Appendix 4-6:
2017 Nonroad Projection Emissions Inventory

1.0 Nonroad Sources

Nonroad mobile sources include internal combustion engines used to propel marine vessels, airplanes, and locomotives, or to operate equipment such as forklifts, lawn and garden equipment, portable generators, etc. For activities other than marine vessels, airplanes, and locomotives, the inventory was developed using the most current version of USEPA's nonroad model, NONROAD2008a (NONROAD). The NONROAD model is now incorporated in the most current version of the USEPA's Motor Vehicle Emission Simulator model, MOVES2014a-20151201 (movesdb2016IIIT) (MOVES). Since the NONROAD model does not include emissions from marine vessels, airplanes, and locomotives, these emissions were estimated using the latest USEPA guidance or by groups such as the Eastern Regional Technical Advisory Committee (ERTAC) and Starcrest.

1.1 NONROAD Model

The USEPA's NONROAD model estimates emissions from equipment such as recreational marine vessels, recreational land-based vehicles, farm and construction machinery, lawn and garden equipment, aircraft ground support equipment (GSE) and rail maintenance equipment. This equipment is powered by diesel, gasoline, compressed natural gas or liquefied petroleum gas engines.

New Jersey ran the NONROAD model for each county included in the New Jersey portion of the Northern New Jersey-New York-Connecticut nonattainment area. The NONROAD model utilizes USEPA nonroad defaults for equipment populations and growth factors and interfaces with USEPA MOVES highway defaults for fuel specific parameters and climatological data. New Jersey made only one change to these defaults. The pleasure craft equipment populations were updated based on a study conducted by the National Marine Manufacturers Association (NMMA). Also, New Jersey did not include the airport ground support equipment inventory developed by the MOVES NONROAD model as discussed below.

1.1.1 Recreational Marine Vessel Population Revision

Total New Jersey default populations for each of the three major recreational marine vessel categories contained in the NONROAD model (outboard, inboard/sterndrive and personal watercraft) were updated. The NMMA provided updated populations for the outboard and personal watercraft vessel engine categories for the year 2007. The population files used by the NONROAD model were configured with population values for various horsepower categories. The fraction of the total population for each marine vessel type was calculated for each horsepower category. These fractions were then used to allocate the total state population obtained from NMMA to the various horsepower categories. The only exception to this was the addition of data for sailboats. The sailboat populations were split among the outboard and inboard/sterndrive watercraft vessels.

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Updated recreational marine population data was also estimated for the year 2017. USEPA recommends that separate population estimates for each projection year should be prepared and included in the population files rather than use the default growth algorithm built into the NONROAD model for those states that had their 2007 base year updated for this category. The national default growth factors supplied in the NONROAD model were used to estimate populations for each year. Each horsepower/population category in the 2007 population file was grown to 2017 using the ratio between the 2005 and 2015 national growth factors (to

represent growth between 2007 and 2017). Those ratios were used to grow the 2007 population to 2017.

1.1.2 Airport Ground Support Equipment Removal

USEPA's NONROAD model estimates emissions from Airport GSE. Airport GSE emissions are also included in the USEPA's aircraft inventory that was calculated by the Federal Aviation Administration's (FAA) Emissions and Dispersion Modeling System (EDMS). Correspondence with the USEPA indicated that they consider the emissions calculated by EDMS to be more accurate than those calculated by their NONROAD model. For this reason, all emissions calculated by the NONROAD model for airport GSE were removed from the inventory to avoid double counting.

1.1.3 NONROAD Model Growth Information

In estimating future year emissions, the NONROAD model includes growth and scrappage rates for equipment in addition to a variety of control programs. The growth data used in the NONROAD model is documented in a USEPA report.[1]

Before running the core model, you must define the scenario you are interested in modeling by creating an option file which designates the growth year that you want to run. The growth year selected will include all controls applied up until the end of that year. It is not possible to separate out the growth year emissions due to "growth only" to that year and "control only" to a prior year in a single run. That is, the model run provides a single growth year estimate that is a "growth and control" scenario.

All model input files and scenario specific parameters are specified in the input option file. The information contained in each option file is separated into "packets" based on common information. For example, all data items related to the period of time for which you are interested in estimating emissions is grouped in a single packet, as are the data files related to the population of equipment for a modeling region.

The growth packet of the NONROAD model cross-references each source classification code (SCC) to a growth indicator code. The indicator code is an arbitrary code that identifies an actual predicted value such as human population or employment that is used to estimate the future year equipment population. The growth packet also defines the scrappage curves used to estimate the future year model year distribution.

1.1.4 NONROAD Model Control Information

The NONROAD model also accounts for all USEPA emission standards for nonroad equipment. There are multiple standards that vary by equipment type, rated power, model year, and pollutant. Exhibit 1.1.4 is a summary of the emission control programs accounted for in the NONROAD model.

[1] U.S. Environmental Protection Agency. Nonroad Engine Growth Estimates. EPA-420/P-04-008, April 2004.

