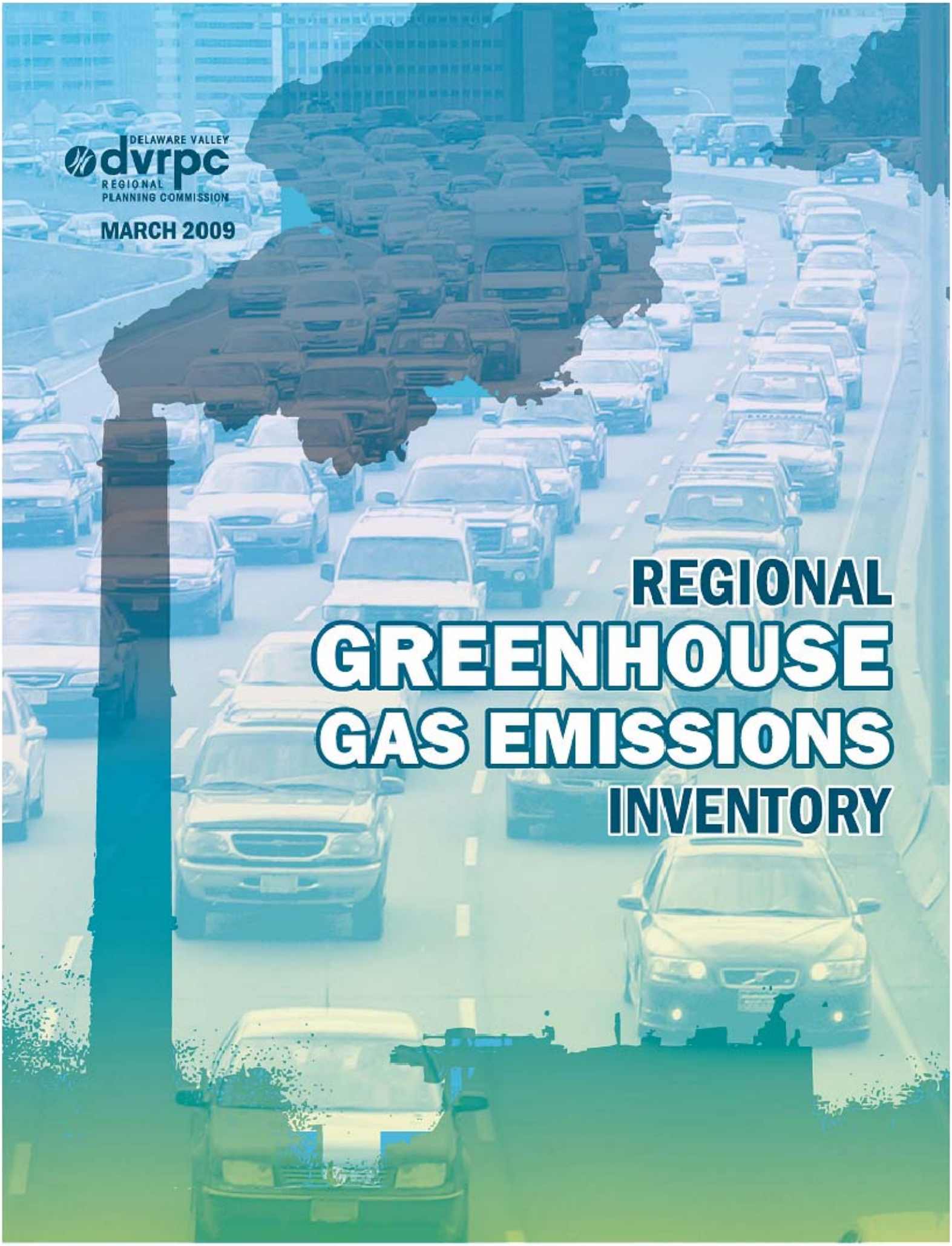

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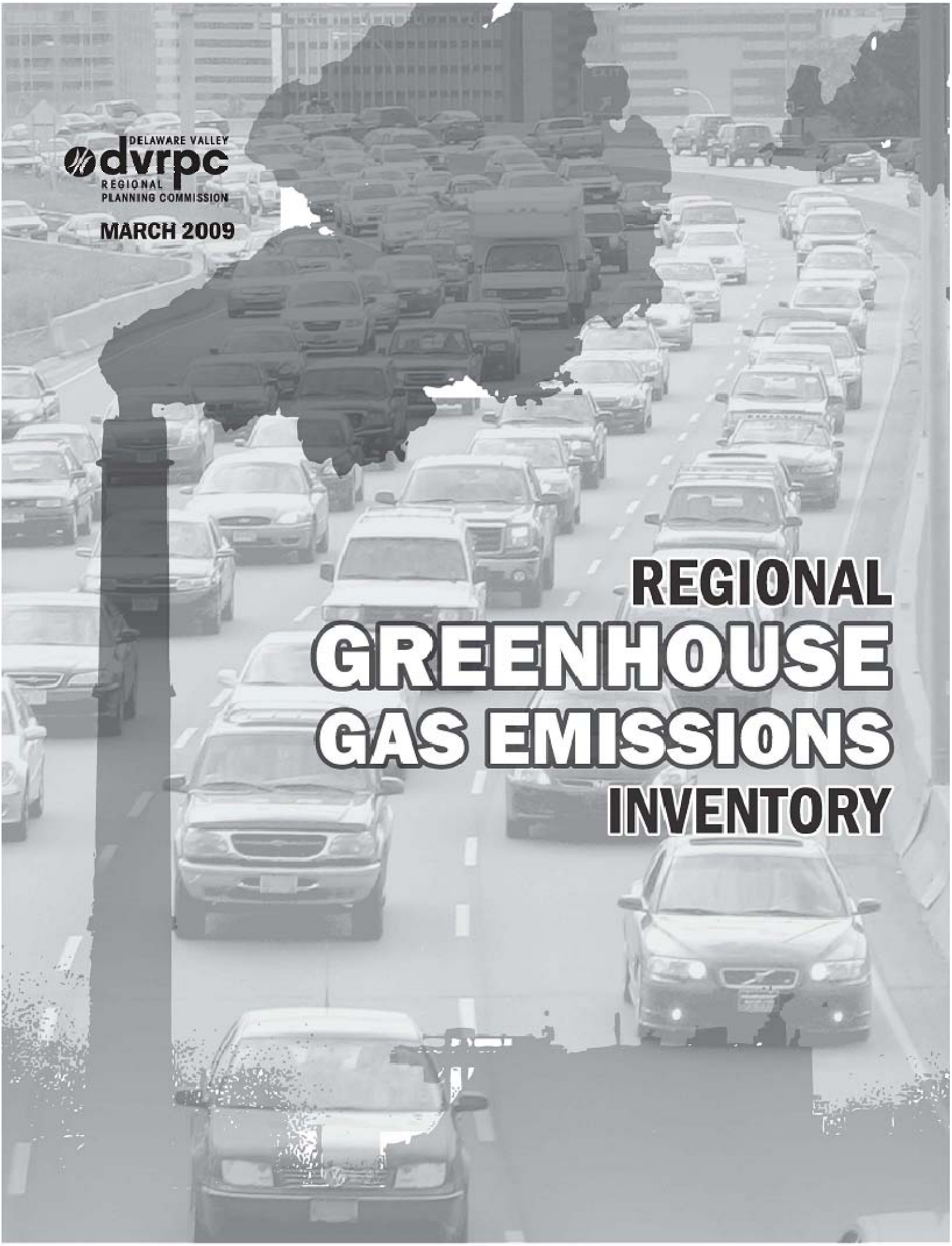
MARCH 2009

REGIONAL GREENHOUSE GAS EMISSIONS INVENTORY

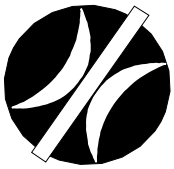


DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

MARCH 2009

REGIONAL GREENHOUSE GAS EMISSIONS INVENTORY

The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals and the public with a common vision of making a great region even greater. Shaping the way we live, work and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region - leading the way to a better future.



Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole, while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for its findings and conclusions, which may not represent the official views or policies of the funding agencies.

DVRPC fully complies with Title VI of the Civil Rights Act of 1964 and related statutes and regulations in all programs and activities. DVRPC's website may be translated into Spanish, Russian and Traditional Chinese online by visiting www.dvrpc.org. Publications and other public documents can be made available in alternative languages and formats, if requested. For more information, please call (215) 238-2871.

ACKNOWLEDGEMENTS

The form and content of the Regional Greenhouse Gas Emissions Inventory was shaped through a series of meetings and consultations with an advisory group and other stakeholders. Appendix B contains a list of the individuals who participated in one or more meetings of the Greenhouse Gas Emissions Inventory Advisory Group or otherwise provided or facilitated feedback and guidance as the inventory was being prepared

Assistance on methodology development, data development, calculations, and report drafting was provided by a team at ICF International, Incorporated, led by Anne Choate and Phil Groth.

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EXECUTIVE SUMMARY

There is overwhelming consensus within the global scientific community that the earth's climate is changing due in large part to atmospheric changes attributable to human activity. In order to provide regional leadership on this important issue, the Board of Commissioners of the Delaware Valley Regional Planning Commission (DVRPC), the metropolitan planning organization for the nine county Greater Philadelphia region,[1] established a Climate Change Initiatives program area.

The first task in this program area was to inventory greenhouse gas (GHG) emissions in the region. Identifying and quantifying the emissions sources in the region is a key first step to developing strategies for reducing emissions. This effort was accompanied by the allocation of the inventory to each of the region's nine counties and 352 municipalities.

The base year for this analysis is 2005. Greenhouse gas emissions, measured in metric tons of carbon dioxide equivalent ($MTCO_2E$), are calculated for energy used in the residential, commercial, and industrial sectors, as well as the transportation sector, which includes on-road transportation, passenger and freight rail, aviation, marine transportation, and off-road vehicles. Emissions resulting from waste management (solid waste and wastewater), agriculture processes (both animal and plant related), non-energy-related emissions from industrial processes, and fugitive emissions from fuel systems (natural gas systems and petroleum systems) are also included.

Within the DVRPC region, these sectors resulted in emissions of 90.3 million metric tons of carbon dioxide equivalent ($MMTCO_2E$) in 2005. Over 91 percent of these emissions resulted from energy consumption, including stationary energy consumption by the residential, commercial, and industrial sectors, and mobile energy consumption from the transportation sector. Waste management and industrial processes each accounted for an additional 3 percent of total emissions. When the net change in carbon stocks in the region's trees is taken into account, the region's total emissions are slightly higher, at 90.4 $MMTCO_2E$.[2]

Together, regional emissions accounted for about 1.2 percent of gross national emissions. With 1.9 percent of the nation's population in 2005, per capita emissions in the DVRPC region were about one third lower than in the nation as a whole. This is largely due to the region's lower per capita commercial and industrial energy consumption, on-road mobile emissions, and agricultural emissions.

The results from allocation of emissions to the municipal level clearly demonstrate that municipalities with higher density tend to produce lower per capita emissions.

The report begins with an overview of the 2005 Baseline Inventory, and follows with a discussion of the methods and data used to estimate 2005 emissions. It continues with a discussion of the methods used to allocate the inventory to the region's municipalities. The report contains an appendix that presents the results of the allocation by county and municipality and an appendix listing participants in the inventory advisory group and other stakeholders.

DVRPC will use this inventory in its work to develop policies and programs for the region to reduce greenhouse gas emissions. DVRPC will also use this inventory to support inventory efforts at the county and municipality level, as well as to support regional analysis of where investments in energy conservation and efficiency might be most productively made.

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[1] Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; Burlington, Camden, Gloucester, and Mercer in New Jersey.

[2] The emissions source category of *land use, land use change, and forestry* is generally handled separately from other emissions sources, as in some geographies, such as the United States as a whole, it is a net negative, removing CO_2 from the atmosphere. This is discussed in the report.

1 2005 BASELINE INVENTORY

The Delaware Valley Regional Planning Commission (DVRPC), comprised of nine counties in Pennsylvania and New Jersey, including the City of Philadelphia, resolved to inventory greenhouse gas (GHG) emissions in the region. This effort was initiated at the request of the DVRPC Board of Commissioners in support of regional efforts to quantify and ultimately reduce emissions associated with climate change. This effort was accompanied by the allocation of the inventory to each of the region's nine counties and 352 municipalities.

1.1 What is a Greenhouse Gas Emissions Inventory and Why is it Important?

A greenhouse gas inventory is **an accounting of greenhouse gases emitted to or removed from the atmosphere over a period of time** (e.g., one year). Policy makers use inventories to track emission trends, develop strategies and policies to reduce greenhouse gas emissions, and assess progress. Scientists use them as inputs to atmospheric and economic models. An inventory begins with a defined baseline year.

An inventory can help with any or all of the following tasks:

- Identifying the greatest sources of greenhouse gas emissions within a particular geographic region.
- Understanding emission trends.
- Quantifying the benefits of activities that reduce emissions.
- Establishing a basis for developing an action plan.
- Tracking progress in reducing emissions.
- Setting goals and targets for future reductions.

Because it's hard to manage what's not measured, developing an inventory is usually the first step taken by states, regions, and localities—as well as organizations—that want to reduce their greenhouse gas emissions.

1.2 Key Steps and Issues in Establishing an Inventory

At its most basic, a greenhouse gas inventory is carried out by identifying activities that are responsible for greenhouse gas emissions, ascertaining the level of each activity, and then calculating the associated greenhouse gas emissions.[3] In order to determine the greenhouse gas emissions from driving a standard gasoline-powered car, for example, one needs to know how many miles are driven and the quantity of emissions generated per mile.

Each of these steps—defining the activities, measuring the level of the activity, and determining the consequent emissions—must be carefully defined in order to result in a credible, transparent, and easily reproducible inventory. To achieve this, DVRPC has based the inventory methodology on established guidelines, or protocols, wherever possible. While there are well-established protocols for carrying out a GHG emissions inventory at the state and municipal level, there is as yet no such protocol established for carrying out an inventory at the metropolitan area level. As DVRPC was initiating this project, US EPA headquarters expressed an interest in having DVRPC's efforts align with an ongoing effort to develop just such an emissions protocol. As such, this work has benefitted from, and provided benefit to, the development of a national standard protocol for metropolitan area inventories.[4]

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[3] For a detailed overview of greenhouse gas emissions inventory work, see: US EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*, April 2007. Available for download at: http://epa.gov/climatechange/emissions/usinventoryreport.html

[4] See: *Draft Regional Greenhouse Gas Inventory Guidance*, U.S. Environmental Protection Agency, Municipal Clean Energy Program, State and Local Branch, January 20, 2009.

The process of designing an inventory entails a number of decisions and procedural steps:

- **Inventory geography and boundaries:** The geography for this inventory is that of the nine-county DVRPC region (see Figure 1). As will be seen below, this inventory includes emissions from electricity imported into the region and from emissions from waste that is exported from the region. Product life-cycle emissions (e.g., emissions associated with the production and distribution from imported goods and services) are not included.

Figure 1. The DVRPC Region

- **Scope:** The activities selected for the regional inventory are based on those defined by the US Environmental Protection Agency and the Intergovernmental Panel on Climate Change. These categories are:
  - **Stationary Energy Consumption**—use of energy in homes, businesses, and other non-mobile uses;
  - **Mobile Energy Consumption**—use of energy in transportation, including on-road transportation, passenger and freight rail, aviation, marine transportation, and off-road vehicles;
  - **Agriculture**—non-energy emissions from agriculture, including both crops and livestock (e.g., methane emissions associated with livestock and nitrous oxide emissions associated with fertilizer application);
  - **Waste Management**—non-energy emissions related to managing solid waste, including trash and wastewater (e.g., methane emissions associated with the anaerobic decay of waste disposed of in landfills);
  - **Industrial Processes**—non-energy emissions associated with industrial activity (e.g., carbon dioxide emissions associated with cement production or emissions associated with coolants for air conditioners);
  - **Fugitive Emissions from Fuel Systems**—leakages in the production, distribution, and transmission of fossil fuels (e.g., methane leaks from natural gas transmission and distribution), and;
  - **Land Use, Land Use Change, and Forestry**—emissions from changes in the amount of carbon stored in soil and plants due to land use and forestry practices (e.g., from clearing forest land for residential, commercial, or agricultural use).
- **Greenhouse gases included:** In its 2005 national greenhouse gas emissions inventory, the US Environmental Protection Agency evaluated the impact of seventeen gases as contributing to changes in the atmosphere to trap heat. In this inventory, DVRPC evaluates the impact of the three gases which together comprise 98 percent of national emissions: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), as well as HFCs, PFCs, and SF_6 emissions from the substitution of ozone depleting substances.[5] Together, these greenhouse gases accounted for 99.5 percent of national greenhouse gas emissions in 2005.[6]

[5] Different greenhouse gases have different capacities to trap heat in the atmosphere. In order to compare and sum the impacts of different gases, the United Nations' Intergovernmental Panel on Climate Change (IPCC) developed the Global

- **Quantification approach:** As detailed in Section 2 of this document, this inventory uses a blend of top-down data (e.g., state fuel consumption estimates) and bottom-up data (customer utility data). This mix was dictated by data availability, existing protocols, and resource limitations.
- **Level of effort:** Emissions inventories are never completely accurate (better data is always available with more effort) and are never finished (the mix of activities is always changing). Given limited resources, DVRPC directed its resources most intently toward inventorying the largest sources of emissions, and those sources that regional and sub-regional policies can help reduce.
- **Base year:** The base year for this analysis is 2005. 2005 was selected because it is the most current year for DVRPC's land use data, and population and employment estimates. In addition, 2005 was the most recent year available for a significant amount of other government-provided data (e.g., electricity generations emissions data). 2005 was also selected as it appeared to align with base years of several local inventories taking place in the region, and sets the rhythm for a five-year update cycle.
- **Engaging stakeholders**: DVRPC felt it was essential to engage regional stakeholders in the development of the inventory from the outset, to provide valuable input on establishing a baseline, provide data and information on data resources, build confidence in the methodologies used, provide input on key methodological and data questions, and build awareness of the inventory. DVRPC formed a regional greenhouse gas emissions advisory group, comprised of approximately 100 individuals, representing municipalities, counties, community groups, activists, the business community, state government (both PA and NJ), neighboring MPOs, and the federal government.[7]
- **Certification**: In some instances it may be appropriate for an inventory to go through a third-party review and certification process to assure that the inventory is high quality and that it is complete, consistent, and transparent. This may be required, for example, for a facility-level inventory that may serve as the basis for generating tradable carbon reduction certificates. Because the purpose of this inventory is informing public policy, and because the raw data was obtained from public or quasi-public sources, DVRPC did not deem it necessary to obtain such certification.

