlet restrictor are present. Vehicles will fail inspection if any of these devices are missing.

7 DE Admin. Code 1145, Excessive Idling of Heavy Duty Vehicles, is designed to eliminate emissions caused by extending idling. While MOVES delineates emissions processes for extended idling, the currently available control programs within MOVES do not account for anti-idling measures. Delaware currently has no off-model method to determine emission benefits from either ATP or 7 DE Admin. Code 1145.

5.3 Emission Estimation Methodologies

A single MOVES model run was used to compute both the SSWD emissions and the annual emissions. To achieve this, MOVES was run by selecting all months, both day types, all hours, and the output time aggregation of "24-hour day". An Excel pivot table was created from the MOVES Output Table (provided in Appendix D, Tab 1. Pivot SSWD), to select the summer months of June, July, and August and just the weekdays. The pivot table results were averaged to calculate average SSWD emissions for each pollutant.

The first step in calculating annual emissions was to calculate *Daily Emissions* from the MOVES Output Table. A new column was added to the same MOVES Output Table to calculate *Daily Emissions* using the following equation:

$$emissionQuant \times DayID / 7 \times DaysInMonth$$

where:	emissionQuant	= MOVES model output, quantity of emissions (tons/day)
	DayID	= MOVES model output, representing weekend (2) or weekday (5)
	DaysInMonth	= number of days in a particular month

Then, an Excel pivot table was created from the MOVES Output table (provided in Appendix D, Tab 2. Pivot Annual), selecting all months and both DayID types. Table 5-8 summarizes the fields that were utilized in the pivot tables to calculate SSWD and annual emissions.

Table 5-8. Calculation of SSWD and Annual Emissions Pivot Table Details

Pivot Table Fields	Emission Tally Type	
	SSWD	Annual
Columns	Pollutant	Pollutant
Rows	MonthID (Select 6,7,8)	MonthID (Select All)
	DayID (Select 5)	DayID (Select Both)
∑ values	Sum of Emission Quant	Sum of Daily Emissions
Post Processing	Calculate Average	Use Grand Total Columns

5.4 Calculated 2017 Onroad Emissions

Table 5-9. 2017 Annual and SSWD Emissions for Onroad Mobile Sources

County	Annual (tpy)			SSWD (tpd)		
	VOC	NO_X	CO	VOC	NO_X	CO
New Castle	2,213	5,184	28,807	6.23	15.70	87.23