Exhibit 1.1.4
Control Programs Included in the USEPA's NONROAD Model

Regulation/(USEPA's emission standard reference guide)	Description
Control of Air Pollution; Determination of Significance for Nonroad Sources and Emission Standards for New Nonroad Compression Ignition Engines At or Above 37 Kilowatts 59 FR 31036 June 17, 1994 (EPA-420-B-16-022, March 2016)	This rule establishes Tier 1 exhaust emission standards for HC, NO_x, CO, and PM for nonroad compression-ignition (CI) engines ≥37kW (≥50hp). Marine engines are not included in this rule. The start dates and pollutants affected vary by hp category as follows: 50-100 hp: Tier 1,1998; NO_x only 100-175 hp: Tier 1, 1998; NO_x only 175-750 hp: Tier 1, 1996; HC, CO, NO_x, PM >750 hp: Tier 1, 2000; HC, CO, NO_x, PM
Emissions for New Nonroad Spark-Ignition Engines At or Below 19 Kilowatts; Final Rule 60 FR 34581 July 3, 1995 (EPA-420-B-16-028, March 2016)	This rule establishes Phase 1 exhaust emission standards for HC, NO_x, and CO for nonroad spark-ignition engines ≤19kW (≤25hp). This rule includes both handheld (HH) and non-hand-held (NHH) engines. The Phase 1 standards become effective in 1997 for : Class I NHH engines (<225cc), Class II NHH engines (≥225cc), Class III HH engines (<20cc), and Class IV HH engines (≥20cc and <50cc). The Phase 1 standards become effective in 1998 for: Class V HH engines (≥50cc)
Final Rule for New Gasoline Spark-Ignition Marine Engines; Exemptions for New Nonroad Compression-Ignition Engines at or Above 37 Kilowatts and New Nonroad Spark-Ignition Engines at or Below 19 Kilowatts 61 FR 52088 October 4, 1996 (EPA-420-B-16-026, March 2016)	This rule establishes exhaust emission standards for HC+ NO_x for personal watercraft and outboard (PWC/OB) and Stern Inboard (SI) marine engines. The standards are phased in from 1998-2010 for PWC/OB and from 2010-2012 for SI engines.
Control of Emissions of Air Pollution From Nonroad Diesel Engines 63 FR 56967 October 23, 1998 (EPA-420-B-16-22, March 2016)	This final rule sets Tier 1 standards for engines under 50 hp, phasing in from 1999 to 2004. It also phases in more stringent Tier 2 standards for all engine sizes from 2001 to 2006, and yet more stringent Tier 3 standards for engines rated over 50 hp from 2006 to 2008. The Tier 2 standards apply to NMHC+ NO_x, CO, and PM, whereas the Tier 3 standards apply to NMHC+ NO_x and CO. The start dates by hp category and tier are as follows: hp<25: Tier 1, 2000; Tier 2, 2005; No Tier 3 25-50 hp: Tier 1, 1999; Tier 2, 2004; No Tier 3 50-100 hp: Tier 1, 1998: Tier 2, 2004; Tier 3, 2008 100-175 hp: Tier 1, 1997: Tier 2, 2003; Tier 3, 2007 175-300 hp: Tier 1, 1996: Tier 2, 2003; Tier 3, 2006 300-600 hp: Tier 1, 1996; Tier 2, 2001; Tier 3, 2006 600-750 hp: Tier 1, 1996; Tier 2, 2002; Tier 3, 2006 >750 hp: Tier 1, 2000; Tier 2, 2006, No Tier 3 This rule does not apply to marine diesel engines > 50 hp.
Phase 2: Emission Standards for New Nonroad Nonhandheld Spark Ignition Engines At or Below 19	This rule establishes Phase 2 exhaust emission standards for HC+ NO_x for nonroad nonhandheld (NHH) spark-ignition engines ≤19kW (≤25hp). The Phase 2 standards

Regulation/(USEPA's emission standard reference guide)	Description
Kilowatts 64 FR 15207 March 30, 1999 (EPA-420-b-16-028, March 2016)	for Class I NHH engines (<225cc) become effective on August 1, 2001 or August 1, 2003 for any engine initially produced on or after that date. The Phase 2 standards for Class II NHH engines (≥225cc) are phased in from 2001-2005.
Phase 2: Emission Standards for New Nonroad Spark-Ignition Handheld Engines At or Below 19 Kilowatts and Minor Amendments to Emission Requirements Applicable to Small Spark-Ignition Engines and Marine Spark-Ignition Engines; Final Rule 65 FR 24268 April 25, 2000 (EPA-420-B-16-028, March 2016)	This rule establishes Phase 2 exhaust emission standards for HC+ NO_x for nonroad handheld (HH) spark-ignition engines ≤19kW (≤25hp). The Phase 2 standards are phased in from 2002-2005 for Class III and Class IV engines and are phased in from 2004-2007 for Class V engines. The Phase 3 standards are phased in from 2011-2012 for Class I, II and III-V.
Control of Emissions From Nonroad Large Spark-Ignition Engines and Recreational Engines (Marine and Land-Based); Final Rule 67 FR 68241 November 8, 2002 (EPA-420-B-16-023, March 2016) (EPA-420-B-16-027, March 2016) (EPA-420-B-16-029, March 2016) (EPA-420-B-16-025, March 2016)	This rule establishes exhaust and evaporative standards for several nonroad categories: 1) Two tiers of emission standards are established for large spark-ignition engines over 19 kW. Tier 1 includes exhaust standards for HC+ NO_x and CO and is phased in from 2004-2006. Tier 2 becomes effective in 2007 and includes exhaust standards for HC+ NO_x and CO, as along with evaporative controls affecting fuel line permeation, diurnal emissions and running loss emissions. 2) Exhaust and evaporative emission standards are established for recreational vehicles, which include snowmobiles, off-highway motorcycles, and all-terrain vehicles (ATVs). For snowmobiles, HC and CO exhaust standards are phased-in from 2006-2012. For off-highway motorcycles, HC+ NO_x and CO exhaust emission standards are phased in from 2006-2007. For ATVs, HC+NO_x and CO exhaust emission standards are phased in from 2006-2007. Evaporative emission standards for fuel tank and hose permeation apply to all recreational vehicles beginning in 2008 and for Stern Inboard (SI) marine engines beginning in 2009. 3) Exhaust emission standards for recreational marine diesel engines over 50 hp for NOx becomes effective in 2004. This is a "Tier 1" standard. While the "Tier 2" standard for HC+ NO_x, CO, and PM begins in 2006-2009, depending on the engine displacement. "Tier 3" standards begin in 2009-2014.
Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel; Final Rule (Clean Air Nonroad Diesel Rule – Tier 4) 69 FR 38958 June 29, 2004 (EPA-420-B-16-022, March 2016)	This final rule sets Tier 4 exhaust standards for CI engines covering all hp categories (except marine and locomotives), and also regulates nonroad diesel fuel sulfur content. 1) The Tier 4 start dates and pollutants affected vary by hp and tier as follows: hp<25: 2008, PM only 25-50 hp: Tier 4 transitional, 2008, PM only; Tier 4 final, 2013, NMHC+ NO_x and PM 50-75 hp: Tier 4 transitional, 2008; PM only;