All emissions are reported in metric tons of carbon dioxide equivalent ($MTCO_2E$) or million metric tons of carbon dioxide equivalent ($MMTCO_2E$). A metric ton is 1,000 kilograms, or 2,206 pounds – about 10 percent larger than the 2,000 pound ton commonly used in the United States.

1.3 Emissions Summary

Within the DVRPC planning region, gross emissions of greenhouse gases totaled 90.3 million metric tons of carbon dioxide equivalent ($MMTCO_2E$) in 2005. These emissions are summarized in Table 1, below. When the small amount of carbon emitted from the net loss of trees is included, net emissions were estimated to be 90.4 $MMTCO_2E$. Over 92 percent of the gross emissions resulted from energy consumption, including stationary energy consumption by the residential, commercial, and industrial sectors, and mobile energy consumption from the transportation sector. Waste management and industrial processes each accounted for an additional 3 percent of total emissions, while agriculture, fugitive

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Warming Potential (GWP) concept, where the GWP of each greenhouse gas is compared to that of CO_2, whose GWP is defined as 1. The GWP of methane (CH_4) is 21, and nitrous oxide (N_2O) is 310. GWPs for some gases are much higher—the GWP for SF_6, for example is 23,900. For more information, see US EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*, April 2007, page ES-2.

[6] US EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*, April 2007, page ES-5.

[7] Advisory group participants and other stakeholders consulted are listed in Appendix B of this report.

emissions from fuel systems, and emissions resulting from loss of forest land together contributed an additional 2.5 percent.

Table 1. Summary of DVRPC Regional Greenhouse Gas Emissions—2005

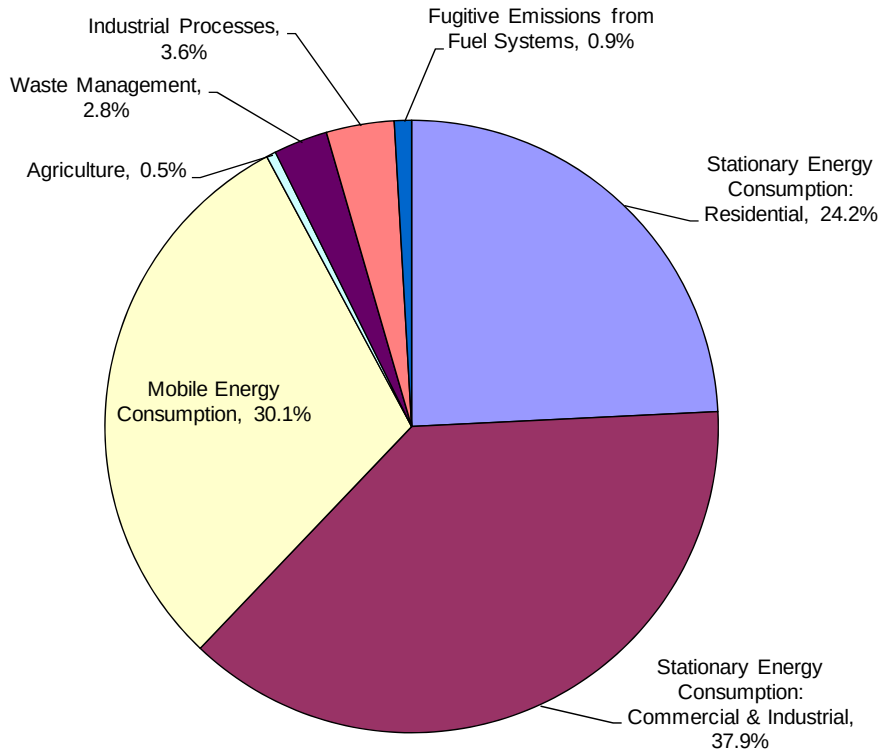
Emissions Source Category	Emissions ($MMTCO_2E$)	Percent of Total
Stationary Energy Consumption—Residential	21.9	24.2%
Stationary Energy Consumption—Commercial & Industrial	34.2	37.9%
Mobile Energy Consumption	27.1	30.1%
Agriculture	0.5	0.5%
Waste Management	2.6	2.8%
Industrial Processes	3.2	3.6%
Fugitive Emissions from Fuel Systems	0.8	0.9%
Gross Emissions	**90.3**	**100%**
Land Use, Land Use Change, and Forestry[8]	0.2	
Net Emissions	**90.4**	

Source: DVRPC, 2009

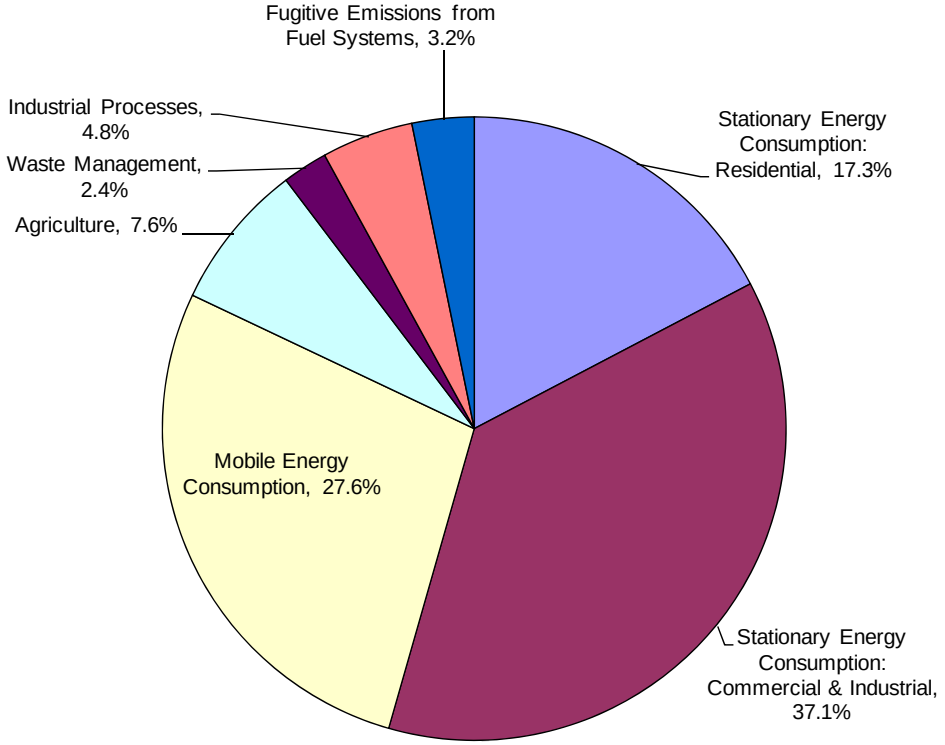
In Figure 2 below, each slice on the graph represents a single emissions source category. The size of the slice represents emissions from a given source category as a percentage of gross emissions. The relative contribution of each source category to total emissions in the DVRPC region is shown beside a similar graph for the United States. Note that the contribution of some source categories in the region, such as combustion of fuel for mobile sources, is similar to the contribution of those same source categories at the national level. In other cases, like agriculture, the relative share of emissions is quite different.

[8] The category of land use, land use change, and forestry is generally discussed separately from other emissions sources, in part because for some geographies, such as the United States as a whole, it is a net negative, removing CO_2 from the atmosphere. This is discussed below.

Figure 2. Relative Contribution of Emission Sources to Total DVRPC and National GHG Emissions by Source Category—2005



DVRPC Region

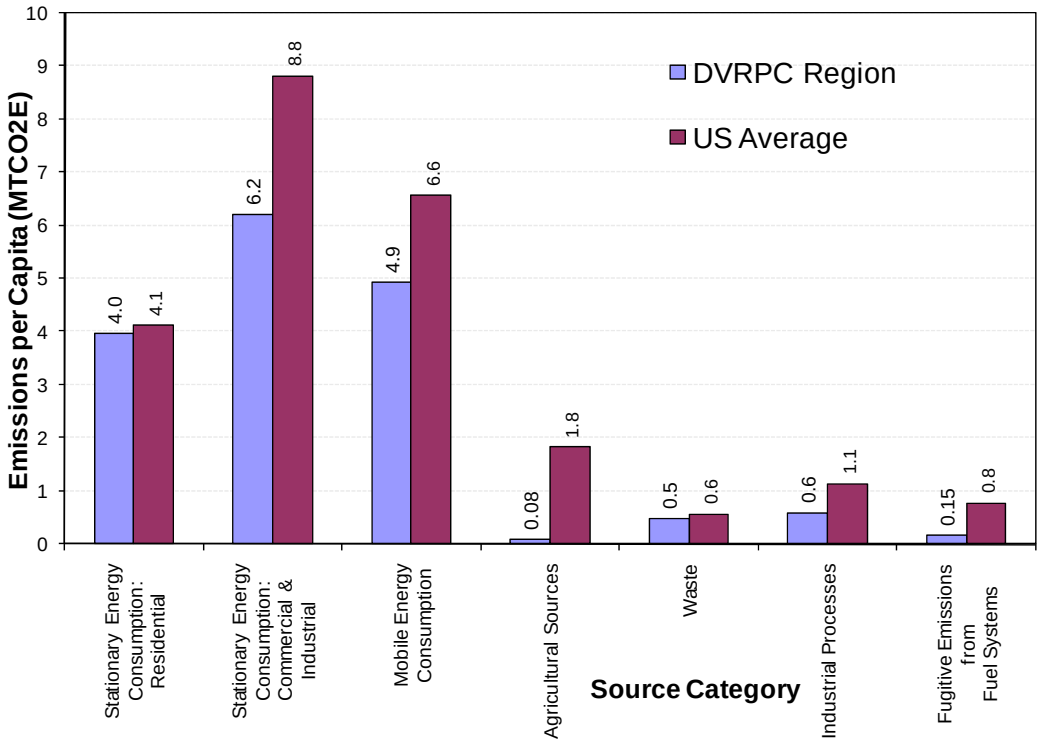


United States

Source: DVRPC, 2009

Figure 3 presents the per capita emissions by source category for both the region and the nation. The region's per capita gross emissions of 16.5 $MTCO_2E$ per person are one third lower than the national average of 24.5 $MTCO_2E$ per capita. This difference is driven largely by the region's lower per capita transportation, commercial/industrial, and agricultural emissions.

Figure 3. Comparison of 2005 DVRPC and National Per Capita Emissions, by Source Category ($MTCO_2E$)



Source: DVRPC, 2009

The remainder of this section provides additional details on emissions from each of the source categories summarized above. The percentage at the end of each heading indicates the portion of regional emissions from that source category. Details on the methodology used for each source category is included in the following section.

1.4 Stationary Energy Consumption—Residential, Commercial, and Industrial (62.1%)

The source category "stationary energy consumption" includes emissions from residential, commercial, and industrial activities in the DVRPC planning region. This includes direct emissions from the combustion of natural gas, coal, kerosene, distillate, motor gasoline and other fuels, as well as indirect emissions from electricity consumption. To avoid double-counting, fuels combusted for the generation of electricity are excluded from the estimates of direct emissions, as they are accounted for as indirect emissions from electricity consumption. Residential energy consumption contributed 24.2 percent of total regional emissions. By contrast, residential energy consumption constituted just 17.3 percent of national emissions, although residential emissions on a per capita basis are slightly lower in this region.

Commercial and industrial energy consumption are reported together due to co-mingled utility data. As a percent of total regional emissions, commercial and industrial emissions were also slightly higher than the national values, at 37.9 percent versus 37.1 percent of total emissions, although again per capita emissions are lower in the region as compared to national averages.

Emissions from these sectors are detailed in Table 2 and Table 3 below.

Table 2. GHG Emissions from Residential Energy Consumption—2005

Source	Fuel Type	Emissions $MTCO_2E$
Direct Emissions	Natural Gas	6.6
	Coal	0.003
	Distillate Fuel Oil	2.3
	Kerosene	0.2
	LPG	0.2
Indirect Emissions	Purchased Electricity	12.5
Total		**21.9**
	Percent of region	24.2%
	Percent for nation	17.3%
Per capita ($MTCO_2E$/person)	Region	4.0
	U.S.	4.1

Source: DVRPC, 2009

Table 3. GHG Emissions from Commercial and Industrial Consumption—2005

Source	Fuel Type	Emissions $MTCO_2E$
Direct Emissions	Natural Gas	7.6
	Coal	0.2
	Petroleum Coke	1.5
	Distillate Fuel Oil	1.7
	Residual Fuel	0.5
	Kerosene	0.2
	LPG	0.2
	Other fuels	1.0
Indirect Emissions	Purchased Electricity	21.3
Total		**34.2**
	Percent of region	37.9%
	Percent for nation	37.1%
Per capita ($MTCO_2E$/person)	Region	6.2
	U.S.	8.8

Source: DVRPC, 2009

1.5 Mobile Energy Consumption (30.1%)

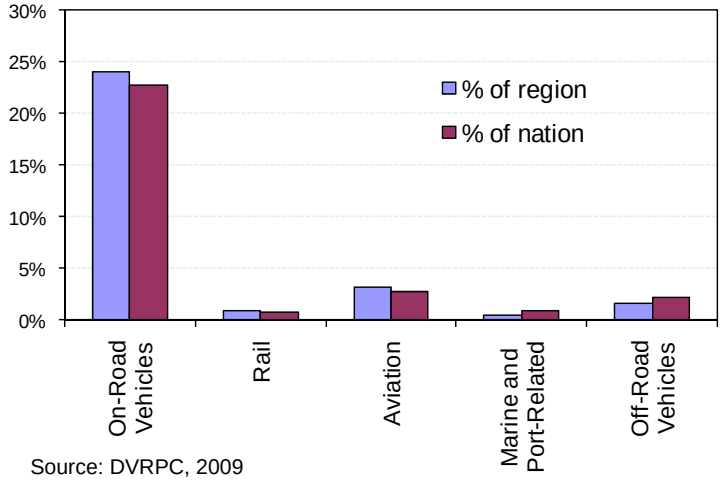
Fossil fuels used to power cars, trucks, mass transit, passenger and freight rail, aviation, and marine transport in the planning region resulted in emissions of approximately 27.1 $MMTCO_2E$ in 2005, representing 30.1 percent of total emissions. A summary of major mobile sources is presented in Table 4 below, while additional detail regarding on-road mobile sources is presented in Table 5. As shown in Figure 4 below, the region's mobile GHG emissions align very closely with national emissions as a percent of total emissions, though the per capita emissions are significantly lower than the nation as a whole.

Table 4. Summary of GHG Emissions from Mobile Sources—2005

Source		Emissions MMTCO$_2$E
On-Road		21.8
Rail		0.8
Aviation		2.8
Marine & Port-Related		0.4
Off Road Vehicles		1.4
Total		**27.1**
	Percent of region	30.1%
	Percent for nation	27.6%
Per capita (MTCO$_2$E/person)	Region	4.9
	U.S.	6.6

Source: DVRPC, 2009

Figure 4. Mobile Energy Consumption – DVRPC vs. National GHG Emissions—2005



Source: DVRPC, 2009

Table 5. Detailed GHG Emissions from On-Road Mobile Sources—2005

Vehicle Type		Emissions MMTCO$_2$E
Light-duty gas vehicles		7.2
Light-duty gas trucks		9.7
Heavy-duty gas vehicles		1.0
Light-duty diesel vehicles		0.01
Light-duty diesel trucks		0.03
Heavy-duty diesel vehicles		3.7
Motorcycles		0.04
Public transit buses		0.06
Total		**21.8**
	Percent of region	24.1%
	Percent for nation	22.8%
Per capita (MTCO$_2$E/person)	Region	3.9
	U.S.	6.6

Source: DVRPC, 2009

1.6 Agricultural Sources (0.5%)

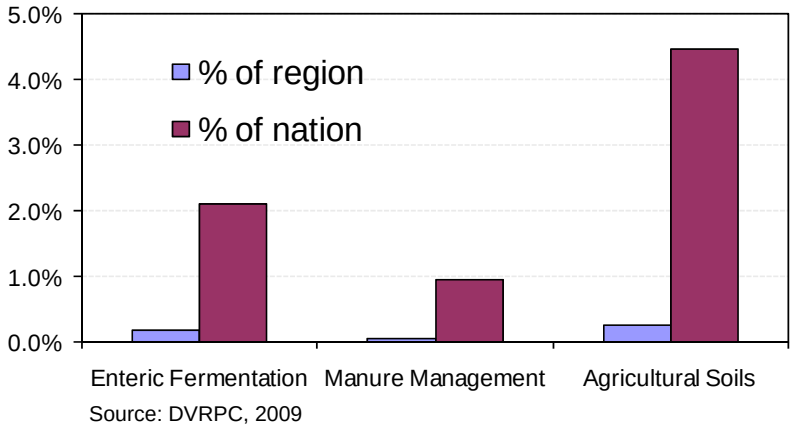
Sources of GHG emissions in the agricultural sector include enteric fermentation, manure management, and agricultural soils. Combined, these sources account for 0.45 $MMTCO_2E$, one-half percent of the region's total emissions. By contrast the agriculture sector represents 7.6 percent of total U.S. emissions.