Regulation/(USEPA's emission standard reference guide)	Description
	Tier 4 final, 2013, NMHC+ NO_x and PM 75-175 hp: Tier 4 transitional, 2012, HC, NO_x, and PM; Tier 4 final, 2014, HC, NO_x, PM 175-750 hp:Tier 4 transitional, 2011, HC, NO_x, and PM; Tier 4 final, 2014, HC, NO_x, PM >750 hp: Tier 4 transitional, 2011, HC, NO_x, and PM; Tier 4 final, 2015, HC, NO_x, PM 2) This rule will reduce nonroad diesel fuel sulfur levels in two steps. First, starting in 2007, fuel sulfur levels in nonroad diesel fuel will be limited to a maximum of 500 ppm, the same as for current highway diesel fuel. Second, starting in 2010, fuel sulfur levels in most nonroad diesel fuel will be reduced to 15 ppm.
Control of Emissions From Nonroad Spark-Ignition Engines and Equipment; Final Rule (Bond Rule) 73 FR 59034 October 8, 2008 (EPA-420-B-16-026, March 2016)	This rule establishes exhaust and evaporative standards for small SI engines and marine SI engines: 1) Phase 3 HC+ NO_x exhaust emission standards are established for Class I NHH engines starting in 2012 and for Class II NHH engines starting in 2011. There are no new exhaust emission standards for handheld engines. New evaporative standards are adopted for both handheld and nonhandheld equipment. The new evaporative standards control fuel tank permeation, fuel hose permeation, and diffusion losses. The evaporative standards begin in 2012 for Class I NHH engines and 2011 for Class II NHH engines. For handheld engines, the evaporative standards are phased-in from 2012-2016. 2) More stringent HC+ NO_x and CO standards are established for Pleasurecraft/Outboard (PWC/OB) and stern inboard (SI) marine engines beginning in 2010. In addition, new exhaust HC+ NO_x and CO standards are established for SI marine engines also beginning in 2010. High performance SI marine engines are subject to separate HC+ NO_x and CO exhaust standards that are phased-in from 2010-2011. New evaporative standards were also adopted for all SI marine engines that control fuel hose permeation, diurnal emissions, and fuel tank permeation emissions. The hose permeation, diurnal, and tank permeation standards take effect in 2009, 2010, and 2011, respectively.

1.1.5 NONROAD Model Equipment Emission Inventory

Table 1 summarizes the 2017 NONROAD model source emissions for summer work week day by county for VOC, NO_x and CO. Appendix 4-6, Attachment 1 contains the detailed NONROAD Model source emission inventories. This attachment is only available electronically.

Table 1
2017 NONROAD Model Equipment Emission Inventory by County and Pollutant
New Jersey portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NO_x Tons per Day	CO Tons per Day
Bergen	10.02	7.62	186.04
Essex	3.88	4.05	71.29
Hudson	3.38	3.84	45.24
Hunterdon	2.48	1.87	33.77
Middlesex	6.85	6.65	123.56
Monmouth	8.03	6.24	112.62
Morris	7.39	4.36	110.67
Passaic	3.98	2.91	58.98
Somerset	4.57	3.12	81.77
Sussex	3.33	1.54	27.00
Union	4.07	2.95	73.86
Warren	1.77	0.96	17.13
Total	**59.75**	**46.09**	**941.93**

1.1.6 NONROAD Model Equipment Emission Reductions

Control measure emission reductions are normally calculated by the difference between the 2017 projection year emissions without post-2011 controls applied (growth only scenario) and the 2017 projection year emissions with all controls applied (controlled scenario). However, the current NONROAD model embedded in MOVES does not readily allow for control technology adjustments to a year different from the designated model run year. Therefore, 2011 year emissions were used for the 2017 projection year growth only scenario. This generally realizes less emission reductions because the 2017 growth only scenario generates greater emissions from six years of growth without application of new control measures after 2011

Emission reductions accrue from rules establishing lower emission standards for nonroad spark and compression ignition engines as described above in Section 1.1.4. Table 2 summarizes the 2017 projection year NONROAD Model equipment emission benefits by county for average summer work week day for VOC, NOx and CO. In this table, negative CO emission reductions have been generated for Hudson County. This is because nonroad CO emission control measures are not as significant as those estimated for NOx and VOC and there is a significant nonroad equipment growth that overcomes CO emission control measures in Hudson County.

Appendix 4-6, Attachment 5 contains the detailed non-road source emission reductions. This attachment is only available electronically.

Table 2
2017 NONROAD Model Equipment Emission Reductions
by County and Pollutant
New Jersey Portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NO_x Tons per Day	CO Tons per Day
Bergen	3.36	3.60	8.92
Essex	1.19	2.15	0.47
Hudson	0.20	1.74	-5.75
Hunterdon	0.52	0.80	1.52
Middlesex	2.20	3.57	8.35
Monmouth	1.30	2.17	0.16
Morris	1.62	2.17	6.90
Passaic	1.05	1.40	2.59
Somerset	1.51	1.63	5.55
Sussex	0.70	0.48	0.03
Union	1.46	1.62	5.12
Warren	0.51	0.41	1.06
Total	**15.61**	**21.73**	**34.93**

1.2 Commercial Marine Vessels (CMV)

For the purpose of emission calculations, CMV engines are divided into three categories based on displacement (swept volume) per cylinder. Category 1 and Category 2 marine diesel engines typically range in size from about 500 to 8,000 kW (700 to 11,000 hp). These engines are used to provide propulsion power on many kinds of vessels including towboats, assist tugs, pushboats, supply vessels, fishing vessels, and other commercial vessels in and around ports. They are also used as stand-alone generators for auxiliary electrical power on vessels. Category 3 marine diesel engines typically range in size from 2,500 to 70,000 kW (3,000 to 100,000 hp). These are very large marine diesel engines used for propulsion power on ocean-going vessels such as container ships, oil tankers, bulk carriers and cruise ships.
The majority of marine vessels are powered by diesel engines that are either fueled with distillate or residual fuel oil blends. For the purpose of emission inventories, USEPA has assumed that Category 3 vessels primarily use residual blends while Category 1 and 2 vessels typically use distillate fuels.