Table 6. Agriculture GHG Emissions—2005

Source		Emissions $MMTCO_2E$
Enteric Fermentation		0.17
Manure Management		0.04
Agricultural Soils		0.24
Total		**0.45**
	Percent of region	0.5%
	Percent for nation	7.6%
Per capita ($MTCO_2E$/person)	Region	0.1
	U.S.	1.8

Source: DVRPC, 2009

Figure 5. Agriculture – DVRPC vs. National GHG Emissions—2005



Source: DVRPC, 2009

1.7 Waste Management (2.8%)

The majority of the DVRPC planning region's solid waste is disposed in landfills, where methane is generated during the anaerobic decomposition of the organic matter in waste. Some landfills are equipped with landfill gas-to-energy systems. Based on reports to the U.S. EPA's Landfill Methane Outreach Program, an estimated 42 percent of the region's potential landfill methane emissions were avoided through landfill gas recovery efforts. When emissions are adjusted to reflect emissions avoided through landfill gas collection systems, net emissions from waste disposal were estimated at 1.9 $MMTCO_2E$ in 2005. Note that emissions associated with landfill gas-to-energy systems are accounted for in the regional electricity emissions factor when used to generate electricity, or included in industrial, residential, or commercial energy emissions when used for heating or process fuel.

An estimated 16 percent of waste in New Jersey, and 19 percent of waste in Pennsylvania was assumed to be incinerated. However, because these waste incineration facilities are used to generate electricity, their emissions are accounted for in the regional electricity emission factors. In addition to emissions from the region's landfills, methane and nitrous oxide are emitted during wastewater treatment. Emissions from the region's wastewater treatment plants accounted for 0.7 $MMTCO_2E$. As a percentage

of the region's total emissions, waste management accounts for a slightly higher portion of regional emissions than it does for the nation as a whole, although per capita emissions are slightly below the national average, as shown in Table 7 below.

Table 7. Waste Management GHG Emissions—2005

Source Category		Emissions $MMTCO_2E$
Wastewater		0.7
Landfill Methane		1.9
Total		**2.6**
	Percent of region	2.8%
	Percent for nation	2.4%
Per capita ($MTCO_2E$/person)	Region	0.5
	U.S.	0.6

Source: DVRPC, 2009

1.8 Industrial Processes (3.5%)

In 2005, industrial processes contributed 3.2 $MMTCO_2E$ to the region's GHG emissions total. In the DVRPC planning region, three industrial source categories were evaluated: cement manufacture, iron and steel production, and substitution of ozone-depleting substances (ODS). Although other sources of industrial emissions likely exist in the region, these were chosen because of their national magnitude and data availability.

Table 8. Industrial Processes GHG Emissions—2005

Source Category		Emissions $MMTCO_2E$
Cement		0.4
Iron & Steel		0.9
Ozone-depleting Substances Substitutes (ODS)		2.0
Total		**3.2**
	Percent of region	3.5%
	Percent for nation	4.7%
Per capita ($MTCO_2E$/person)	Region	0.6
	U.S.	1.1

Source: DVRPC, 2009

1.9 Fugitive Emissions from Fuel Systems (0.9%)

In accordance with GHG accounting rules, fugitive methane emissions from coal, oil, and natural gas systems are calculated separately from carbon dioxide emissions associated with the combustion of fossil fuels. Emissions from coal mining activities in the region were zero, as there are no active or abandoned coal mines in the DVRPC region. However, fugitive emissions from regional oil refining activities were calculated, as were emissions associated with transmission and distribution losses from natural gas systems. In 2005, fugitive emissions from oil and gas systems totaled 0.82 $MMTCO_2E$.

Table 9. Fugitive GHG Emissions from Fuel Systems—2005

Source		Emissions $MMTCO_2E$
Natural Gas Systems		0.78
Petroleum Systems		0.04
Total		**0.82**
	Percent of region	0.9%
	Percent for nation	3.2%
Per capita ($MTCO_2E$/person)	Region	0.15
	U.S.	0.76

Source: DVRPC, 2009

1.10 Land Use, Land Use Change, and Forestry

The source category termed "land use, land-use change, and forestry" (LULUCF) by the United Nations' Intergovernmental Panel on Climate Change (IPCC) is complex and may seem counter intuitive. This category contains emissions and removals of CO_2 from forest management, other land-use activities, and land-use change. These emissions and removals of CO_2 are due to the loss or gain in the amount of carbon stored in trees and other plants in forests, parks, streets, and private property. When the total amount of plant material increases, carbon is stored or sequestered. When the total amount of plant material decreases, carbon is released or emitted. The DVRPC region as a whole had a net loss in this stored carbon in 2005, resulting in additional emissions of 0.15 $MMTCO_2E$.

Regional per capita net emissions for this sector are 0.027 $MTCO_2E$. In contrast this sector resulted in a net per capita *sequestration* or *uptake* of 2.74 $MTCO_2E$ in the 2005 national GHG emissions inventory. See Section 2.7 for more detail.

2 INVENTORY METHODOLOGY

This section presents the methods and data sources used to develop the 2005 baseline GHG inventory. Throughout all source categories, every effort was made to use the best regional data available and to use inventory methodologies that conform to the methodologies used at the state and national levels. In cases where activity data had to be approximated or new methods were developed, these actions are noted below. While this effort attempted to cover all major emissions sources, techniques for conducting a regional GHG inventory are continually updated as better data and more sophisticated methods become available.

2.1 Stationary Energy Consumption—Residential, Commercial, and Industrial (62.1%)

Stationary energy consumption describes the energy consumed for all purposes other than transportation. This source comprises both direct consumption (e.g., burning of natural gas for home heating) and indirect consumption (e.g., emissions associated with fuel consumed to generate electricity).

2.1.1 Methodology for Calculating the Direct Emissions from Fuel Consumption

Key direct fuels include natural gas, coal, distillate fuel oil, residual fuel oil, kerosene, liquefied petroleum gas (LPG), motor gasoline, industrial petroleum feedstocks, and other petroleum products. Combustion of these fuels leads to the emissions of GHGs (CO_2, CH_4 and N_2O). The respective GHG emissions from the direct fuel consumption by residential, commercial, and industrial end-use sectors are estimated following the methodology implemented in the State Inventory Tool[9] (SIT) (U.S. EPA, 2007):

For CO_2: Fuel consumption × carbon content per unit of fuel × 44/12 (ratio of CO_2 to C)
For N_2O: Fuel consumption × N_2O emission factor per unit of fuel
For CH_4: Fuel consumption × CH_4 emission factor per unit of fuel

See the sections below for methods used in acquiring fuel consumption in the residential and commercial/industrial end-use source categories. The emission factors provided in Table 10 below were taken from the SIT, which in turn utilizes emission factors provided by the Energy Information Administration (EIA).

[9] The State Inventory Tool is an Excel-based tool developed by US EPA for calculating state level greenhouse gas inventories. The tool uses methods from the Intergovernmental Panel on Climate Change and the U.S. National Greenhouse Gas Inventory to generate a top-down estimate of greenhouse gas emissions at the U.S. state level. For additional information, see: http://www.epa.gov/climatechange/emissions/state_guidance.html

Table 10: Fuel Emission Factors—2005

Fuel	lbs C/Million BTU	MT N_2O/Billion BTU	MT CH_4/Billion BTU
Coal	60.27 (PA),62.02 (NJ)	0.0014	0.3007
Distillate Fuel (Oil)	43.94	0.0006	0.0006
Kerosene	43.44	0.0006	0.0006
LPG	37.91	0.0006	0.0006
Natural Gas	31.87	0.0001	0.0001
Residual Fuel	47.33	0.0006	0.01002
Still Gas	38.57	0.0006	0.00301
Motor Gasoline	42.80	0.00060	0.00301
Aviation Gasoline Blending Components	41.56	0.00060	0.00301
Petrochemical Feedstocks, Naphtha	39.96	0.00060	0.00301
Petrochemical Feedstocks, Other Oils	43.94	0.00060	0.00301
Petroleum Coke	61.34	0.00060	0.00301
Pentanes Plus	40.18	0.00060	0.00301
Unfinished Oils	44.45	0.00060	0.00301
Miscellaneous petroleum products	44.45	0.00060	0.00301

Note: The emission factors vary by year for some fuels (LPG, Natural Gas) and by year and by state for coal.

Source: U.S. EPA, 2007

2.1.2 Methodology for Calculating the Indirect Emissions from Fuel Consumption

Indirect emissions result from the consumption of electricity that is in turn generated by the consumption of fuels. These emissions are driven by the fuel mix used to generate electricity consumed in the region. The indirect emissions for the residential, commercial, and industrial sectors are estimated by multiplying electricity consumption by the average regional CO_2, CH_4, and N_2O emission rates, as in the following simple equations:

CO_2 emissions = Electricity consumption × Average Regional CO_2 Emission rate
CH_4 emissions = Electricity consumption × Average Regional CH_4 Emission rate
N_2O emissions = Electricity consumption × Average Regional N_2O Emission rate

The regional emission rates are based on the mix of fuels used to generate electricity consumed in the region, which is located in the PJM grid.[10] As shown in Table 11 below, coal—the most CO_2-intensive fuel—accounts for the largest portion of generation in the PJM region (56.6 percent), while nuclear power, which does not result in GHG emissions, is the second most common fuel with 32.9 percent. In 2005, the average CO_2 emission rate for the PJM region was 1,248 lbs CO_2/MWh. The average emissions rate for methane was 24.5 lbs CH_4/GWh and the average emissions rate for nitrous oxide was 21.4 lbs N_2O/GWh (U.S. EPA, 2008b). These factors include power consumed on-site by electricity generation facilities, but do not include transmission and distribution losses. Assuming national average transmission and distribution losses of 9 percent (EIA, 2008), this analysis increased the

[10] PJM Interconnection LLC (PJM) is a regional transmission organization serving all or parts of 13 states ranging from New Jersey to North Carolina to Illinois, plus the District of Columbia. Because electricity on this grid is shared by all consumers connected to the grid, the average emissions for the entire grid are appropriate for consumers in the DVRPC region.

electricity GHG emission rates by 9 percent to account for these losses. Together these factors result in a net emissions factor of 1368 lbs CO_2E/MWh.

Table 11: PJM Region Electricity Generation Resource Mix—2005

Fuel	Percent of Generation
Coal	56.6%
Nuclear	32.9%
Gas	5.9%
Oil	2.2%
Biomass/wood	0.9%
Hydro	0.7%
Other fossil combustion	0.5%
Wind	0.1%

Source: U.S. EPA, 2008b

The division of stationary energy consumption into sectors (residential, commercial, industrial) is in practice inherently ambiguous, and is somewhat dependent on the geographic level to which available data are disaggregated. On the national level, high-quality energy consumption statistics are available for each sector. On the local level, sector data is often not readily available. In the case of DVRPC, commercial and industrial sector data are often intermingled. While the data was available to estimate portions of these sectors separately, in this report these sectors have been combined, as it is not yet feasible to fully separate consumption in these areas. In addition, many data sources (EIA, local utilities) place multi-family residential buildings with more than four units within the commercial sector.[11]

2.1.3 Estimating Residential Fuel Consumption

The 'residential fuel' source category includes the direct emissions associated with purchased energy use other than electricity (which is discussed below)—that is, from the consumption of natural gas, coal, distillate fuel oil, kerosene, and liquefied petroleum gas (LPG). Procuring high-quality data regarding the consumption of the respective fuel by residences is among the most challenging aspects of the regional inventory process. For the DVRPC region, residential natural gas consumption was obtained from natural gas utilities in the region: Philadelphia Electric Company (PECO), Public Service Enterprise Group (PSEG), Philadelphia Gas Works, South Jersey Gas, and Elizabethtown Gas. This data was provided at either the ZIP code or municipality level, depending on the utility company. Data for about 60 percent of total gas consumption was provided at the municipality level, with the remainder provided at the ZIP code level.

For the remaining fuels, residential consumption data is not directly available. In these cases, residential consumption for each county in the DVRPC region was estimated by apportioning available statewide consumption data based on the relative use of each fuel type for home heating reported in the American Community Survey (ACS). The 2005 ACS provides estimates of the total number of households that use each type of house heating fuel by state and county (U.S. Census Bureau, 2005, Table B25040). Residential fuel consumption in each county was estimated by dividing the number of households in each county using a given fuel by the number of households in the state using that fuel. These factors are presented in Table 12 below. This factor is then applied to the statewide residential consumption of that fuel. For instance, 16.4 percent of the New Jersey households that use coal are

[11] For example, PECO classifies customers as commercial or industrial, based on the voltage at which power is delivered. In some cases, multifamily apartment buildings may be among these customers. Similarly, some large commercial customers may select the industrial rate, and some small industrial customers may use the commercial rate.

located in the four New Jersey DVRPC counties, so 16.4 percent of New Jersey's residential coal usage is allocated to the region. Each fuel (coal, distillate fuel oil, kerosene, and LPG) is apportioned in this manner and then entered into the equations described in Section 2.1.1 above to estimate GHG emissions.

Table 12: Portion of Statewide Households Using Specified Fuel for Heating, by County—2005

	Bottle, tank or LP gas	Fuel oil, kerosene, etc.	Coal or Coke
New Jersey			
Burlington	5.2%	4.4%	2.6%
Camden	3.5%	5.1%	12.1%
Gloucester	3.6%	4.3%	1.8%
Mercer	1.8%	3.9%	0.0%
All DVRPC Counties in NJ	14.1%	17.7%	16.4%
Pennsylvania			
Bucks	3.5%	6.8%	0.3%
Chester	8.7%	5.0%	1.3%
Delaware	1.4%	4.1%	0.4%
Montgomery	4.0%	7.0%	0.4%
Philadelphia	3.7%	3.6%	0.0%
All DVRPC Counties in PA	21.3%	26.4%	2.4%

Source: ACS, U.S. Census Bureau, 2005, Table B25040

2.1.4 Estimating Commercial/Industrial Fuel Consumption

As with the residential sector, commercial and industrial natural gas consumption was obtained from natural gas providers in the region. Some of the providers were able to give separate values for commercial and industrial sectors; others were not, due to concerns about customer confidentiality. In all cases, natural gas supplied to power plants was removed from estimated consumption to avoid double-counting.

The consumption of the remaining fuels in the commercial and industrial end-use source categories is not available on the local level. In these cases, a reasonable proxy was needed for allocating total statewide consumption of these fuels to the county level. The initial method was to apportion state level consumption to counties based on county employment totals. This apportionment uses two steps. First, county employment totals from the Bureau of Labor Statistics were divided by statewide totals to determine the portion of each state's employment that is located in the DVRPC region (BLS, 2008a and BLS, 2008b). Following this, state energy consumption in the commercial and industrial sectors was allocated to the Pennsylvania and New Jersey portions of the DVRPC region using these ratios. In the final step, employment estimates developed by DVRPC were used to allocate energy consumption to the county level.[12] These employment ratios are presented in Table 13 below. What this means, in essence, is that for each fuel, 18.8 percent of New Jersey's statewide consumption plus 32.6 percent of Pennsylvania's statewide consumption is allocated to the DVRPC region. Energy used in the electricity generation sector is excluded to avoid double-counting.

[12] DVRPC county-level employment estimates were used for this final allocation because they differed slightly from BLS employment estimates.

Table 13: Regional Employment as a Percentage of State Employment by County—2005

	Percentage of statewide employment (BLS data)	Percentage of regional employment (DVRPC data)
New Jersey		
Burlington	5.1%	27.7%
Camden	5.4%	28.8%
Gloucester	2.6%	14.0%
Mercer	5.7%	29.5%
All DVRPC Counties in NJ	18.8%	100.0%
Pennsylvania		
Bucks	4.7%	13.9%
Chester	4.2%	12.7%
Delaware	3.7%	11.9%
Montgomery	8.6%	25.3%
Philadelphia	11.3%	36.3%
All DVRPC Counties in PA	32.6%	100.0%

Source: BLS, 2008a; BLS, 2008b; DVRPC, 2009

Once this employment-based allocation was completed, DVRPC found that the implied consumption of some fuels in the region was too high. For instance, it allocated close to 8,000 billion Btus of coal energy to industry located in the City of Philadelphia, the equivalent of just under half a million tons of coal.[13] Officials in the City's Office of Air Management noted that they were not aware of any coal being used as an industrial fuel within the City.[14]

With this in mind, DVRPC used a second method to estimate commercial and industrial end-use fuel consumption. For those commercial and industrial fuels that are also used in the residential sector (coal, distillate fuel oil, kerosene, and LPG), DVRPC based its allocation on the use of those fuels by county at the household level, as described above in Section 2.1.3. An adjustment factor was applied in the calculations to account for the fact that county-level household and employment distributions differ from each other. These adjustment factors are presented in Table 14. This methodology assumed that both the commercial and industrial sectors would use these fuels at the same rate as the residential sector in each county. While this may not be fully accurate, it appears a more reasonable allocation method for these fuels than employment.

[13] Coal ranges in heat value from under 6,000 Btu/lb to close to 14,000 Btu/lb depending on source and type.

[14] Meeting with Kassahun Sellassie and Alison Riley, Philadelphia Air Management Services, December 19, 2008.

Table 14: County Level Adjustment Factors for Industrial and Commercial Fuels—2005

	Percentage of statewide households (Census data)	Percentage of statewide employment (BLS data)	Adjustment Factor
New Jersey			
Burlington	5.2%	5.1%	0.971
Camden	6.1%	5.4%	0.882
Gloucester	3.1%	2.6%	0.840
Mercer	4.0%	5.7%	1.412
All DVRPC Counties in NJ	18.5%	18.8%	
Pennsylvania			
Bucks	4.7%	4.7%	1.004
Chester	3.5%	4.2%	1.199
Delaware	4.2%	3.7%	0.891
Montgomery	6.0%	8.6%	1.438
Philadelphia	11.6%	11.3%	0.972
All DVRPC Counties in PA	30.0%	32.6%	

Source: DVRPC, 2009

2.1.5 Estimating Residential Electricity Consumption

As with natural gas consumption, actual residential sales data was provided by electricity distribution companies, either by ZIP code or municipality. Data for about 70 percent of total electricity consumption was provided at the municipality level, with the remainder provided at the ZIP code level. Companies that provided data include: PECO, PSEG, PPL, Metropolitan Edison, Atlantic City Electric, Hatfield Borough, Pemberton Borough, and Quakertown Borough. Data for several small areas on the edges of the region were not collected. Electricity consumption was estimated for these areas based on the average electricity consumption per household in the region.

2.1.6 Estimating Commercial and Industrial Electricity Consumption

Commercial and industrial sales data were provided by the same electrical companies. In some cases these sectors were reported separately; in other cases they were co-mingled, due to concerns about customer confidentiality. Data for the small areas not collected were estimated based on employment in missing areas and the average electricity consumption per employee throughout the region. Although this may be an imprecise estimate, the amount of the region's electricity that was estimated in this manner is relatively small (less than 1 percent of commercial and industrial electricity). Also included in this sector was electricity used for street and traffic lighting. Only one provider—PECO—was able to report electricity for this purpose. The primary reason for this is that these lights are typically not metered and are instead billed on a per-light basis. To accurately estimate street and traffic light electricity consumption would require a complete inventory of all lights, their bulb types, and their daily usage—a task beyond the resources of this analysis. For the areas not reported, public lighting electricity is estimated based on the ratio of PECO's reported sales to the total of PECO's reported residential and commercial sales. As a result, public lighting consumption for the non-PECO areas was estimated to be equal to 0.84 percent of residential and commercial electricity sales.

2.2 Mobile Energy Consumption (30.1%)

2.2.1 Direct Emissions from Motor Vehicles

CO_2 emissions from motor vehicles for the DVRPC region were estimated using outputs from DVRPC's travel demand model. DVRPC modelers provided annual average daily vehicle miles traveled (VMT) by county and vehicle class from the DVRPC regional transportation model. CO_2 emission factors in grams per mile were provided as an output from MOBILE6, US EPA's vehicle emission modeling software, allowing emissions to be calculated by multiplying VMT by the emission factor. The annual VMT and VMT shares by vehicle type are provided in Table 15 below.

Table 15. Annual VMT and VMT Shares by Vehicle Type—2005

	VMT	VMT Shares by MOBILE6 Vehicle Type (%)						
County	(mi/year)	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
Bucks	4,833,950,500	44%	47%	2.3%	0.05%	0.19%	5.52%	0.60%
Chester	5,057,476,500	44%	47%	2.4%	0.05%	0.19%	5.70%	0.60%
Delaware	3,669,016,500	45%	48%	2.0%	0.05%	0.19%	4.62%	0.61%
Montgomery	6,927,116,000	45%	47%	2.1%	0.05%	0.19%	4.96%	0.60%
Philadelphia	5,663,157,500	45%	47%	2.2%	0.05%	0.20%	5.12%	0.60%
Burlington	4,661,670,500	48%	40%	3.2%	0.17%	0.04%	8.42%	0.56%
Camden	3,896,740,000	48%	40%	3.2%	0.17%	0.04%	8.42%	0.56%
Gloucester	2,810,901,500	48%	40%	3.2%	0.17%	0.04%	8.42%	0.56%
Mercer	3,501,773,500	48%	40%	3.2%	0.17%	0.04%	8.42%	0.56%
Region	41,021,802,500							

LDGV = Light-duty gas vehicle, LDGT - Light-duty gas truck, HDGV - Heavy-duty gas vehicle, LDDV - Light-duty diesel vehicle, LDDT - Light-duty diesel truck, HDDV - Heavy-duty diesel vehicle, MC – Motorcycle
Source: DVRPC, 2009

CH_4 and N_2O were estimated using the methodology employed in the EPA's State Inventory Tool and the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2008). Because CH_4 and N_2O emissions vary based on the age and emissions control technology of vehicles, the total estimated VMT in the DVRPC region was apportioned into VMT per model year based on the national distribution of VMT by vehicle age. Next, based on the known usage of various control technologies by model year, the annual VMT by model year were aggregated into VMT by control technology and multiplied by the control technology-specific emission factors to estimate the methane and nitrous oxide emissions. These emissions equate to approximately 3 percent of the CO_2 emissions from motor vehicles in the region, on a CO_2E basis. More details on this method are available in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2008).

Emissions from motor vehicles were also calculated for public buses in the region because these buses are not included in the DVRPC transportation model. Diesel consumption was collected from the National Transit Database (FTA, 2008) for the Southeastern Pennsylvania Transit Authority (SEPTA) and NJ Transit agencies. All of SEPTA's service was assumed to take place in the DVRPC region,[15] while NJ Transit provided the assumption that 18.6 percent of its bus service takes place in the DVRPC region. The total diesel consumption was then used to estimate emissions in the same manner as the direct fuel consumption calculations discussed above.

[15] That is, emissions from Regional Rail R2 operations that take place in the State of Delaware are included in totals.

2.2.2 Direct Emissions from Aviation

For this analysis, GHG emissions from aviation were estimated based on the region's share of total flight miles in and out of all U.S. airports. This approach includes emissions that occurred outside of the DVRPC region but directly result from air traffic in and out of the region's major airports. This methodology departs from the State GHG Inventory Guidance (EPA, 2007), which counts emissions based on location of aircraft fueling. The approach here seeks to estimate emissions from activities directly tied to the metropolitan area. Flight miles into and out of the Philadelphia International Airport (PHL) and Trenton Airport (TTN) were collected from a database provided by the US Bureau of Transportation Statistics, as were the total flight miles for all other airports in the United States (BTS, 2008).

The database provides the number of flights between each airport pair and the flight miles between those airports. The number of flights between each pair was multiplied by the route miles for each flight and summed for all domestic and international flights to determine the total route miles associated with United States airports in 2005. Next, only those flights either departing from or arriving at PHL or TTN were summed to estimate flight miles associated with the region. In this manner, it was estimated that 3.6 percent of all national flight miles originated from or ended in the region. Because those flights always involved the DVRPC region and another city (either the origin or destination of those flights), one-half of the emissions from these flights were assigned to the region. Emissions were thus estimated to be 1.8 percent of national emissions from aviation (EPA, 2008).[16]

[16] In accordance with IPCC guidelines, fuels used for international aviation are excluded from national emissions.

2.2.3 Direct and Indirect Emissions from Rail

These emissions result from the combustion of diesel fuel and indirect emissions associated with electricity consumption. Within the DVRPC region, there are several types of rail travel: local public transit, intercity passenger rail (Amtrak), and freight rail. For each of these sources, the emissions methodology is straightforward:

For CO_2: Fuel consumption × carbon content per unit of fuel × 44/12 (ratio of CO_2 to C)
For N_2O: Fuel consumption × N_2O emission factor per unit of fuel
For CH_4: Fuel consumption × CH_4 emission factor per unit of fuel

First, energy consumption data were collected from the National Transit Database for local public transit agencies, including SEPTA, Port Authority Transit Corporation (PATCO), and NJ Transit (FTA, 2008). Public transit rail—including light rail, heavy rail, and commuter rail—in the region use both diesel fuel and electricity. For each of these three systems, consumption was multiplied by the appropriate emission factors. With SEPTA and PATCO, all of their operations were assumed to be within the DVRPC region (although one SEPTA line does run into Delaware), so consumption did not have to be adjusted. With NJ Transit, most of that agency's operations take place outside of the DVRPC region. They provided the following assumptions:

- 6 percent of commuter rail electricity use occurs in the region;
- 0.5 percent of commuter rail diesel use occurs in the region;
- Zero percent of light rail electricity use occurs in the region; and
- 100 percent of light rail diesel use occurs in the region.

The authors of the report attempted to obtain comprehensive data for Amtrak's routes in the region, but were not successful. Electricity sales in the electric railroad customer class were obtained from PECO, which allowed an estimation of Amtrak's consumption in the PECO service territory. SEPTA, PATCO, and NJ Transit electricity consumption were subtracted from the PECO electric railway total, and the remainder was assumed to be Amtrak's consumption. This approach likely underestimates Amtrak's consumption, and future efforts may allow for correction of this value.

Freight rail estimates were more difficult due to the fact that energy consumption in this sector is divided among a larger number of rail companies. An alternative method was developed that estimated DVRPC's share of national freight emissions based on the region's share of national rail freight rail flows. Freight flow data were obtained from the Freight Analysis Framework, which provides estimated tonnage of goods shipped by type of commodity and mode of transportation within 114 areas (FHWA, 2008). The 2002 data is based primarily on the Commodity Flow Survey and other components of the Economic Census.

From the total U.S. freight rail tonnage flows provided by the dataset, data pertaining specifically to the Philadelphia region were selected by sorting for flows either originating or ending in Philadelphia, then summed (Table 16). To avoid double counting flows attributed to the DVRPC region using this calculation, this Total Philadelphia figure was divided in half, resulting in a more accurate portion of freight rail flow, "DVRPC portion". The DVRPC portion of flow was then divided by the total U.S. flow to result in a DVRPC proportion of total U.S. freight flow. As data were not available for 2005, the 2002 proportion was used for this analysis. The 2005 GHG emissions from freight railroads as reported in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* (EPA, 2008) were then multiplied by this proportion to estimate emissions from freight rail associated with the region. As with aviation, this methodology differs from state methods in that emissions that occur outside of the region are included here. Note also that this methodology looks only at tonnage, and does not take distance into account.

Table 16. Summary of DVRPC-area and National Freight Rail Flows

	2002
Total U.S. ('000 tons) [a]	1,804,570
Total Philadelphia ('000 tons) [b]	20,385
DVRPC portion [c]	10,193
DVRPC % of total [d]	0.56%

a = Total U.S. freight rail flow (FHWA 2002)

b = Freight rail flow originating or ending in Philadelphia (FHWA 2002)

c = One-half of Total Philadelphia flow to avoid double counting

d = Percent of U.S. flow that is attributed to DVRPC region

Source: DVRPC, 2009

2.2.4 Direct Emissions from Marine Vessels

The emissions from marine vessels and associated activities in the DVRPC region were estimated using methods developed and data collected for an effort by the U.S. EPA to estimate air pollutant and GHG emissions from maritime transportation sources. While this work has not yet been published, it is to date the most comprehensive effort to estimate emissions from the nation's ports. For the DVRPC GHG inventory, the estimated emissions for the five ports in the DVRPC region—Philadelphia, Camden, Chester, Marcus Hook, and Paulsboro—were aggregated to estimate the region's total emissions in this sector. Included in this inventory are emissions from ocean going vessels, harbor craft, cargo handling equipment, and idling heavy trucks. The methods used for each of these sources are discussed below.

Ocean Going Vessels

Ocean going vessels (OGVs) with displacements of at least five liters per cylinder were considered in this category, while vessels with displacements of less than five liters per cylinder were included in the harbor craft inventory. Emissions for ships that stop in any port area, including private terminals, were included in the inventory. In addition to emissions directly within a port area, emissions of ships transiting to the port down rivers, bays and other waterways were also calculated along with cruises in the open ocean. Emissions per ship call and mode were determined using this equation:

$E = P \times LF \times A \times EF$

Where:

E = Emissions (grams [g])

P = Maximum Continuous Rating Power (kilowatts [kW])

LF = Load Factor (percent of vessel's total power)

A = Activity (hours [h])

EF = Emission Factor (grams per kilowatt-hour [g/kWh])

Emissions from ships were calculated using the mid-tier methodology described in the Best Practices and Current Methodology document (ICF Consulting, 2006). This method uses ship characteristics and calls at a given port to extrapolate the detailed typical port information.[17] In this methodology, U.S. Army Corps of Engineers (USACE) entrance and clearance data for 2004 together with ship characteristics data from Lloyd Register Fairplay was used to estimate the number of calls and ship characteristics at each port in 2005 (USACE, 2004; Lloyd Resister Fairplay, 2008). Entrances and clearances data were not available for 2005 at the time of this analysis so 2004 data were used. Because this estimate was activity-

[17] When available, local port data was used. Several ports provided recent inventories and these were used to develop inventories for those ports.

based and not based on fuel consumption, it is likely that some emissions from international bunker fuels are included here, despite the fact that they are excluded from the national GHG inventory.

Harbor Craft

Harbor craft (H/C) are a diverse group of vessel types that usually operate locally at a home port, although some types, such as tow boats and ferries, may travel between ports as part of their normal operation. None of the five ports in the DVRPC region are considered *principal ports*; they are considered as *like ports*. In a method similar to that used by the California Air Resources Board (CARB) in their H/C inventory (CARB, 2004), vessel counts by vessel type for each *like port* of interest were determined from the most recent version of the USCG's Merchant Vessels of the United States database (dated June 5, 2007). Annual H/C emissions at each typical port were determined as the product of the number of vessels of a given type operating in the harbor area, the load factor, the average annual activity, the average number of engines of each type per vessel, and the average rated horsepower.

Cargo Handling Equipment

Cargo handling equipment (CHE) at ports is specialized, commonly diesel-fueled, heavy-duty machinery responsible for loading and unloading vessels and transferring the cargo to or from either storage or other transportation modes that carry it to or from the port. While the array of CHE at ports is large, the amount of detailed information on CHE usage is small. Detailed emission inventories have been completed for only five ports nationwide; none of these ports are in the DVRPC region. In 2003, Philadelphia's port collected and prepared less detailed CHE information, which is included in this analysis. The methodology developed here is based largely on the EPA's NONROAD model. Annual CHE emissions at each typical port were then determined as the product of the number of pieces of equipment of a given type, the load factor, the adjusted annual activity, and the average rated horsepower.

Heavy Duty Trucks

While on-road truck emissions were calculated elsewhere in this analysis, emissions from the large amount of time trucks spend idling in the ports were included in this section. Truck emissions were calculated by multiplying emission factors by measures of truck activity (hours of operation or fuel use). Port truck activity was estimated based on waterborne cargo activity at each port, since these data were readily available for all port areas considered in this analysis. For the ports that had quantified truck emissions in their detailed emissions inventories, their estimates were used directly if their assumptions were comparable to the ones in this analysis. Because the truck emissions are considered as part of a national port inventory, average inputs were used for the five ports of interest to quantify maritime transportation-related truck emissions. The dataset covered the year of 2005. Idling emission factors (in grams per hour) were derived by multiplying 20 mph emission factors in grams per mile (in MOBILE6.2) by 20 to obtain idling emission factors in grams per hour (4,579 grams CO_2/hour).

2.2.5 Off-road Vehicles

Off-road CO_2 emissions for the DVRPC region were calculated using EPA's NONROAD2005 model (downloaded from www.epa.gov/otaq/nonrdmdl.htm). All datasets used to generate results were provided with the NONROAD model. NONROAD provides estimates of various off-road equipment types by county, summed by equipment segment. The equipment segments represented in the model are agriculture, airport support equipment, commercial equipment, construction, industrial, lawn & garden, logging, other oil field equipment, other underground mining equipment, railway, recreational, and recreational marine. For the purposes of this analysis, commercial equipment, industrial equipment, and railway equipment were excluded. It was assumed that fuel consumption for these sectors was already included in the commercial, industrial, and freight/passenger rail sections.

The model was run using the same options that Pennsylvania Department of Environmental Protection's Bureau of Air Quality (BAQ) used to generate 2002, 2008, and 2009 off-road emissions of VOCs, NO_x, and CO:

Reid vapor pressure = 6.7 psi
Annual average temperatures of 49°F minimum, 66°F maximum, and 57°F average
Stage II vapor recovery = 100%
Percent oxygen = 0.0%

The full methodology used by BAQ can be viewed at: www.dep.state.pa.us/dep/deputate/airwaste/aq/plans/plans/philly/Technical_Appendices_TOC.pdf.

NONROAD's analysis is based on the model's default assumption of hours of operation for all equipment per year in the DVRPC region. The model output includes CO_2 emissions, in tons per year, for each type of equipment in each county. Regional emissions are summarized in Table 17 by category of off-road equipment.

Table 17: Summary of Off-road Vehicle GHG Emissions—2005

Equipment Category		Emissions $MMTCO_2E$
Agriculture		0.0
Airport Support Equipment		0.0
Construction		0.7
Lawn & Garden		0.5
Logging		0.0
Other Oil Field Equipment		0.0
Recreational		0.0
Recreational Marine		0.1
Total		**1.4**
% of region		1.4%
% for nation		2.2%
Per capita ($MTCO_2E$/person)	Region	0.25
	U.S.	0.52

Source: DVRPC, 2009

2.3 Agricultural Sources (0.5%)

Emissions from the agricultural sector come from three sources: manure management, enteric fermentation, and agricultural soils.

2.3.1 Emissions from Manure Management

The management of manure results in CH_4 and N_2O emissions. These emissions are driven by the number and type of livestock, as well as the manure management techniques used. The methodology used for estimating emissions from manure management was the same used to estimate emissions from manure management in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2008). The formulas used in that methodology requires detailed animal population data.

County-level population data for dairy cattle, beef cattle, swine, poultry, sheep, and other animals at the county level was obtained from the United States Department of Agriculture's National Agricultural Statistics Service (USDA, 2008). The Agriculture Module of the State Inventory Tools was used to further disaggregate animal population data to the level required by the model (EPA, 2007). This

methodology applies the state-level distribution of animal sub-types within each state to the county totals by broader animal type category for each county. Table 18 below provides an overview of these estimates for the DVRPC region. This population data was then used to calculate the CH_4 and N_2O emissions from manure using the formulas laid out in the national GHG inventory (EPA 2008).

Table 18: DVRPC Region Animal Population Data—2005

Animal	Number
Dairy Cattle	25,000
Dairy Cows	*16,811*
Dairy Replacement Heifers	*8,189*
Beef Cattle	37,900
Beef Cows	*12,340*
Beef Replacement Heifers	*3,299*
Heifer Stockers	*4,040*
Steer Stockers	*11,743*
Feedlot Heifers	*1,087*
Feedlot Steer	*3,534*
Bulls	*1,857*
Sheep	8,065
Sheep On Feed	*766*
Sheep Not on Feed	*7,299*
Goats	551
Swine	25,797
Horses	17,945
Poultry	
Layers 20 weeks and older	*565,783*
Pullets	*511,251*
Broilers	*114,279*
Turkeys	*36,575*

Source: USDA, 2008; US EPA, 2008; DVRPC, 2009

2.3.2 Emissions from Enteric Fermentation

Enteric fermentation emissions are associated with dairy and beef cattle, swine, sheep, goats, and horses. For these animal types, GHG emissions from enteric fermentation consist of CH_4. Animal population data from Table 18 was used to calculate the CH_4 emissions from enteric fermentation using the formulas laid out in the national GHG inventory (EPA 2008).