CMV emission inventories for Category 1, 2 and 3 vessels were available from USEPA 2014 National Emission Inventory (NEI).[2] This NEI database included residual and diesel fueled CMV emissions for both the port and underway operation modes of Cruise (C), Maneuver (M), Reduced Speed Zone (Z) and Hoteling (H) that can be configured into CMV Category 1, 2 and 3 vessels emission inventories. This database was matched to GIS ArcInfo shape files for use in plotting emissions.

New Jersey indicated that they had developed CMV emission inventories that they preferred over those provided by USEPA for certain counties. However, these emissions were only available in NEI Input format (NIF) at the county/SCC summary level and not spatially allocated. Thus for consistency, NJDEP mapped the shape files to determine exactly what constituted the port and underway areas in both South and North New Jersey. New Jersey visually determined that the USEPA shape files for the port mainly constituted the docking facilities themselves

[2] U.S. Environmental Protection Agency. 2014 National Emissions Inventory, version 1, Technical Support Documentation, December 2016.

while those for the underway region constituted almost all the waterborne area outside or adjacent to the docking facilities. On this basis and following guidance included in a September 28, 2011 email from Laurel Driver of the USEPA, New Jersey classified all residual fueled (Category 3) vessels not otherwise docked as conducting either a C or Z mode of underway operation and all residual fueled (Category 3) docked vessels as conducting an H mode of port operation. For all diesel fueled (Category 2) vessels, New Jersey classified them as mainly conducting either a C mode of underway operation, and in a few instances where EPA made this determination, as conducting a M mode of port operation. Exhibit 1.2 below provides a summary of these determinations as well as the Source Category Code (SCC) designation of each CMV operation included in the 2017 emission inventory:

Exhibit 1.2
CMV SCC, Description, Mode and Vessel Category

SCC	Description	Emission Mode	Vessel Category
2280002100	Diesel Port	M	Category 1 & 2
2280002200	Diesel Underway	C	Category 1 & 2
2280003100	Residual Port	H or M	Category 3
2280003200	Residual Port	C or Z	Category 3

A description of how CMV emissions were determined for the New Jersey counties included in the New Jersey portion of Northern New Jersey-New York-Connecticut nonattainment area follows below.

1.2.1 New Jersey Portion of the New York Northern New Jersey (NYNNJ) Harbor System

The most significant New Jersey CMV operations occur in the New Jersey portion of the NYNNJ Harbor system. This encompasses the North Jersey counties of Bergen, Hudson, Essex, Union, Middlesex and Monmouth.

CMV emissions for the NYNNJ harbor system were developed from the information included in the CMV Emissions Inventory Report prepared by Starcrest Consulting Group, LLC.[3] This inventory was prepared as a part of the New York Harbor Deepening Project. This report relied on actual operational data, to the extent such information was available, and then used local activity parameters to extend emission estimates to those portions not directly inventoried. Actual operational data was obtained from extensive interviews with vessel operators, crew, pilots, and the United States Coast Guard's vessel traffic system that tracks oceangoing commercial marine vessels from points of origin and destination. From these emission estimates were prepared based on estimated horsepower demand. The original inventory was conducted for the year 2000 and did not consider USEPA Tier 1 or MARPOL control measures for CMV. Therefore, NJDEP needed to grow the emissions to 2017 and then apply USEPA Tier 1/MARPOL control factors to the grown emissions.

1.2.2 CMV Growth Factors

The Port Authority of New York and New Jersey (PANYNJ) Trade Statistics were used to grow the Northern NJ Starcrest emissions from 2000 to 2015. These trade statistics provide the total bulk and general cargo tonnage and the number of motor vehicles and twenty foot equivalent containers (TEUs) delivered to or from Northern Jersey ports from 2000 to 2015. New Jersey then conducted a linear regression analysis based on ten years of trade statistical data to determine trade volume for 2017 or assumed that the 2015 trade volume would remain the

[3] Starcrest Consulting Group, LLC, 2003, "The New York, Northern New Jersey, Long Island Nonattainment Area Commercial Marine Vessel Emissions Inventory"

same if the last few years of data indicated a flat or very small growth. New Jersey divided the amount of cargo, TEUs and cars estimated to be delivered in 2017 or 2015 over those delivered in 2000 to obtain growth factors to be applied to each type of category 3 vessel emissions associated with their delivery to and from the port. This is a direct correspondence because the Starcrest report includes separate emissions for each major type of category 3 vessel that operates in the port. For example, the growth in containers delivered to and from the port from 2000 to 2015 and then adjusted to 2017, relates directly to the growth in containerships and hence the growth in their emissions during this period. Similarly, the growth in bulk and general cargo and cars respectively relates to the growth in category 3 bulk carriers, Roll-On/Roll-Off (RoRo) vessels and car carriers emissions. Regarding category 3 tankers, the growth rate was based on the increase in petroleum products delivered to and from New Jersey from 2000 and 2015 as determined by the Energy Information Administration (EIA), United States Department of Energy. New Jersey assumed that the petroleum product deliveries conducted in 2015 would remain the same for 2017.