2.3.3 Emissions from Agricultural Soils

Emissions from agricultural soils result from runoff from livestock manure, fertilizer use, and plant residues. In the national GHG inventory, emissions are estimated in a complex modeling process that includes a variety of county-level outputs, described in detail in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2008). Model results for DVRPC counties were obtained in cooperation with the U.S. EPA and Colorado State University, and were incorporated in this inventory.

2.4 Waste Management (2.8%)

2.4.1 Solid Waste Management

Solid waste management can result in the emission of methane due to the anaerobic decomposition of the organic matter in waste that takes place in landfills. GHG emissions also result from the incineration of waste, but as discussed in Section 2.1.2, all waste incineration in the DVRPC region is used to produce electricity, thus those emissions are accounted for in electricity consumption. Therefore, only emission of landfill methane is discussed here.

Landfill methane emissions were estimated using the first order decay equation presented in EPA's AP-42 guidance (EPA, 1998) and implemented in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2008) and EPA's State Inventory Tool (EPA, 2007). This equation is as follows:

$$Q_{Tx} = A \times k \times R_x \times L_o \times e^{-k(T - x)}$$

Where:

Q_{Tx} = Amount of CH_4 generated in year T by the waste R_x,
T = Current year
x = Year of waste input,
A = Normalization factor, $(1-e^{-k})/k$
k = CH_4 generation rate (yr^{-1})
R_x = Amount of waste landfilled in year x
L_o = CH_4 generation potential

This model functions by estimating annual landfill deposits for the time period 1960-2005. These were estimated based on population estimates provided by DVRPC and per capita waste generation factors provided by the U.S. EPA's *State Inventory Tool* (EPA, 2007). Because the per capita values for Pennsylvania did not include industrial waste, the estimated Pennsylvania total was increased by 7 percent to account for methane-generating industrial waste (*ibid.*). An estimated 16 percent of waste in New Jersey and 19 percent of waste in Pennsylvania was assumed to be incinerated (*ibid.*); therefore, the total waste generation was reduced by this amount, leaving the amount estimated to be landfilled each year. These waste generation estimates were then entered into the first-order decay model to estimate potential methane generation in the region.

Many of the region's landfills are equipped with landfill gas-management systems. The U.S. EPA's Landfill Methane Outreach Program database was used to determine emissions avoided in 2005 based on projects that were collecting landfill methane at that time in the DVRPC region. It was determined that 1.61 $MMTCO_2E$ of methane emissions were avoided through these gas-management systems, amounting to a reduction of about 42 percent of the region's potential landfill methane emissions (EPA, 2008c). This amount was subtracted from total potential methane generation to yield estimated methane emissions.

2.4.2 Municipal Wastewater Treatment

GHG emissions from wastewater treatment consist of CH_4 and N_2O, and are a direct result of treating municipal wastewater. CH_4 emissions arise from anaerobic treatment of organic matter. N_2O emissions are associated with two distinct sources: emissions from centralized wastewater treatment processes themselves, and emissions from the effluent of centralized treatment systems that has been discharged into aquatic environments.

Estimates for both gases are carried out using methodologies from the *State Inventory Tool* and the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2007; EPA, 2008). These methodologies

are based on population, the fraction of the population not on septic[18], and per capita emissions factors for each gas derived using formulas from the *State Inventory Tool* and the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. These formulas are based on estimates of per capita BOD_5[19], fraction of wastewater treated anaerobically, and annual protein consumption.[20] The resultant per capita emission factors are provided in Table 19. These are multiplied by population to arrive at annual emissions.

Table 19: Per Capita Emission Factors for Wastewater Treatment—2005

Emission Category	Value (kg/year)
CH_4	67.26
N_2O associated with treatment	1.12
N_2O associated with effluent	58.37

DVRPC, 2009, based on EPA, 2007 and EPA, 2008

2.5 Industrial Processes (3.5%)

Over twenty industrial process (IP) sources are included in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. The methodology for most sources is relatively simple, and usually consists of multiplying an activity (e.g. production in tons) by the appropriate emissions factor. While national level activity data is readily available, activity data at the metropolitan geography and/or a suitable method for downscaling state or national data is very limited. For this inventory, DVRPC focused on the three industrial process sources that produce the most GHG emissions at a national level: substitution of ozone-depleting substances, iron and steel manufacturing, and cement manufacturing. Together, these three sources account for about 65 percent of national Industrial Process GHG emissions (EPA, 2008).

2.5.1 Ozone-Depleting Substances Substitutes

Several classes of ozone-depleting substances are being phased out under the terms of the *Montreal Protocol* and Clean Air Act Amendments of 1990 and replaced with substitutes that, while not harmful to the stratospheric ozone layer are potent GHGs (EPA, 2008). Ozone-depleting substance substitutes (ODS substitutes) are widely used chemicals present in refrigerators, air conditioners, fire extinguishers, foams, aerosols, and other products. Because their use is widespread and the methods and data needed to estimate emissions from this sector on the national level are complex, emissions in the region were estimated by multiplying the national per capita emissions (0.36 $MTCO_2E$) times the regional population. This methodology was provided by the *State Inventory Tool* (EPA, 2007).

2.5.2 Iron & Steel Manufacturing and Cement Manufacturing

For these two sources, local production volumes were not available. Emissions were estimated by apportioning national emissions based on the ratio of the number of regional firms in these sectors to the national number of firms in these sectors. Economic data were provided by the U.S. Census Bureau's *County Business Patterns* database (Census, 2008). National emissions were provided by the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2008).

[18] The Philadelphia Water Department provided estimates of the fraction of population not on septic as follows: Philadelphia = 100 percent; remainder of region = 90 percent.

[19] BOD represents the amount of oxygen that would be required to completely consume the organic matter contained in the wastewater through aerobic decomposition processes. A standardized measurement of BOD is the "5-day test" denoted as BOD_5.

[20] Data on annual per capita protein consumption for the United States have been published by the United States Department of Agriculture Food and Agriculture Organization (USDA, 2007).

2.6 Fugitive Emissions from Fuel Systems (0.9%)

2.6.1 Natural Gas Systems

CH_4 is emitted from the production, transmission, and distribution of natural gas. Because natural gas is not produced in the region, emissions for the DVRPC region were instead estimated based on the national emissions from transmission and distribution activities divided by national natural gas sales. The national average fugitive emissions rate was estimated by dividing national emissions from transmissions and distribution (EPA, 2008) by national consumption in 2005 (EIA, 2008b), for an implied emission factor of 2.99 $MTCO_2E$ per million cubic feet of natural gas consumed. This implied emission factor was then multiplied by regional consumption in 2005. This is conceptually parallel to the electricity transmission loss factor discussed in Section 2.1.2 above.

2.6.2 Petroleum Systems

Methane is emitted from the production, refining, and transportation of petroleum products. As with natural gas systems, the sector is very difficult to accurately estimate, particularly at the local level. Of the main petroleum system activities, only refining is likely to result in emissions in the DVRPC region. Emissions for the region were estimated by apportioning national emissions based on the ratio of regional petroleum refining capacity to national petroleum refining capacity. Regional capacity in 2005 was estimated at one million barrels per day, based on the capacity of five refineries in the region listed in the EIA's *Refining Capacity Report 2005* (EIA, 2005), versus national capacity in 2005 of 17.1 million barrels per day (EIA, 2008c). It was then assumed that regional emissions from petroleum refining were approximately 5.8 percent of national emissions of 0.6 $MMTCO_2E$ (EPA, 2008).[21]

2.7 Land Use, Land Use Change, and Forestry

The source category termed "land use, land-use change, and forestry" (LULUCF) by the United Nations' Intergovernmental Panel on Climate Change (IPCC) contains emissions and removals of CO_2 from forest management, other land-use activities, and land-use change. These emissions and removals of CO_2 are due to the loss or gain in the amount of carbon stored in trees and other plants in forests, parks, streets, and private property. When the total amount of plant material increases, carbon is stored or sequestered. When the total amount of plant material decreases, carbon is released or emitted.

Perhaps counterintuitively, this means that the greatest LULUCF emissions may come from those areas of the region that have historically been most heavily forested, because in these areas preparing forested land for development results in greater loss of trees—and hence greater emissions—than preparing agricultural or abandoned industrial land for development.

Emissions from this sector are calculated by estimating the change in forest carbon and the change in carbon stored in urban trees. These are summarized below.

2.7.1 Forest Carbon

Estimating the net change in forest carbon is a difficult process. For this analysis, DVRPC applies a method similar to that applied in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA, 2008). For the national estimate, the US Forest Service uses the Carbon Calculation Tool and the Forest Inventory Analysis database (FIA). The FIA provides an inventory of all U.S. forest acreage by species. The inventory is compiled largely from state studies that are conducted at various intervals. By interpolating the values in between, a time series of forest acreage is constructed. The Carbon Calculation

[21] Conversations with regional petroleum industry professionals suggest that the total emissions from refineries in the region may be higher than this methodology estimates. DVRPC will refine the methodology used here in any future inventory work.

Tool then applies carbon stock factors (tons of carbon/acre), which are region- and species-specific, to this acreage time series. This results in a stored carbon estimate for each year. The change in these stocks is the net carbon emission or sequestration, depending on whether stocks decrease or increase.

Developing the estimate of forest carbon for DVRPC required three elements: carbon stock factors, the forest acreage, and the change in acreage. Carbon stock factors were obtained from the Carbon OnLine Estimator (COLE), provided by the National Council for Air and Stream Improvement (NCASI, 2008). COLE provides values for different forest types (i.e. species mixes), and, for each, breaks down the carbon factor by above ground live tree, down dead wood, soil, etc. The factors COLE provides are specific to the county level, so data for the nine counties were collected.

Forest acreage was obtained from the FIA Database (USDA Forest Service, 2008). A query for the nine counties was run using the "Area by Forest Type" report – this provides acreage by forest type (species mix). The data is drawn from New Jersey's study conducted from 2004 to 2006 and Pennsylvania's study that was conducted from 2001 to 2005. Forest land in the FIA is defined as land that is at least 10 percent stocked by forest trees; the minimum area for classification is 0.5 hectares. The stock factors were applied to the acreage (although some forest types had to be matched to a similar, not exact, stock factor), and a total carbon stock for the area was estimated for 2005.

DVRPC then provided detailed land use estimates for 2000 and 2005. The 2000 acreage of wooded land was subtracted from the 2005 acreage of wooded land and divided by five to estimate annual change of acreage. Although the county carbon stocks are based on the areas of different forest types in each county, it was assumed that any change in wooded land area by county affected all forest types in each county uniformly. A summary of the forest carbon stocks, average storage factors, and annual changes between 2000 and 2005 are presented in Table 20 below. Note that a hectare (ha) is equal to 2.471 acres. Philadelphia is discussed in Section 2.7.2, below.

Table 20. Forest Carbon Sequestration Estimates—2005

County	2005 Forest Carbon Stocks (MT)	Forest Acres	Average Carbon Storage Factor (MT C/ha)	Annual Change in Acreage and Carbon Stock		Net Sequestration (MT)
				Percent Change	Change in C Stock (MT)	
Burlington	28,869,938	273,683	260.7	-0.24%	-67,963	-249,198
Camden	2,196,777	18,725	289.9	-0.54%	-11,768	-43,151
Gloucester	4,945,429	46,342	263.7	-0.76%	-37,357	-136,976
Mercer	3,825,205	39,581	238.8	-0.63%	-24,191	-88,699
Bucks	10,700,114	93,276	283.5	-0.43%	-46,418	-170,198
Chester	10,388,879	93,603	274.3	-0.69%	-72,088	-264,322
Delaware	1,260,236	11,889	261.9	-1.31%	-16,560	-60,718
Montgomery	2,475,485	24,871	246.0	-0.21%	-5,299	-19,429
Total or Avg.	64,662,063	601,970	265.4		-281,643	**-1,032,690**

Source: NCASI, 2008; USDA Forest Service, 2008; DVRPC, 2009

2.7.2 Urban Trees

In the *Inventory of U.S. Greenhouse Gas Emissions and Sinks,* the change in carbon stored in urban trees is estimated based on the results of studies of 14 urban forests by the U.S. Forest Service. The average net sequestration rate (kg C per sq. m of tree canopy) is calculated using these 14 urban forests. The City of Philadelphia was one of the cities studied, thus values for sequestration by Philadelphia's urban forest were obtained directly from *Inventory of U.S. Greenhouse Gas Emissions and Sinks (*EPA, 2008).

The urbanized area in the DVRPC region outside of Philadelphia required some additional analysis. The basic method requires multiplying the urban area first by the average tree cover, and then by the carbon sequestration rate per area of tree cover. The urbanized area of Greater Philadelphia was provided by the U.S. Census Bureau (Census Bureau, 2002a). This value included only the areas of the metropolitan region in New Jersey and Pennsylvania, and excluded the urbanized area that extends into Delaware. For the parts in New Jersey and Pennsylvania, all of the area lies inside the DVRPC area (Census Bureau, 2002b). The area of the city of Philadelphia lies entirely inside this urbanized area, and had already been analyzed for urban forestry, so it was subtracted from the urbanized area. This provided a value for the urbanized area in the eight DVRPC counties outside of the city of Philadelphia. This value was then multiplied by the national urban tree coverage estimate, 27.1 percent, to determine tree coverage area (EPA, 2008).

This urban tree coverage was multiplied by the national urban tree sequestration factor to get an annual sequestration estimate (MT C/year). This and the values for the city of Philadelphia were summed to obtain an urban tree sequestration for the DVRPC area, as shown in Table 21.

Table 21. Urban Trees Sequestration Estimates—2005

Geography	Urbanized Area (ha)	Tree Cover Area (ha)	Annual Carbon Storage Factor (MT C/ha)	Annual Net Sequestration (MT C)	Annual Net CO_2 Sequestration (MT CO_2)
Philadelphia	33,967	5,333	1.97	10,530	38,609
Remainder of Region	381,252	103,319	2.23	230,191	844,032
Total or Avg.	**415,219**	**108,652**		**240,720**	**882,641**

Source: EPA, 2008; Census Bureau, 2002b; DVRPC, 2009

2.7.1 Net Land Use, Land Use Change, and Forestry (LULUCF) Emissions

Net emissions CO_2 emissions associated with LULUCF in the DVRPC region are the sum of forest carbon (emissions of 1,032,690 MT) and urban carbon (sequestration of 882,641 MT), or net emissions of 150,049 MT.

3 ALLOCATION OF THE 2005 INVENTORY

To provide the DVRPC's member communities with assistance in their GHG planning activities, the 2005 GHG inventory was allocated both to the region's nine counties and to the region's 352 municipalities, referred to here as using the census term "Minor Civil Divisions", or MCDs. These MCDs include the region's cities, townships, and boroughs. Because of the large number of MCDs, it was necessary that the methods used be simple and replicable on a large scale, since completing 352 individual inventory efforts was beyond the scope of this effort. Because of this, it is important that municipalities and counties using the allocated inventory values understand where they came from, what their limitations are, and where efforts to improve them at the local level might best be directed.

Despite these limitations, this effort provides MCDs with an excellent starting point, and for some emissions categories provides information that DVRPC believes is as good as is feasible to acquire for municipal efforts to inventory community-wide emissions. DVRPC encourages municipalities and counties to use this inventory to support their inventory efforts, as well as to support analysis of where investments in energy conservation and efficiency might be most productively made. DVRPC has additional detailed information that is not presented in this report that it will share with municipalities and counties upon request.

This section first presents an overview of the allocation results, and then discusses the methods used to produce the allocation. The county- and municipality-level results of this allocation are presented in Appendix A: 2005 Allocated Inventory.

3.1 Overview of Allocation Results

Figure 6 shows how the municipalities in the region differ from each other in density of population and employment. Figure 7 and Figure 8 illustrate the results of the municipality level greenhouse gas emissions allocation and their relationship to density in two different views.[22]

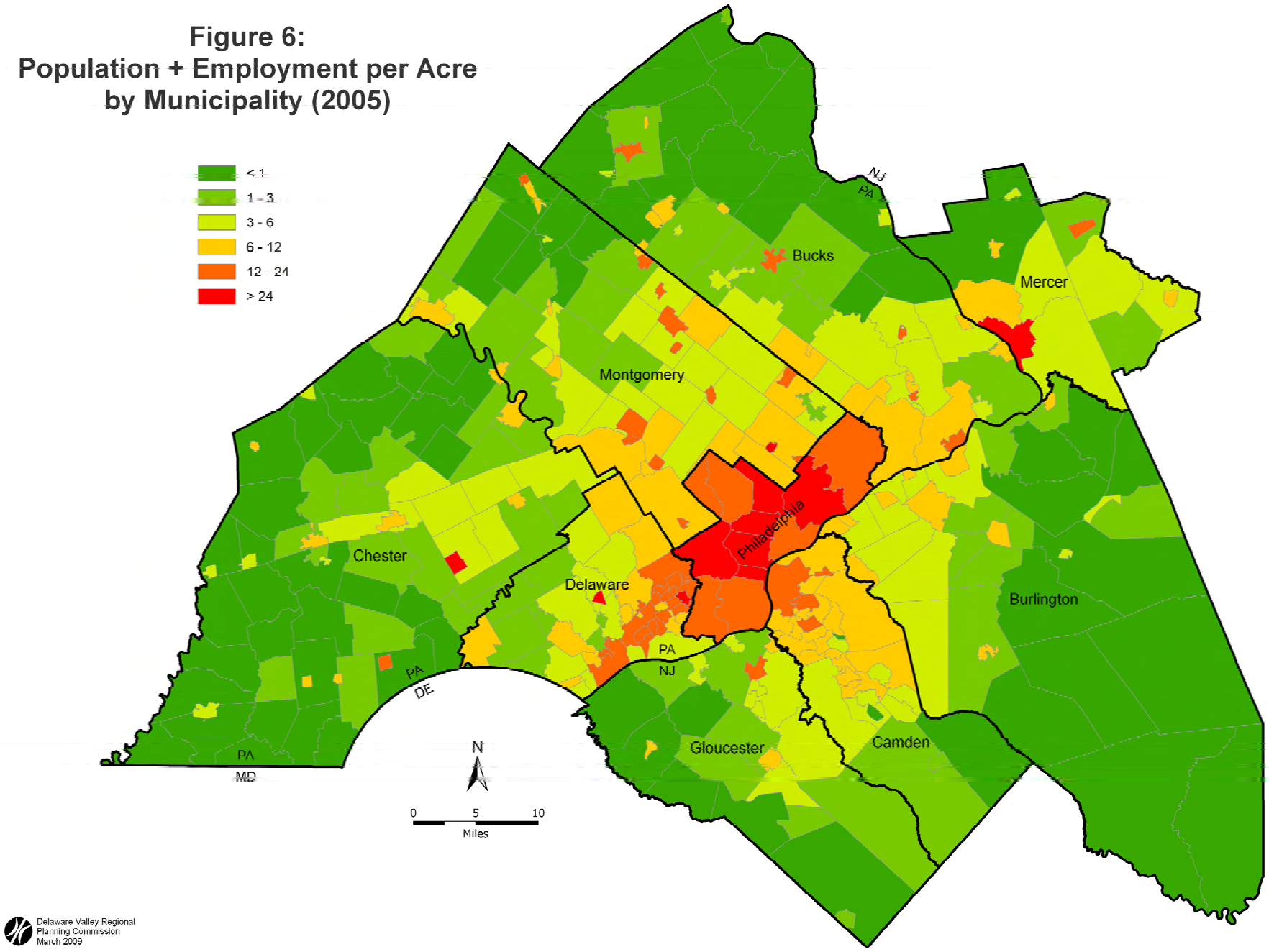
Figure 7 shows greenhouse gas emissions per acre by municipality for the DVRPC region.[23] As might be expected, the denser areas of the region produce more of the emissions, as these are the areas where people live and where businesses are located.