The Starcrest report also specifically relates emissions from harborcraft such as assist tug boats to the specific type of OGV that they assist in their harbor maneuvering and docking so that the same OGV growth factors may be applied to them. Regarding towboats, which represent the other major contributor of harbor-craft emissions that operates in the New York and North New Jersey harbor, New Jersey assumed that their growth would relate to the increase in bulk and general cargo from 2000 to 2017. This is because towboats pull or push barges that transport bulk and general cargo.

1.2.3 CMV Category 1 & 2 Engine Control Factors

Once the growth rate was applied, then a control factor for each pollutant was developed based on methodologies documented in three USEPA regulatory impact analyses (RIA). The USEPA's May 2008 RIA (EPA2008a) was used to develop the 2017 projection year inventory for category 1 and 2 vessels (diesel). While the USEPA's December 2009 RIA (EPA2009a) and April 2009 proposal (EPA2009b) was used to develop the 2017 projection year inventory for category 3 vessels (residual).[4,5] In developing their emission projections USEPA considered the following scenarios that accounted for both the 2004 Nonroad diesel rule and the 2008 diesel marine vessel rule:

1. The impact of existing tier 1 and 2 engine regulations that took effect in 2004 and 2007,
2. The 2004 Clean Air Nonroad Diesel Rule that will decrease the allowable levels of sulfur in fuel beginning in 2007,
3. Fleet turnover,
4. The reductions from USEPA's 2008 rule Final Locomotive-Marine rule for tier 3 and 4 engines,
5. The 2008 final rule that includes the first-ever national emission standards for existing marine diesel engines, applying to engines larger than 600kW when they are remanufactured. The rule also sets tier 3 emissions standards for newly-built engines that are phasing in from 2009. Finally, the rule establishes tier 4 standards;
6. For newly-built commercial marine diesel engines above 600kW, phasing in beginning in 2014.

[4] Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. EPA420-R-09-019.
[5] Proposal to Designate an Emissions Control Area for Nitrogen Oxides, Sulfur Oxides, and Particulate Matter. EPA420-R-09-007.

EPA2009a applied the above control measures to develop control factors for category 2 and 1 (diesel) CMV propulsion and auxiliary engines (residual). The control factor was obtained by dividing the USEPA 2017 base year controlled emission factor by the USEPA 2000 controlled emission factor. The 2017 control factors obtained for VOC, NOx and CO are shown below in Exhibit 1.2.3 and a complete listing of the controlled emission factors developed for these engines is included in Appendix 4-6, Attachments 2A & B.

Exhibit 1.2.3
CMV Category 1 & 2 Engine 2017 Control Factors by SCC and Pollutant

CMV	VOC	NOx	CO
Category 1 propulsion (government & harbor maintenance)	0.35	0.42	0.29
Category 1 Auxiliary (tugs, tows & ferries)	0.23	0.34	0.30
Category 2 propulsion (tugs, tows & ferries)	0.13	0.39	0.09

1.2.4 CMV Category 3 Engine Control Factors

In February 2003, the USEPA established standards for Category 3 marine engines manufactured on January 1, 2004 or later.

On March 26, 2010, the International Maritime Organization (IMO) officially designated waters off North American coasts as an emissions control area (ECA) in which stringent international emission standards will apply to ships. In practice, implementation of the ECA means that ships entering the designated area need to use compliant fuel for the duration of their voyage that is within that area, including time in port and voyages whose routes pass through the area without calling on a port. The North American ECA includes waters of the Atlantic Ocean extending up to 200 nautical miles from the east coast of the US. The quality of fuel that complies with the ECA standard will change over time. From the effective date in 2012 until 2015, fuel used by vessels operating in designated areas cannot exceed 1.0 percent sulfur (10,000 ppm). Beginning in 2015, fuel used by vessels operating in these areas cannot exceed 0.1 percent sulfur (1000 ppm). Beginning in 2016, NO_x after treatment requirements become applicable.

In April 30, 2010, USEPA adopted final emission standards under the Clean Air Act for new marine diesel engines with per-cylinder displacement at or above 30 liters (called Category 3 CMV engines) installed on U.S.-flagged vessels. The final engine standards are equivalent to those adopted in the amendments to Annex VI to the International Convention for the Prevention of Pollution from Ships (a treaty called "MARPOL"). The emission standards apply in two stages: near-term standards for newly-built engines will apply beginning in 2011, and long-term standards requiring an 80 percent reduction in NO_x will begin in 2016. USEPA also adopted changes to the diesel fuel program to allow for the production and sale of diesel fuel with no more than 1,000 ppm sulfur for use in Category 3 marine vessels. The regulations generally forbid production and sale of fuels with more than 1,000 ppm sulfur for use in most U.S. waters, unless operators achieve equivalent emission reductions in other ways.

EPA2009a applied the above control measures to develop controlled emission inventories factors for category 3 propulsion engines (residual) CMV. The control factor was obtained by dividing the controlled emission inventory by the uncontrolled emission inventory. These 2017 control factors for NOx, VOC and CO are shown below in Exhibit 1.2.4 and a complete listing of

the controlled and uncontrolled inventories developed for these engines is included in Appendix 4-6, Attachments 2A & B.

Exhibit 1.2.4
Category 3 Engine 2017 Control Factors by SCC and Pollutant

SCC	NOx	VOC	CO
Category 3 propulsion	0.412	0.135	0.036

The Category 3 vessels also possess a Category 2 auxiliary engine. The control factor for this engine was determined by following the procedure included above in Section 1.2.3 for category 2 main propulsion engines.

1.2.5 Commercial Marine Vessel Emission Inventory

Table 3 summarizes the projection year 2017 CMV source emission inventory for summer work week day by county for VOC, NO_x and CO. Appendix 4-6, Attachment 2B contains the detailed CMV emission inventories. This attachment is only available electronically.

Table 3
2017 Commercial Marine Vessel Emission Inventory by County and Pollutant
New Jersey Portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NO_x Tons per Day	CO Tons per Day
Bergen	0.02	0.39	0.09
Essex	0.02	0.58	0.13
Hudson	0.25	4.83	1.17
Hunterdon	0	0	0
Middlesex	0.05	0.76	0.17
Monmouth	0.11	1.66	0.46
Morris	0	0	0
Passaic	0	0	0
Somerset	0	0	0
Sussex	0	0	0
Union	0.25	4.71	1.07
Warren	0	0	0
Total	0.71	12.93	3.10

Specifics on the equations used for the calculation of these emissions, other assumptions and references for data can be found in CMV file included in Appendix 4-6, Attachments 2A & B.

1.2.6 CMV Control Measure Emission Reductions

CMV control measure emission reductions were calculated by the difference between the 2017 projection year emissions without post 2011 controls (growth only scenario) and the 2017 projection year emissions with all controls applied (controlled scenario).

Emission benefits accrue from existing tier 1 to 2 standards that took effect in 2004 and 2007 for category 1, 2 and 3 engines, the long term effects of the May 2008 Final Locomotive-Marine rule tier 3 and 4 standards for category 2 engines, the April 2010 rule on the new tier standards for new category 3 diesel engines, and the implementation of ECA as referenced above in

Sections 1.2.3-4. Emission benefits are summarized below in Table 4 by county for VOC, NOx and CO. Appendix 4-6, Attachment 5 contains the detailed CMV emission benefits. This attachment is only available electronically.

Table 4
2017 CMV Emission Reductions by County, Nonattainment Area (NAA) and Pollutant
New Jersey Portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NO_x Tons per Day	CO Tons per Day
Bergen	0.00	0.12	0.01
Essex	0.00	0.17	0.01
Hudson	0.03	1.32	0.06
Hunterdon	0	0	0
Middlesex	0.01	0.23	0.01
Monmouth	0.00	0.47	0.01
Morris	0	0	0
Passaic	0	0	0
Somerset	0	0	0
Sussex	0	0	0
Union	0.04	1.43	0.07
Warren	0	0	0
Total	**0.08**	**3.74**	**0.16**

1.3 Aircraft

Aircraft emissions in the projection year 2017 emission inventory are available on either a county-by-county or airport-by-airport basis for six types of aircraft operations:

- Air carrier operations represent landings and take-offs (LTOs) of commercial aircraft with seating capacity of more than 60 seats (SCC 22-75-020-000);
- Commuter/air taxi operations are one category. Commuter operations include LTOs by aircraft with 60 or fewer seats that transport regional passengers on scheduled commercial flights. Air taxi operations include LTOs by aircraft with 60 or fewer seats conducted on non-scheduled or for-hire flights (SCC 22-75-060-011 (Piston) or 012 (Turbine));
- General aviation represents all civil aviation LTOs not classified as commercial (SCC 22-75-050-011 (Piston) or 012 (Turbine));
- Military operations represent LTOs by military aircraft (SCC 22-75-001-000);
- Ground Support Equipment (GSE) typically includes aircraft refueling and baggage handling vehicles and equipment, aircraft towing vehicles, and passenger buses (SCC 22-65-008-005 (4-Stroke Gasoline), 22-67-008-005 (LPG), 22-68-008-005 (CNG), 22-70-008-005 (Diesel)); and
- Auxiliary power units (APUs) provide power to start the main engines and run the heating, cooling, and ventilation systems prior to starting the main engines. (SCC 22-75-070-000).

1.3.1 Aircraft Emissions Estimation Methodology

Aircraft emissions were based on 2014 emissions calculated by the USEPA for the 2014 NEI, version 1. Aircraft exhaust, GSE and APU emissions estimates are associated with aircrafts' LTO cycle. LTO data was obtained from the Federal Aviation Agency (FAA) databases. For airports where the available LTO data included detailed aircraft-specific make and model information (e.g., Boeing 747-200 series), the USEPA used FAA's Emission Dispersion Modeling System (EDMS) to estimate 2014 emissions associated with the LTO cycle. For airports where FAA databases do not include such detail, the USEPA used assumptions regarding the percent of these LTOs that were associated with piston-driven (using aviation gas) versus turbine-driven (using jet fuel) aircraft and then applied a USEPA default emission factor to these LTO counts. Details about how USEPA's developed these estimates can be found at https://www.epa.gov/sites/production/files/2016-08/documents/neiair2014_fin.pdf and the estimated LTO counts for each New Jersey Airport are included in the database Point-LTO Estimates used in 2014NEIv1 Aircraft Emission Estimates found at https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-documentation. The emissions determined from these calculations for each airport in New Jersey are included in the USEPA 2014NEIv1.

1.3.2 Airport Growth Factors

Aircraft operations were projected from 2014 to the projection year 2017 by applying activity growth using data on itinerant (ITN) operations at every airport in New Jersey as reported in the Federal Aviation Administration's (FAA) Terminal Area Forecast (TAF) System for 1990-2045.[6] The ITN operations are defined as aircraft LTOs.

The data was aggregated and applied at the county level for the four operation types: commercial, general, air taxi and military. A growth factor was computed for each operation type by dividing inventory year 2017 ITN by 2014-year ITN. Inventory SCCs were assigned factors based on the operation type, as shown in Exhibit 1.3.2.1.