Figure 8 shows the allocated greenhouse gas emissions at the municipality level normalized by the sum of population and employment, which together serve to indicate the level of human activity. This view indicates a clear correlation between municipalities with higher density of population and employment, and lower per capita greenhouse emissions. In general, these municipalities have amenities closer together than municipalities with less dense population and employment. This allows shorter trips, and the ability to walk for some trips that might require driving in less dense municipalities. In addition, these municipalities may provide sufficient density to make mass transit feasible for some residents and employees. In addition, residential and commercial buildings may be smaller per capita or employee, and may be directly connected to adjacent housing or businesses (e.g., rowhouses or businesses with apartments above them), providing the energy efficiency benefits of shared walls. Further analysis of the data would be required to develop a better understanding of these relationships.

[22] Emissions associated with industrial natural gas and electricity energy consumption are not included in this analysis, as these emissions are not available for all municipalities.

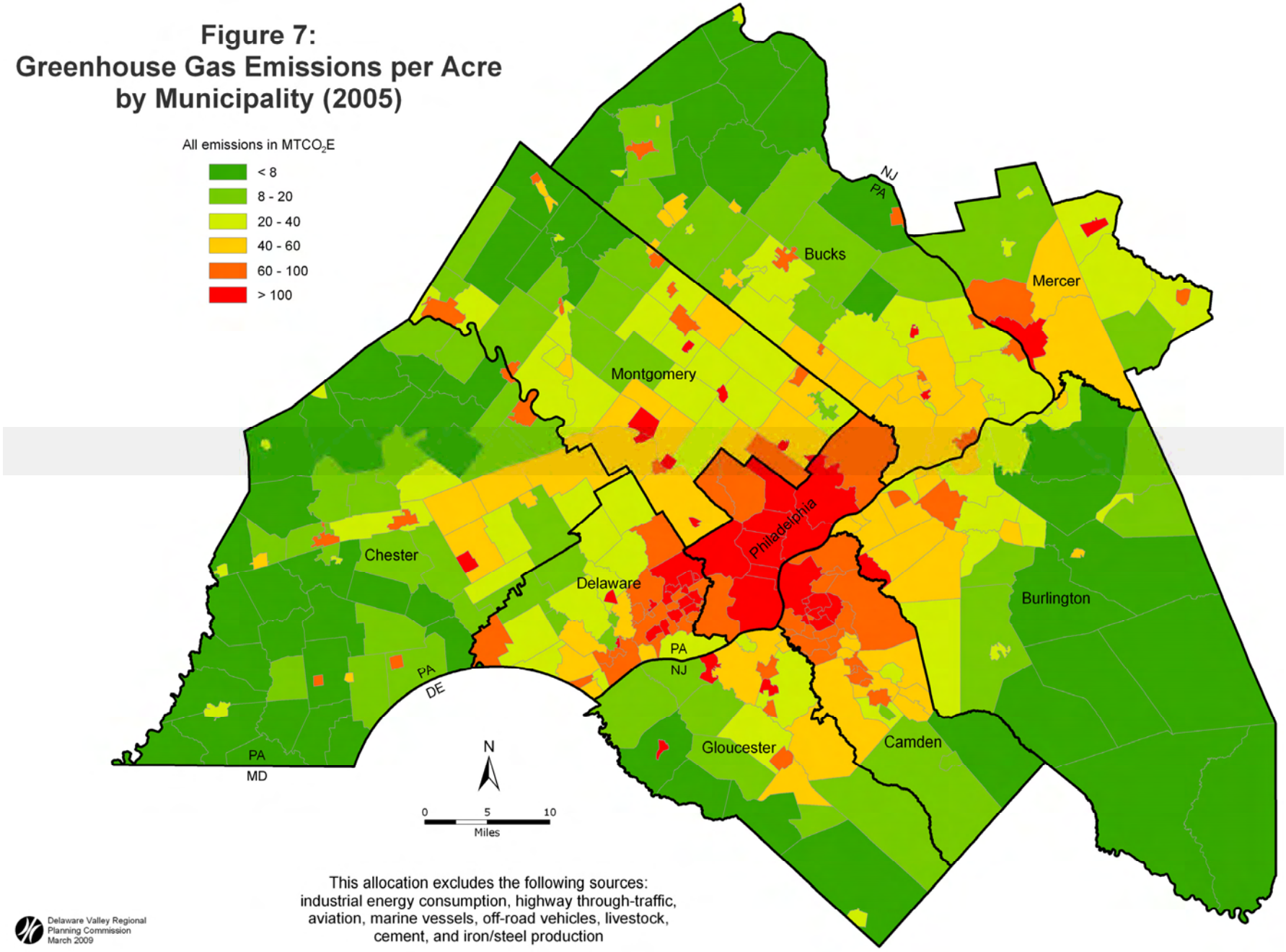
[23] For these maps, the City of Philadelphia is subdivided into its twelve planning areas, with emissions calculated for each based on population and employment.

Figure 6:
Population + Employment per Acre by Municipality (2005)



Delaware Valley Regional Planning Commission
March 2009

Figure 7:
Greenhouse Gas Emissions per Acre by Municipality (2005)



This allocation excludes the following sources: industrial energy consumption, highway through-traffic, aviation, marine vessels, off-road vehicles, livestock, cement, and iron/steel production

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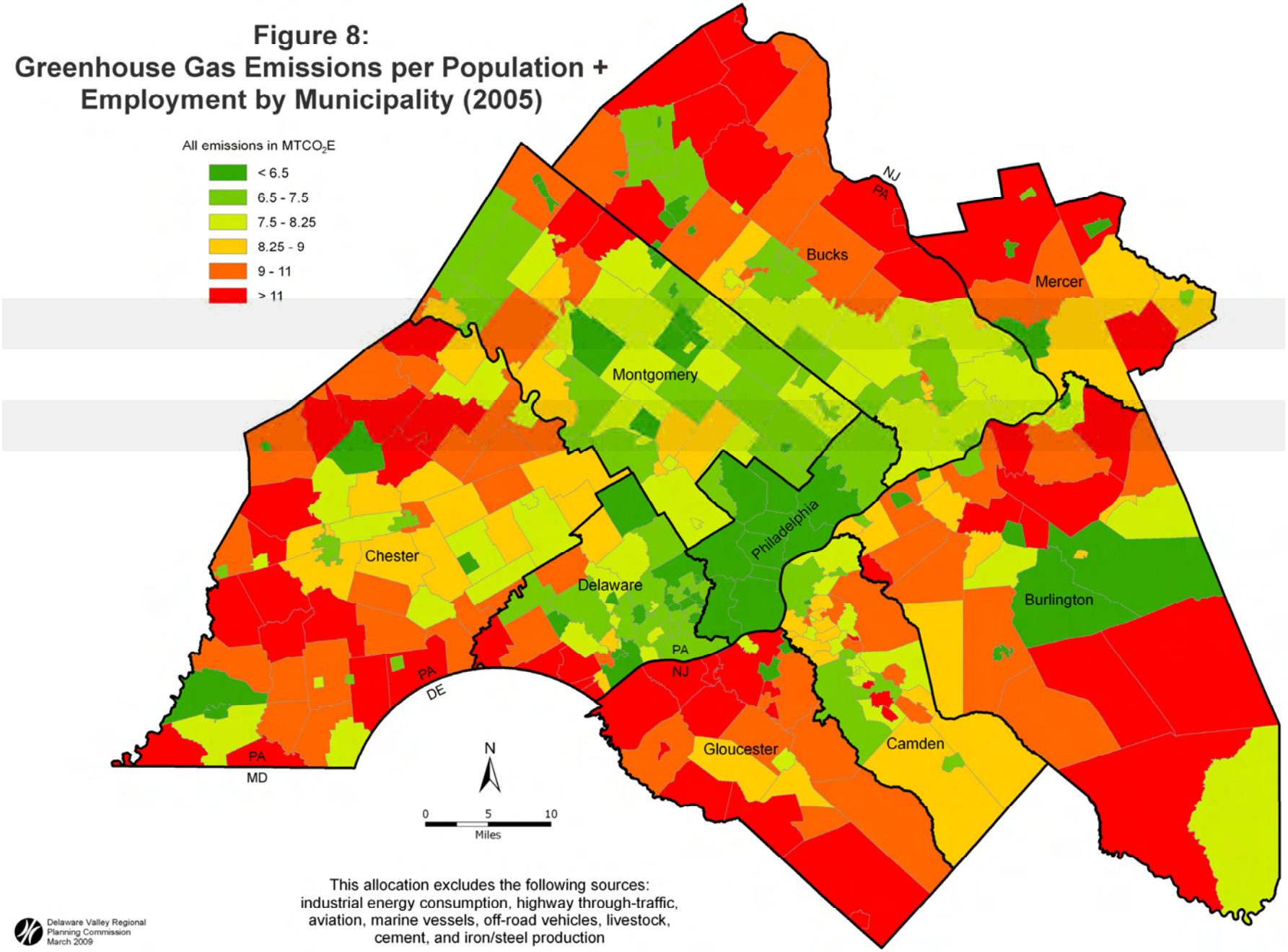
Figure 8:
Greenhouse Gas Emissions per Population + Employment by Municipality (2005)



This allocation excludes the following sources: industrial energy consumption, highway through-traffic, aviation, marine vessels, off-road vehicles, livestock, cement, and iron/steel production

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3.2 Sources Included and Omitted

Due to data availability and the nature of some emission source categories, it was not possible to allocate all emissions included in the 2005 GHG inventory to the County or MCD level. In some cases, suitable data were not available. For example, emissions from industrial energy due to non-utility fuel consumption were not able to be allocated to the MCD level because no local level information exists. The quantity and type of fuels used vary widely between different industrial sectors and facilities. Industrial energy consumption other than utility gas and electricity was estimated for the region as a whole based on proxy data, as discussed in Section 2.1.4. Those fuels that used actual residential fuel usage patterns as a factor in estimating consumption were allocated to the county level, but not to the MCD level (coal, distillate, kerosene, and LPG).

In other cases, assigning emissions to MCDs may not make sense. For example, the region's marine ports and airports are both major sources of emissions, yet they are concentrated in a few specific geographic areas. It is not clear how to allocate emissions from these activities fairly. Allocating them to the areas in which they occur would ignore the fact that the entire region depends on economic activity and services associated with marine ports and airports. At the same time, it is equally unclear how these emissions could be allocated fairly throughout the region. These issues are in active discussion in national inventory dialogue and research. Based on these considerations, the emission sources that were included and excluded from the allocation process are provided in Table 22 below. For context, each source is presented beside estimated emissions. As the table indicates, 90 percent of the region's gross emissions were allocated to the region's counties, and 84 percent to the region's MCDs. Note that emissions associated with industrial natural gas and electricity consumption are allocated only to some municipalities as discussed below. The remainder of this section provides details on the allocation methodologies.

The portion of Table 22 labeled "confidence in allocation" is a general guide to how accurate the allocation is for each of the emissions sources. This information should be useful to municipal level efforts that might wish to enhance the accuracy of their inventories. For example, as described above in Section 2.4.1, landfill methane is estimated based on statewide per capita waste generation estimates for PA and NJ, as well as regional averages for methane recovery from landfills. If a municipality had current and historic municipal level waste generation data and information on the landfills and other disposal methods used for that waste, it could use that information to arrive at information that would be more accurate for that municipality. Note, however, that any such efforts should be guided not only by a desire for greater accuracy, but also by the relative magnitude of the emissions source. As Table 22 indicates, DVRPC believes that over 90 percent of the allocated emissions are allocated using the same methodology as would be used to carry out an inventory for a single municipality.

Table 22. Overview of Inventory Allocation

Emissions Source Category	2005 Emissions ($MMTCO_2E$)	Allocated		Confidence in Allocation		
		County	MCD	Good	Better	Best
Stationary Energy— Residential						
Fuel Type						
Natural Gas	6.65	x	x			x
Coal	0.0033	x	x			x
Distillate Fuel Oil	2.33	x	x			x
Kerosene	0.16	x	x			x
LPG	0.23	x	x			x
Purchased Electricity	12.49	x	x			x
Stationary Energy— Commercial						
Fuel Type						
Natural Gas	5.61	x	x			x
Coal	0.04	x	x		x	
Distillate	0.87	x	x		x	
Kerosene	0.07	x	x		x	
LPG	0.05	x	x		x	
Residual Fuel	0.11	x	x	x		
Motor Gasoline	0.01	x	x	x		
Purchased Electricity	9.84	x	x			x
Stationary Energy— Industrial						
Fuel Type						
Natural Gas	1.97	x	some MCDs			x
Coal	0.20	x		x		
Distillate	0.87	x		x		
Kerosene	0.11	x		x		
LPG	0.12	x		x		
Residual Fuel	0.35					
Petroleum Coke	1.53					
Other Fuels	0.98					
Purchased Electricity	11.45	x	some MCDs			x
Mobile Energy						
Highway (ex. thru & airport traffic)	20.00	x	x			x
Public transit (buses and rail)	0.34	x	x			x
Highway through & airport traffic	1.74					
Freight Rail	0.28					
Intercity Rail (electric)	0.20					
Aviation	2.82					
Marine & Port-Related	0.38					
Off-Road Vehicles	1.37	x		x		
Agriculture						
Manure Management	0.04	x			x	
Enteric Fermentation	0.17	x			x	
Agricultural Soils	0.24	x	x			x
Waste Management						
Landfill Methane	1.88	x	x		x	
Wastewater	0.69	x	x		x	
Industrial Processes						
Cement Manufacture	0.39					
Iron & Steel Production	0.88					
ODS Substitutes	1.97	x	x			x
Fugitive Emissions						
Natural Gas Systems	0.78	x	x			x
Petroleum Systems	0.04					
Land Use, Land Use Change, and Forestry						
LULUCF Net	0.15	x	x			x
Total ($MMTCO_2E$)	**90.4**	**81.2**	**75.9**	**2.8**	**3.8**	**74.6**
	100%	**90%**	**84%**	**3%**	**5%**	**92%**

Source: DVRPC, 2009

3.3 Allocation Methodology

3.3.1 Stationary Energy Consumption—Residential

Residential energy consumption data were allocated in different ways, depending on the fuel type and data source. For electricity and natural gas consumption data that were already available by MCD, no further allocation was needed. About 60 percent of the natural gas consumption and 70 percent of the electricity consumption was provided by electricity and natural gas companies at the MCD level, with the remainder provided at the ZIP code level. For data provided at the ZIP code level, a GIS analysis was performed to map the ZIP code-based data to MCDs, since many of the ZIP code areas covered parts of multiple MCDs.

First, population per MCD per ZIP code was estimated using a proportional overlay technique using GIS data provided by DVRPC. ZIP code areas were compared to the MCD boundaries and Census 2000 tract areas to show where they intersect. The intersecting areas were divided by the tract areas and the results were expressed as ratios. The population count per Tract was multiplied by these ratios to determine the estimated population for each of the intersected areas, and then the intersecting areas were aggregated by ZIP code. The population results were summed to arrive at the population estimate per MCD per ZIP Code. These populations were then used to allocate electricity and natural gas consumption to MCDs. For example, if ZIP Code 55555 had reported electricity sales of 1,000,000 kWh and it was estimated that 30 percent of the population of the ZIP Code area fell under MCD A, 25 percent were in MCD B, and 45 percent were in MCD C, then it would be assumed that of that ZIP Code's consumption, 300,000 kWh (30 percent) would be allocated to MCD A, 250,000 kWh (25 percent) to MCD B, and 450,000 kWh (45 percent) to MCD C. If any of those MCDs fell entirely within the ZIP Code area, then those MCDs would be complete. If other ZIP codes covered other parts of an MCD, then this process was repeated for all other ZIP codes. This method assumes that the population is uniformly distributed within each Census tract, and that all consumers in a given ZIP code consume equally.

Emissions from other fuels—fuel oil, coal, LPG, and kerosene—were allocated based on MCD level household heating fuel use data obtained from the 2000 Census (SF-3, Table H40). Regional fuel consumption was apportioned to the MCDs by dividing the number of households using a given fuel within an MCD by the total number of households in the region using that fuel (New Jersey and Pennsylvania were calculated separately).