Exhibit 1.3.2: Crosswalk between SCC and FAA Operations Type

SCC	SCC Description	FAA Operation Type Used for Growth Factor
2265008005	Airport Ground Support Equipment, 4-Stroke Gas	Total Itinerant Operations
2267008005	Airport Ground Support Equipment, LPG	Total Itinerant Operations
2268008005	Airport Ground Support Equipment, CNG	Total Itinerant Operations
2270008005	Airport Ground Support Equipment, Diesel	Total Itinerant Operations
2275001000	Aircraft /Military Aircraft /Total	Itinerant Military Operations
2275020000	Aircraft /Commercial Aircraft /Total: All Types	Itinerant Air Carrier Operations
2275050011	Aircraft /General Aviation /Piston	Itinerant General Aviation Operations
2275050012	Aircraft /General Aviation /Turbine	Itinerant General Aviation Operations
2275060011	Aircraft /Air Taxi /Piston	Itinerant Air Taxi Operations
2275060012	Aircraft /Air Taxi /Turbine	Itinerant Air Taxi Operations
2275070000	Aircraft /Aircraft Auxiliary Power Units /Total	Total Itinerant Operations

[6] Federal Aviation Administration, Terminal Area Forecast 2009-2030 Database File

1.3.3 Aircraft Control Factors

The NO_x aircraft engine emissions standards adopted by USEPA in November 2005 were reviewed.[7] The standards are equivalent to the NO_x emission standards (adopted in 1999 for implementation beginning in 2004) of the United Nations International Civil Aviation Organization (ICAO), and will bring the US aircraft standards into alignment with the international standards. The standards apply to new aircraft engines used on commercial aircraft including small regional jets, single-aisle and twin-aisle aircraft, and 747s and larger aircraft. The standards also apply to general aviation and military aircraft, which sometimes use commercial engines. For example, small regional jet engines are used in executive general aviation aircraft, and larger commercial aircraft engines may be used in military transport aircraft.

Nearly all previously certified or in-production engine models currently meet or perform better than the standards USEPA adopted in the November 2005 rule. In addition, manufacturers have already been developing improved technology in response to the ICAO standards. According to USEPA's recent analysis for the proposed transport rule, this rule is expected to reduce NO_x emissions by approximately two percent in 2015 and three percent in 2020.[8] Because of the relatively small amount of NO_x reductions, our aircraft emission projections assume a control factor of one between 2014 and 2017.

1.3.4 Aircraft Emission Inventory

Table 5 summarizes the projection year 2017 aircraft source operation emission inventory that includes all 11 types of aircraft operations by summer work week day by county for VOC, NO_x and CO. Appendix 4-6, Attachment 3 contains the detailed aircraft emission inventories. This attachment is only available electronically.

Table 5
2017 Aircraft Emission Inventory by County and Pollutant
New Jersey Portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NOx Tons per Day	CO Tons per Day
Bergen	0.07	0.06	1.29
Essex	1.23	7.82	9.88
Hudson	0.00	0.00	0.01
Hunterdon	0.01	0.01	0.54
Middlesex	0.00	0.00	0.13
Monmouth	0.02	0.01	0.52
Morris	0.03	0.02	0.77
Passaic	0.00	0.00	0.17
Somerset	0.02	0.01	0.74
Sussex	0.01	0.01	0.44
Union	0.01	0.01	0.34
Warren	0.01	0.00	0.38
Total	**1.43**	**7.95**	**15.21**

[7] U.S. Environmental Protection Agency. Control of Air Pollution from Aircraft and Aircraft Engines, Emission Standards and Test Procedures: Final Rule. November 17, 2005.
[8] U.S. Environmental Protection Agency. Transport Rule Emission Inventories Notice of Data Availability (NODA). Docket ID No. EPA-HQ-QAR-2009-0491. October 27, 2010.

Specifics on the equations used for the calculation of these emissions, other assumptions and references for data can be found in the Aircraft file included in Appendix 4-6, Attachment 3.

1.3.5 Aircraft Control Measure Emission Reductions

Aircraft emission reductions were considered to be zero because of the de minimis NO_x emission reductions that occur after 2017 as explained above in Section 1.3.3.

1.4 Railroad Diesel Locomotives

Railroad diesel locomotive engines are classified into the following categories:

- Class I line haul locomotives are operated by large freight railroad companies and are used to power freight train operations over long distances (SCC 22-85-002-006);
- Class II/III line haul locomotives are operated by smaller freight railroad companies and are used to power freight train operations over long distances (SCC 22-85-002-007);
- Inter-city passenger train locomotives are operated primarily by Amtrak to provide inter-city passenger transport (SCC 22-85-002-008);
- Independent commuter rail systems operate locomotives provide passenger transport within a metropolitan area (SCC 22-85-002-009); and
- Yard/switch locomotives are used in freight yards to assemble and disassemble trains, for short hauls of trains that are made up of only a few cars (SCC 22-85-002-010).

1.4.1 Class I/II/III Line Haul, Yard, Commuter and Passenger Diesel Locomotives

USEPA has developed fuel usage based emission factors for each of the above referenced locomotive engine categories for every year from 2006 to 2040.[9] New Jersey developed its emission inventory for these categories by applying 2017 emission factors to 2014 fuel usage data grown to 2017 as discussed below in section 1.4.3. This data was obtained from Class I/II/III line haul and independent commuter rail systems and yard/switch freight and commuter rail yards. Some Class III railroads did not provide any information. Therefore, fuel usage data that was previously provided in 2007 or 2011 had to be used instead. This data was assumed to be equivalent to their 2014 usage. Also, an estimation of fuel consumption based on gross tons miles (tons of freight and number of cars multiplied by the miles traveled) and a fuel consumption index (gross ton miles per gallon of fuel) was prepared for Class 1 Norfork Southern railroad to convert its fuel refueling activity in New Jersey to actual consumption in New Jersey.

Regarding passenger locomotive emissions (AMTRAK), AMTRAK only used electric powered locomotives on the Northeast corridor line in New Jersey. These electric engines do not generate any emissions.

1.4.2 Railroad Diesel Locomotives Hydrocarbon Emissions

Both Class I and Class II/III emissions were reported as hydrocarbons (HC). These emissions were converted to VOC emissions by multiplying the HC emissions by a factor of 1.053.[10]

[9] Emission Factors for Locomotives, EPA-420-F-09-025, April 2009
[10] U.S. Environmental Protection Agency. Emission Factors for Locomotives; EPA-420F09025, 2009.