3.3.2 Stationary Energy Consumption – Commercial

Emissions from commercial energy consumption in stationary sources were calculated in a similar manner as the residential sector. Electricity and natural gas consumption data by MCD were used where available. The remaining electricity and natural gas data were allocated from ZIP codes to MCDs in the same method discussed above. This method assumes that commercial energy use within a given ZIP code is distributed to the various MCDs within that ZIP code in a manner corresponding to the distribution of population to the various MCDs.

For those commercial fuels that are also used in the residential sector (coal, distillate fuel oil, kerosene, and LPG), the allocation is based on the use of those fuels by municipality at the household level, similar to the methodology described above in Section 2.1.3. A municipal level adjustment factor is applied in the calculations to account for the fact that municipal-level household and employment distributions differ from each other. This methodology assumed that both the commercial and industrial sectors would use these fuels at the same rate as the residential sector in each county. While this may not be fully accurate, it appears a more reasonable allocation method for these fuels than employment.

The remaining commercial fuels (residual fuels and motor gasoline) were allocated based on employment counts. This method assumes that consumption of these fuels correlates with employment. In

the absence of locally available data, DVRPC believes this is the best proxy to use to allocate these emissions to the MCD level.

3.3.3 Stationary Energy Consumption – Industrial

Because of the uncertainties regarding the location of commercial energy use, the allocation of industrial energy to the county or MCD level is limited to emissions associated with industrial use of utility natural gas or electricity for those MCDs for which all natural gas or electricity is reported at the MCD level. Thus, those MCDs for which the use of either natural gas or electricity is reported entirely or in part by ZIP code are excluded from the allocation of these emissions sources. Even with this exclusion, 74 percent of the emissions associated with industrial natural gas and 84 percent of the emissions associated with industrial electricity are allocated to the MCD level.

3.3.4 Mobile Emissions – Highway (excluding through traffic and airport traffic)

To estimate GHG emissions from on-road mobile sources, DVRPC developed the following methodology to estimate VMT on a municipal level. This methodology was developed as a balance between the desire for accuracy and the need to accomplish these calculations using existing data and modeling resources.

The methodology begins with an estimate of total regional VMT. This estimate is provided by the Highway Performance Monitoring System (HPMS), a federal program that monitors travel throughout the country. The HPMS program takes counts on highway facilities throughout the DVRPC region on a three year cycle. The regional VMT is estimated by the HPMS based on these counts. For 2005, the HPMS estimated total daily VMT in the DVRPC region to be 112.3 million.

The HPMS total includes through trips (trips that pass through the region but do not stop in the region). Using DVRPC's travel demand model, daily total through trip VMT were estimated as 6.4 million. As these cannot be allocated to an origin or destination within the region, they were subtracted from total VMT, resulting in total daily non-through trip VMT of 105.9 million (allocation of emissions associated with through trips is discussed below).[24]

VMT was apportioned to municipalities based on the number of trips made to and from each municipality and by the distance of those trips. A vehicle trip table from DVRPC's 2005 regional simulation was obtained; this gave the number of trips occurring between each Travel Analysis Zone (TAZ) in the region. This trip table consisted of auto, light truck, heavy truck, and taxi trips. It did not include transit bus trips or trips made by non-motorized modes. Through trips were then removed from the trip table. Different trip tables were obtained for each time period used in the DVRPC model—peak, midday, and evening.

A TAZ to TAZ distance table (skim matrix) was also obtained for the 2005 simulation for each time period. The distance between each TAZ pair was determined from the shortest path through the congested network as determined in the final iteration of highway assignment. A correction was required for external-internal trips (those trips that have one end inside of the region and one end outside of the region). The distance table only contains the portion of the trip from the internal TAZ to the regional cordon line or boundary. Using this distance directly will significantly underestimate the VMT due to these trips, especially for trips originating near the regional boundary, where a significant portion of the trip can occur outside of the region. A correction was applied which assigns a distance to external-internal trips for a particular TAZ to be at least equal to the average internal-internal trip (that is, trips that have both origin and destination within the DVRPC region) for the same TAZ.

[24] The transportation modeling community carries out analysis in terms of the daily travel averaged over the entire year. Daily VMT for 2005 is converted to annual VMT by multiplying by 365.

A second correction was required for intra-zonal trips (trips that begin and end in the same TAZ). The distance table does not have a value for these trips as they are not assigned to the network in the regional simulation. Using a standard transportation modeling approach, these intrazonal trips are assigned a distance equal to half the distance to the nearest neighboring TAZ.

Once these corrections were made, a preliminary VMT estimate was made for each TAZ pair by multiplying the trip table by the distance table for each time period (peak, midday, and evening). When aggregated, the total VMT estimate for the region was about 2.5 percent higher than the total from the HPMS data. Because this method assumes that the HPMS data is more accurate, preliminary VMT estimates for each TAZ are multiplied by a correction factor to realign them with the HPMS total. In this way the HPMS VMT minus the through-trip VMT acted as a control total for this study. For each TAZ pair, half the VMT was allocated to the origin and half to the destination. For example, for a trip from home to work, half of the VMT is allocated to the work location and half to the home location.

The CO_2 emissions for each TAZ were calculated by multiplying the VMT by the composite emissions factor of 506.2 g/mile. This composite emissions factor comes from EPA's MOBILE 6.2 post-processer, and assumes the same region-specific vehicle type mix as used for air quality conformity analysis for the 2005 simulation year.[25] The CO_2 emissions per TAZ were rolled up into municipality totals using a correspondence table that matched TAZs with municipalities.[26] For the City of Philadelphia, the data was broken down into 12 county planning areas (CPAs). Non-CO_2 emissions were then estimated based on the average N_2O and CH_4 emissions rates per VMT in the region.

The data and methodology raise two additional caveats worth mentioning:

- Trips made by travelers to the airport are assumed by modeling convention to be leaving the region. Thus, one half of the VMT from the traveler trips to the airport are not allocated to any particular MCD, with the MCD of origin being allocated the other half (the entire trip is included in the regional inventory). The VMT from trips made by employees that work at the airport are allocated as with all other TAZs.
- As noted, this methodology does not allocate VMT or emissions associated with through trips.

3.3.5 Mobile Emissions – Transit (Public Buses and Trains)

To allocate emissions from public transit, the region's total emissions were apportioned to MCDs based on the count of workers who made the journey to work by public transit according to the 2000 U.S. Census (SF-3, Table P30). These estimates were collected for each MCD, and each MCD's share of total emissions was assumed to be equal to its count of workers who commute via public transit divided by the total number in the region. This allocation is based on two assumptions: that commuting patterns are a good proxy for total ridership and that all riders utilize the system equally. Regarding the former assumption, commuting accounts for only a portion of total trips, yet this portion is likely to vary by municipality: suburban residents who commute via commuter rail and center city residents who commute via subway both use public transit to commute, but it is less likely that the suburban resident would also use transit for non-commuting trips, as opposed to center city residents. Regarding the second assumption, the commuting trips from the suburbs into Philadelphia may typically be longer and thus more fuel-intensive than trips that originate in the downtown area.

[25] DVRPC recognizes that applying a uniform emissions factor across all TAZs assumes that the vehicle mix, vehicle speed, and other factors that affect CO_2 emissions per mile traveled are the same for all TAZs. In any future inventory work, DVRPC will consider applying refinements to this model to take into account—at least partially—the differences in such factors in the region's TAZs. For instance, vehicle mix and vehicle speed by TAZ and time period is known.

[26] An MCD will contain one or more TAZ, depending on the MCD's size. TAZ boundaries do not cross MCD boundaries.

3.3.6 Mobile Emissions—Off-Road Vehicles

As noted in Section 2.2.5 above, emissions from off-road vehicles were estimated at the county level. There was not sufficient information to allocate these emissions to the MCD level.

3.3.7 Agriculture—Manure Management and Enteric Fermentation

As noted in Sections 2.3.1and 2.3.2 above, emissions from manure management and enteric fermentation were estimated at the county level. There was not sufficient information to allocate these emissions to the MCD level.

3.3.8 Agricultural Soil Emissions

Emissions from agricultural soils were allocated to municipalities based on the amount of agricultural land reported in each community. Detailed land use data for each MCD was provided by DVRPC, and each MCD's emissions from agricultural soils was estimated to be the emissions of its county times the acres of agricultural land in a given MCD divided by the acres of agricultural land in that county. This method accounts for the different agricultural practices and soil types in each county, but assumes that these factors are the same for all MCDs within a given county.

3.3.9 Landfill Methane Emissions

As discussed in Section 2.4.1, landfill methane emissions were estimated on a per capita basis, thereby making it straightforward to allocate emissions to communities in the region. The only major distinctions between communities in that methodology were the different per capita waste generation and landfilling rates in New Jersey and Pennsylvania. The emissions for the two states were estimated separately, and then allocated to their respective communities. This method does not account for local differences in waste generation and landfill methane capture technologies. Individual communities may be able to improve their estimates, if they have locally-specific information about waste generation rates and the presence and effectiveness of methane collection systems at the landfill(s) used.

3.3.10 Wastewater Treatment

Because emissions from wastewater treatment were estimated based on population, these emissions are allocated based on MCD populations.

3.3.11 Industrial Processes—Ozone-Depleting Substances Substitutes

As discussed in Section 2.5.1 above, emissions associated with ODS substitutes were estimated for the region using regional population multiplied by the national per capita emissions. These emissions were allocated to the MCD level by multiplying MCD populations by national per capita emissions.

3.3.12 Fugitive Methane Emissions from Natural Gas Systems

As discussed in Section 2.6.1 above, fugitive emissions from natural gas systems were estimated using the national emission factor derived by dividing national fugitive emissions by national natural gas consumption, that is, a certain portion of loss is assumed in natural gas transmission. This same factor was applied to residential and commercial natural gas consumption as estimated at the MCD level (as discussed above) to estimate emissions from this source at the municipal level.

3.3.13 Land Use, Land-Use Change, and Forestry

Net carbon sequestration/emissions from forests and urban trees were estimated based on detailed MCD-level land use estimates provided by DVRPC and on urban forest studies conducted by the U.S. Forest Service.

For forest carbon, DVRPC's wooded land use area estimates for 2000 and 2005 were used to estimate the annual change in forested land by MCD. The annual change for each MCD was then multiplied by the appropriate county average carbon storage factor (Table 20) to estimate net change in forest carbon stocks. This method assumes that the carbon storage factor for forested land within each MCD is the same as the average for each county. Although this is not likely to be the case, it is difficult to improve on this estimate without detailed field measurements. Because of this, the sum of the MCD-level LULUCF emissions differs slightly from the county totals that were used in the regional inventory.

Allocating sequestration from urban trees to MCDs utilized a method similar to the one employed for the regional inventory. However, rather than relying on U.S. Census Bureau data to calculate urban areas within each MCD, the urbanized area in each MCD was estimated to be the total area of the MCD, with land classified as "agricultural", "wooded", and "water" subtracted from the total. The estimated urbanized area for each MCD was then multiplied by the national average urbanized area tree coverage (a different factor was used for Philadelphia) and the carbon sequestration rate, as discussed in Section 2.7.2.

The sum of the forest carbon and urban trees sequestration/emissions results in a net LULUCF sequestration/emissions value for each municipality.

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APPENDIX A: 2005 ALLOCATED INVENTORY

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2005 Greenhouse Gas Emissions Allocated to Counties (1000s $MTCO_2E$)

	Stationary Energy					Waste						
County	Residential	Commercial	Industrial	Mobile Energy	Agri-culture	Landfill	Waste water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF[27]	Net Emissions
Burlington	1,887	1,749	563	2,046	23	170	56	159	68	**6,721**	138	**6,859**
Camden	2,033	1,815	501	1,838	0	196	65	183	66	**6,696**	(28)	**6,669**
Gloucester	1,236	1,441	574	1,208	16	104	34	98	61	**4,772**	71	**4,843**
Mercer	1,420	1,771	336	1,649	70	139	46	130	58	**5,618**	28	**5,646**
Bucks	2,696	1,465	1,297	2,644	108	202	78	222	33	**8,746**	21	**8,766**
Chester	2,092	1,344	1,706	2,505	180	153	60	169	26	**8,235**	118	**8,353**
Delaware	2,134	942	1,806	2,233	3	180	70	198	49	**7,614**	(12)	**7,602**
Montgomery	3,296	2,183	3,143	3,833	51	253	98	278	69	**13,203**	(154)	**13,050**
Philadelphia	4,952	3,379	4,641	3,751	0	480	187	528	213	**18,132**	(37)	**18,095**

Source: DVRPC, 2009

As noted in Table 22, county allocations exclude the following emissions sources:

- industrial fuels other than coal, distillate, kerosene, and LPG;
- highway through-traffic and airport traffic;
- freight rail;
- intercity rail;
- aviation;
- marine and port related sources;
- cement and iron/steel production; and
- fugitive emissions from petroleum systems.

[27] LULUCF is "Land Use, Land Use Change, and Forestry," as described in section 1.10.

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Burlington County, NJ – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste-water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Bass River Township	7,983	3,040	0	N/A	5,019	139	590	195	552	0	17,516	(660)	16,856
Beverly City	6,719	3,244	N/A	N/A	8,168	-	1,008	333	943	178	20,591	96	20,687
Bordentown City	5,215	3,976	N/A	N/A	18,708	-	1,505	497	1,409	110	31,421	125	31,546
Bordentown Township	29,967	26,575	N/A	N/A	55,554	86	3,893	1,285	3,642	1,137	122,139	9,814	131,953
Burlington City	25,078	26,336	N/A	N/A	42,921	<0.5	3,695	1,219	3,457	714	103,421	(1,277)	102,144
Burlington Township	87,141	99,825	N/A	N/A	100,890	125	8,270	2,729	7,738	2,957	309,675	9,377	319,053
Chesterfield Township	35,566	19,721	N/A	N/A	13,647	1,368	2,357	778	2,205	1,095	76,737	4,301	81,038
Cinnaminson Township	74,961	54,676	N/A	N/A	61,777	25	5,717	1,887	5,349	2,406	206,796	969	207,765
Delanco Township	27,595	18,683	N/A	N/A	18,860	36	1,496	494	1,400	800	69,364	3,897	73,262
Delran Township	75,287	52,151	N/A	N/A	62,203	52	6,572	2,169	6,149	2,149	206,732	8,309	215,041
Eastampton Township	30,588	29,166	N/A	N/A	22,283	175	2,539	838	2,376	906	88,870	520	89,390
Edgewater Park Township	29,473	15,427	N/A	N/A	23,888	30	3,026	999	2,831	924	76,599	2,719	79,318
Evesham Township	198,687	150,309	N/A	N/A	199,651	239	17,723	5,849	16,581	5,179	594,218	2,583	596,801
Fieldsboro Borough	1,708	1,066	N/A	N/A	2,393	-	220	72	206	36	5,701	653	6,354
Florence Township	72,710	68,435	N/A	N/A	43,158	270	4,316	1,424	4,038	2,451	196,803	12,270	209,073
Hainesport Township	24,935	16,640	N/A	N/A	34,155	116	2,232	737	2,088	530	81,433	7,850	89,283
Lumberton Township	34,259	38,544	N/A	N/A	43,194	543	4,689	1,547	4,387	1,194	128,356	(1,232)	127,124
Mansfield Township	37,222	22,325	N/A	N/A	29,353	1,135	2,890	954	2,704	1,049	97,632	3,602	101,234
Maple Shade Township	70,330	227,010	N/A	N/A	70,453	1	7,360	2,429	6,886	11,317	395,787	(335)	395,452
Medford Township	138,153	86,400	N/A	N/A	106,054	700	8,913	2,942	8,339	4,429	355,930	16,405	372,335
Medford Lakes Borough	7,774	3,321	N/A	N/A	13,539	-	1,579	521	1,478	144	28,357	(582)	27,774
Moorestown Township	123,630	155,161	N/A	N/A	123,760	212	7,552	2,492	7,066	4,372	424,245	1,033	425,278
Mount Holly Township	18,874	18,670	N/A	N/A	49,881	1	4,025	1,328	3,766	445	96,991	(814)	96,177
Mount Laurel Township	189,836	242,986	N/A	N/A	211,691	221	15,336	5,061	14,348	5,138	684,618	(1,436)	683,182
New Hanover Township	9,324	76,298	N/A	N/A	43,902	137	3,637	1,195	3,387	3,974	141,853	(535)	141,319
North Hanover Township	25,196	11,360	N/A	N/A	40,797	923	2,869	947	2,684	727	85,504	3,826	89,329
Palmyra Borough	32,330	15,281	N/A	N/A	26,135	-	2,883	952	2,698	868	81,147	572	81,719
Pemberton Borough	4,076	3,203	N/A	N/A	7,722	2	499	165	467	14	16,148	3,012	19,160
Pemberton Township	48,398	37,229	N/A	N/A	114,447	1,372	10,904	3,599	10,202	2,543	228,695	1,351	230,046
Riverside Township	21,450	12,394	N/A	N/A	24,759	-	3,015	995	2,821	495	65,929	(750)	65,179
Riverton Borough	8,623	5,298	N/A	N/A	9,771	-	1,033	341	967	208	26,241	(347)	25,894
Shamong Township	37,368	7,518	N/A	N/A	25,980	559	2,591	855	2,424	188	77,483	7,434	84,917
Southampton Township	19,966	5,368	N/A	N/A	48,374	1,705	4,125	1,361	3,860	182	84,941	5,782	90,723
Springfield Township	44,578	37,208	N/A	N/A	15,805	1,969	1,343	443	1,257	1,442	104,043	2,182	106,225
Tabernacle Township	46,786	12,420	N/A	N/A	26,804	666	2,775	916	2,596	168	93,131	30,412	123,543
Washington Township	13,010	3,712	0	N/A	3,213	426	244	80	228	170	21,084	2,019	23,103
Westampton Township	56,785	56,775	N/A	N/A	46,301	384	3,268	1,079	3,058	1,760	169,410	(1,560)	167,850
Willingboro Township	145,414	59,337	N/A	N/A	90,906	3	12,616	4,163	11,804	4,463	328,707	(3,445)	325,262
Woodland Township	16,679	7,851	N/A	N/A	11,396	508	517	171	484	309	37,914	8,391	46,305
Wrightstown Borough	3,554	13,738	N/A	N/A	15,668	4	281	98	279	546	34,169	1,392	35,561