1.4.3 Railroad Diesel Locomotives Growth Factors

In March 2008, USEPA finalized a three part diesel locomotive rule that will dramatically reduce emissions from diesel locomotives of all types -- line-haul, switch, and passenger rail. As part of this work, USEPA performed a Regulatory Impact Analysis (RIA) in May 2008 (EPA2008a), to document the methodologies it utilized to develop the baseline (pre-control) and controlled diesel locomotive emissions included in the national emissions inventory for calendar years 2002 through 2040.[11] These projection methodologies used 2006 Annual Energy Outlook energy use projection data from the U.S. Department of Energy, Energy Information Administration (EIA2006).[12] This data showed that freight rail energy use will grow 1.6 percent annually on a national basis. New Jersey used this growth rate for all diesel locomotive operations.

1.4.4 Railroad Diesel Locomotives Control Measures

USEPA specific year diesel locomotive emission factors referenced in Section 1.4.1 above decreased from 2011 to the projection year 2017 because of the application of the following USEPA Control Measures:

1. The impact of existing regulations for Tier 0, 1, and 2 locomotive engines that took effect in 2008,

2. The 2004 Clean Air Nonroad Diesel Rule that will decrease allowable levels of sulfur in locomotives fuel beginning in 2007,

3. Fleet turnover.

4. Reductions from USEPA's 2008 Final Locomotive-Marine rule for Tier 3 and 4 engines. This rule lowered diesel sulfur content and tightened emission standards for existing and new locomotives.
5. Voluntary retrofits under the National Clean Diesel Campaign are not included in these projections.

1.4.5 Railroad Diesel Locomotive Emission Inventory

Table 6 summarizes the projection year 2017 railroad diesel locomotive emission inventory for the summer work week day by county for VOC, NOX and CO. Appendix 4-6, Attachment 4B contains the detailed railroad source emission inventories. This attachment is only available electronically.

[11] U.S. Environmental Protection Agency. Regulatory Impact Analysis: Control or Emissions of Air Pollution from Locomotive Engines and Marine Compression Engines Less than 30 Liters Per Cylinder. EPA420-R-08-001a. May 2008.
[12] U.S. Department of Energy, Energy Information Administration, Table A-7, Annual Energy Outlook with Projections to 2030 document, DOE/EIA-0383. February 2006.

Table 6
2017 Railroad Diesel Locomotive Emission Inventory by County and Pollutant
New Jersey Portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NO_x Tons per Day	CO Tons per Day
Bergen	0.08	1.88	0.44
Essex	0.07	1.17	0.19
Hudson	0.05	1.03	0.21
Hunterdon	0.02	0.58	0.14
Middlesex	0.04	0.83	0.15
Monmouth	0.04	0.90	0.21
Morris	0.02	0.49	0.11
Passaic	0.02	0.50	0.12
Somerset	0.03	0.74	0.17
Sussex	0.00	0.04	0.01
Union	0.05	0.89	0.17
Warren	0.00	0.09	0.02
Total	**0.43**	**9.14**	**1.94**

Specifics on the equations used for the calculation of these emissions, other assumptions and references for data can be found in the Railroad file included in Appendix 4-6, Attachments 4A & B.

1.4.6 Railroad Diesel Locomotives Control Measure Emission Reductions

Railroad diesel locomotive control measure emission reductions were calculated by the difference between the 2017 projection year emissions without post 2011 controls applied (growth only scenario) and the 2017 projection year emissions with all controls applied (controlled scenario). Multiplication of 2011 specific locomotive emission factors referenced above in Section 1.4.1 to locomotive fuel use data grown to 2017 determined the growth only scenario. The controlled scenario is the controlled 2017 projection year emissions referenced above in Section 1.4.1 wherein a 2017 specific locomotive emission factor is applied to the locomotive fuel use data grown to 2017. An emission benefit is achieved because 2017 emission factors are less than those for 2011.

Emission reductions accrue from existing tier 0 to 2 engine standards that took effect in 2008 and the long term effects of the May 2008 Final Locomotive-Marine rule for Tier 3 and 4 engines. Emission benefits are summarized below in Table 7 for summer work week day by county for VOC, NO_x and CO. Appendix 4-6, Attachment 5 contains the detailed railroad emission benefits. This attachment is only available electronically.

Table 7
2017 Railroad Diesel Locomotive Emission Reductions by County and Pollutant
New Jersey Portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NO_x Tons per Day	CO Tons per Day
Bergen	0.06	0.82	0
Essex	0.01	0.16	0
Hudson	0.03	0.37	0
Hunterdon	0.02	0.24	0
Middlesex	0.01	0.21	0
Monmouth	0.03	0.43	0
Morris	0.02	0.23	0
Passaic	0.02	0.23	0
Somerset	0.02	0.28	0
Sussex	0.00	0.01	0
Union	0.02	0.29	0
Warren	0.00	0.03	0
Total	**0.23**	**3.30**	**0**

1.5.1 Total Nonroad Emission Inventory

Table 8 summarizes NONROAD model equipment, CMV, Aircraft and Locomotive sources projection year 2017 emission inventory for summer work week day by county for VOC, NO_x and CO. Appendix 4-6, Attachment 5 contains the detailed nonroad source emission inventories. This attachment is only available electronically.

Table 8
Total 2017 Non-road Source Emission Inventory by County and Pollutant
New Jersey Portion of Northern NJ-NY-CT Nonattainment Area

County	VOC Tons per Day	NO_x Tons per Day	CO Tons per Day
Bergen	10.19	9.94	187.86
Essex	5.21	13.62	81.49
Hudson	3.67	9.69	46.63
Hunterdon	2.52	2.45	34.44
Middlesex	6.94	8.25	124.00
Monmouth	8.20	8.81	113.82
Morris	7.43	4.86	111.55
Passaic	4.01	3.41	59.26
Somerset	4.62	3.87	82.69
Sussex	3.34	1.59	27.45
Union	4.38	8.56	75.46
Warren	1.79	1.06	17.53
Total	**62.31**	**76.11**	**962.18**