Source: DVRPC, 2009

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Camden County, NJ – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste-water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Audubon Borough	38,713	22,534	N/A	N/A	28,539	-	3,460	1,142	3,238	1,048	98,675	(798)	96,828
Audubon Park Borough	3,753	2,318	N/A	N/A	3,071	-	408	135	382	119	10,187	(80)	9,987
Barrington Borough	27,012	13,077	N/A	N/A	21,385	<0.5	2,667	880	2,495	766	68,282	(931)	66,585
Bellmawr Borough	43,872	46,796	N/A	N/A	46,145	<0.5	4,259	1,406	3,985	1,698	148,162	(1,492)	144,972
Berlin Borough	31,901	41,112	N/A	3,917	36,724	<0.5	2,815	929	2,634	386	120,417	639	120,670
Berlin Township	24,890	29,049	N/A	N/A	32,067	<0.5	2,042	674	1,911	1,014	91,646	(37)	90,596
Brooklawn Borough	9,574	7,938	N/A	N/A	9,609	-	876	289	820	241	29,346	(243)	28,862
Camden City	235,643	340,350	N/A	N/A	178,333	-	30,343	10,014	28,391	10,696	833,771	(6,686)	816,388
Cherry Hill Township	322,176	376,819	N/A	N/A	315,331	<0.5	27,206	8,979	25,456	11,943	1,087,910	(9,373)	1,066,594
Chesilhurst Borough	6,105	1,576	N/A	12	5,329	<0.5	667	220	624	23	14,557	(117)	14,417
Clementon Borough	40,420	24,444	0	N/A	16,759	-	1,870	617	1,750	731	86,591	(503)	85,358
Collingswood Borough	52,731	53,010	N/A	N/A	41,198	-	5,327	1,758	4,984	1,578	160,586	(1,057)	157,951
Gibbsboro Borough	11,975	16,778	N/A	N/A	14,405	<0.5	934	308	874	377	45,651	501	45,775
Gloucester Township	213,994	125,930	N/A	N/A	191,443	<0.5	25,132	8,295	23,515	8,191	596,499	977	589,286
Gloucester City City	49,009	37,868	N/A	N/A	32,311	-	4,381	1,446	4,099	1,181	130,295	(1,010)	128,104
Haddon Township	65,300	58,324	N/A	N/A	47,650	-	5,513	1,820	5,159	1,988	185,753	(1,021)	182,745
Haddonfield Borough	55,869	23,592	N/A	N/A	45,942	-	4,385	1,447	4,103	1,524	136,861	(1,283)	134,055
Haddon Heights Borough	36,574	14,953	N/A	N/A	25,936	-	2,810	927	2,629	956	84,786	(789)	83,041
Hi-Nella Borough	3,952	1,809	N/A	N/A	2,785	-	384	127	359	112	9,527	(96)	9,320
Laurel Springs Borough	10,686	9,876	0	14	6,267	-	734	242	686	171	28,676	(247)	28,257
Lawnside Borough	12,636	18,424	N/A	N/A	16,331	-	1,051	347	983	509	50,282	599	50,373
Lindenwold Borough	58,195	28,226	N/A	N/A	46,842	-	6,531	2,155	6,111	1,455	149,516	(1,136)	146,925
Magnolia Borough	15,556	5,433	N/A	N/A	12,582	-	1,660	548	1,554	433	37,766	(390)	36,942
Merchantville Borough	11,117	8,252	N/A	N/A	11,951	-	1,445	477	1,352	307	34,901	(347)	34,247
Mount Ephraim Borough	16,297	8,259	N/A	N/A	14,238	-	1,690	558	1,581	451	43,073	(103)	42,519
Oaklyn Borough	19,544	9,084	N/A	N/A	13,224	-	1,557	514	1,457	523	45,903	(350)	45,030
Pennsauken Township	125,811	180,222	N/A	N/A	145,316	-	13,439	4,436	12,575	4,997	486,796	(4,202)	477,597
Pine Hill Borough	42,039	18,565	N/A	N/A	27,448	-	4,277	1,411	4,001	1,273	99,014	(1,163)	96,578
Pine Valley Borough	4,261	4,663	N/A	2	374	-	8	3	8	359	9,677	(46)	9,273
Runnemede Borough	35,085	29,506	N/A	N/A	28,437	-	3,223	1,064	3,016	1,205	101,535	(955)	99,375
Somerdale Borough	22,378	11,217	N/A	N/A	16,466	-	1,950	644	1,825	667	55,146	(592)	53,887
Stratford Borough	26,236	21,712	N/A	N/A	26,109	-	2,727	900	2,551	485	80,721	(765)	79,471
Tavistock Borough	5,945	2,246	N/A	N/A	-	-	9	3	-	149	8,352	(59)	8,144
Voorhees Township	128,968	129,040	N/A	N/A	129,700	<0.5	10,983	3,625	10,276	3,548	416,140	(2,119)	410,474
Waterford Township	51,130	19,461	N/A	N/A	39,922	<0.5	4,052	1,337	3,792	1,068	120,762	(1,371)	118,324
Winslow Township	165,905	69,550	N/A	67,923	115,522	<0.5	14,188	4,683	13,275	3,680	454,726	8,966	460,011
Woodlynne Borough	7,368	2,835	N/A	N/A	4,586	-	1,038	343	972	161	17,304	(114)	17,029

Source: DVRPC, 2009

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Gloucester County, NJ – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste-water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Clayton Borough	31,598	19,768	N/A	11,512	29,144	105	2,769	914	2,591	1,158	99,559	(2,839)	96,720
Deptford Township	135,873	122,328	N/A	N/A	130,126	122	11,213	3,701	10,491	4,656	418,510	(1,629)	416,880
East Greenwich Township	34,505	37,228	N/A	N/A	23,106	636	2,362	780	2,210	2,019	102,846	(674)	102,172
Elk Township	19,745	24,162	N/A	341	16,510	929	1,429	472	1,337	1,692	66,617	4,868	71,484
Franklin Township	78,283	59,489	N/A	319	74,419	1,370	6,280	2,073	5,876	3,213	231,323	16,411	247,734
Glassboro Borough	58,104	85,334	N/A	14,450	74,470	79	7,272	2,400	6,804	3,008	251,921	2,716	254,637
Greenwich Township	26,018	39,710	N/A	N/A	27,859	110	1,877	620	1,757	1,786	99,737	8,727	108,464
Harrison Township	54,119	18,078	N/A	2,421	39,337	838	4,298	1,418	4,021	619	125,149	455	125,604
Logan Township	20,557	113,621	N/A	51,707	53,980	685	2,340	772	2,189	2,471	248,323	32,490	280,813
Mantua Township	105,535	38,910	N/A	N/A	59,058	445	5,721	1,888	5,352	2,713	219,622	3,972	223,594
Monroe Township	149,764	102,893	N/A	9,960	108,196	603	11,860	3,914	11,096	5,320	403,606	15,154	418,760
National Park Borough	13,653	2,748	N/A	N/A	9,119	-	1,215	401	1,137	207	28,480	(436)	28,044
Newfield Borough	10,412	7,983	N/A	2,738	18,564	30	626	207	586	177	41,322	68	41,391
Paulsboro Borough	29,458	127,590	N/A	N/A	24,952	-	2,298	758	2,150	5,818	193,025	(1,102)	191,923
Pitman Borough	38,557	21,250	N/A	27,802	30,667	5	3,488	1,151	3,263	1,061	127,244	(650)	126,594
South Harrison Township	13,705	4,878	N/A	12	12,819	890	1,088	359	1,018	565	35,335	2,246	37,581
Swedesboro Borough	21,291	31,532	N/A	6,805	17,393	6	773	255	723	44	78,823	(106)	78,717
Washington Township	198,095	161,360	N/A	N/A	163,991	190	19,108	6,306	17,879	5,316	572,245	(2,877)	569,368
Wenonah Borough	24,470	5,456	0	N/A	8,434	<0.5	879	290	823	329	40,682	(438)	40,244
West Deptford Township	88,442	296,580	N/A	N/A	88,334	165	7,883	2,602	7,376	13,788	505,169	(2,786)	502,383
Westville Borough	10,207	6,313	N/A	N/A	18,749	-	1,684	556	1,575	183	39,266	(609)	38,657
Woodbury City	29,741	30,955	N/A	N/A	53,797	-	3,934	1,298	3,681	707	124,113	(411)	123,702
Woodbury Heights Borough	14,813	51,959	N/A	N/A	12,309	-	1,139	376	1,066	2,716	84,379	(543)	83,836
Woolwich Township	28,934	31,146	N/A	2,260	27,696	1,075	2,851	941	2,668	1,236	98,807	(1,476)	97,330

Source: DVRPC, 2009

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Mercer County, NJ – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	**Residential**	**Commercial**	**Industrial Gas**	**Industrial Electricity**	**Mobile Energy**	**Agri-culture**	**Landfill**	**Waste-water**	**Industrial Processes**	**Fugitive Methane**	**Gross Emissions**	**LULUCF**	**Net Emissions**
East Windsor Township	42,718	86,515	N/A	N/A	158,462	602	10,159	3,353	9,505	4,746	316,058	9,454	325,512
Ewing Township	170,072	287,337	N/A	N/A	163,521	131	14,130	4,663	13,220	8,995	662,068	(235)	661,833
Hamilton Township	378,930	331,436	N/A	N/A	325,236	633	34,110	11,257	31,913	13,455	1,126,970	13,893	1,140,863
Hightstown Borough	18,500	6,401	N/A	N/A	30,573	3	2,008	663	1,879	346	60,373	727	61,100
Hopewell Borough	3,373	3,072	0	N/A	9,537	13	773	255	723	19	17,764	(864)	16,899
Hopewell Township	127,064	130,750	N/A	N/A	81,200	2,285	6,732	2,222	6,299	3,726	360,279	198	360,477
Lawrence Township	156,640	228,808	N/A	N/A	153,907	433	11,915	3,932	11,148	5,964	572,748	1,176	573,923
Pennington Borough	6,421	2,805	0	N/A	10,957	<0.5	1,023	338	957	87	22,588	(1,069)	21,519
Princeton Borough	20,795	60,127	N/A	N/A	44,524	-	5,159	1,702	4,827	964	138,097	(1,699)	136,398
Princeton Township	94,838	172,735	N/A	N/A	71,818	154	6,544	2,160	6,123	4,029	358,402	(7,999)	350,403
Trenton City	220,037	299,899	N/A	N/A	214,597	-	32,155	10,612	30,085	8,246	815,630	(2,689)	812,942
Washington Township	60,339	63,294	N/A	N/A	53,505	936	4,409	1,455	4,125	2,923	190,986	8,103	199,089
West Windsor Township	119,888	98,286	N/A	N/A	193,718	618	9,860	3,254	9,225	4,058	438,907	8,671	447,578

Source: DVRPC, 2009

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Bucks County, PA – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Bedminster Township	47,920	16,162	304	N/A	22,452	10,514	1,608	625	1,771	31	101,387	382	101,768
Bensalem Township	234,333	196,792	14,949	119,727	273,646	140	19,036	7,398	20,973	3,832	890,825	(4,695)	886,131
Bridgeton Township	5,721	1,230	0	N/A	7,963	232	463	180	510	-	16,299	1,127	17,426
Bristol Borough	40,175	26,600	872	18,422	41,641	-	3,181	1,236	3,505	867	136,498	(905)	135,593
Bristol Township	224,569	125,446	16,038	131,455	178,224	15	17,666	6,865	19,464	2,404	722,146	(1,992)	720,154
Buckingham Township	102,994	28,864	1,653	5,324	67,289	7,853	6,043	2,348	6,658	1,243	230,269	1,951	232,220
Chalfont Borough	21,597	10,222	7,845	N/A	15,658	34	1,359	528	1,498	280	59,022	(298)	58,724
Doylestown Borough	35,510	44,080	0	16,922	47,765	<0.5	2,677	1,040	2,949	834	151,778	(1,088)	150,690
Doylestown Township	79,491	39,632	565	N/A	69,261	1,188	6,116	2,377	6,738	980	206,347	(3,058)	203,288
Dublin Borough	8,258	3,634	0	4,183	9,220	37	706	274	777	0	27,090	78	27,167
Durham Township	7,520	1,321	0	N/A	7,583	2,250	426	166	469	-	19,734	1,122	20,856
East Rockhill Township	19,530	8,492	0	N/A	21,273	1,204	1,853	720	2,041	-	55,113	(1,571)	53,541
Falls Township	125,018	105,958	49,339	97,904	126,752	192	11,080	4,306	12,206	2,369	535,124	(3,990)	531,134
Haycock Township	25,914	13,760	0	N/A	9,478	1,952	762	296	839	-	53,000	5,188	58,189
Hilltown Township	56,351	35,769	0	N/A	49,015	6,705	4,178	1,624	4,603	191	158,437	2,232	160,668
Hulmeville Borough	4,293	905	0	299	2,475	32	284	111	313	62	8,775	216	8,991
Ivyland Borough	3,868	5,248	0	1,560	6,699	21	274	107	302	84	18,164	(59)	18,106
Langhorne Borough	6,469	12,047	10,301	90,570	7,780	5	639	248	704	311	129,075	(235)	128,840
Langhorne Manor Borough	6,684	6,477	0	3,677	7,117	-	349	136	385	131	24,956	(177)	24,779
Lower Makefield Township	160,991	35,545	N/A	N/A	91,535	1,419	10,577	4,110	11,653	2,003	317,834	(4,373)	313,461
Lower Southampton Township	81,972	51,993	1,227	11,715	79,994	127	6,254	2,430	6,890	1,032	243,633	(1,965)	241,668
Middletown Township	177,398	107,066	3,124	15,457	190,432	506	15,376	5,975	16,940	2,370	534,645	(6,022)	528,623
Milford Township	39,669	20,032	0	N/A	38,007	7,139	3,080	1,197	3,393	-	112,516	9,045	121,562
Morrisville Borough	36,172	21,768	14,767	29,681	38,916	<0.5	3,173	1,233	3,496	686	149,891	(878)	149,013
New Britain Borough	11,550	6,234	0	N/A	11,238	5	748	291	824	85	30,975	(472)	30,503
New Britain Township	52,911	26,184	2,955	N/A	40,490	2,343	3,526	1,370	3,884	422	134,084	643	134,728
New Hope Borough	12,353	17,278	0	346	38,856	-	741	288	816	224	70,901	(45)	70,856
Newtown Borough	12,391	11,172	0	1,068	13,500	<0.5	729	283	803	195	40,142	(309)	39,833
Newtown Township	85,126	50,660	698	14,130	82,851	1,316	6,207	2,412	6,839	1,598	251,836	(240)	251,596
Nockamixon Township	16,541	2,970	0	N/A	19,073	3,605	1,195	464	1,316	-	45,164	9,408	54,572
Northampton Township	200,690	53,630	188	10,594	128,648	2,069	13,284	5,162	14,634	1,933	430,832	(9,859)	420,972
Penndel Borough	7,883	9,269	0	6,197	9,798	<0.5	775	301	854	242	35,319	(231)	35,087
Perkasie Borough	28,325	2,605	0	0	31,429	60	2,824	1,097	3,111	-	69,452	(865)	68,587
Plumstead Township	59,527	32,761	2,689	N/A	47,303	6,594	3,862	1,501	4,255	532	159,023	(1,734)	157,289
Quakertown Borough	32,904	20,319	0	N/A	50,362	9	2,854	1,109	3,144	-	110,700	(170)	110,530
Richland Township	34,076	17,092	0	N/A	50,414	4,253	4,066	1,580	4,480	-	115,961	10,840	126,801
Richlandtown Borough	2,037	140	0	N/A	3,959	25	437	170	481	-	7,248	(126)	7,122
Riegelsville Borough	2,710	495	0	N/A	13,098	261	275	107	303	-	17,250	(183)	17,068
Sellersville Borough	5,815	3,513	0	N/A	22,475	1	1,457	566	1,605	-	35,432	(445)	34,988
Silverdale Borough	1,081	420	0	0	4,315	9	316	123	348	-	6,611	(218)	6,393
Solebury Township	53,644	12,301	614	1,524	35,362	5,005	2,873	1,116	3,165	380	115,983	8,157	124,140
Springfield Township	30,601	7,462	0	N/A	21,333	7,205	1,651	642	1,819	-	70,713	4,437	75,150
Telford Borough	4,808	3,683	0	N/A	8,453	<0.5	706	274	778	87	18,790	(240)	18,550
Tinicum Township	18,442	3,381	0	N/A	21,631	5,835	1,382	537	1,523	-	52,731	4,969	57,700
Trumbauersville Borough	1,452	660	0	N/A	5,067	98	346	135	381	-	8,140	(119)	8,021

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

	Stationary Energy						Waste						
Municipality	**Residential**	**Commercial**	**Industrial Gas**	**Industrial Electricity**	**Mobile Energy**	**Agri-culture**	**Landfill**	**Waste water**	**Industrial Processes**	**Fugitive Methane**	**Gross Emissions**	**LULUCF**	**Net Emissions**
Tullytown Borough	8,285	10,603	2,076	11,945	13,479	-	647	251	712	112	48,111	(835)	47,276
Upper Makefield Township	53,914	7,708	0	0	32,933	3,802	2,772	1,077	3,054	99	105,360	8,103	113,462
Upper Southampton Township	63,848	39,714	1,285	22,746	63,030	164	5,022	1,952	5,533	1,459	204,753	(2,388)	202,365
Warminster Township	120,703	85,613	7,905	74,762	115,734	151	10,781	4,190	11,878	3,207	434,922	(4,043)	430,879
Warrington Township	89,110	56,026	220	N/A	80,039	1,548	7,214	2,803	7,948	1,769	246,676	5,856	252,533
Warwick Township	63,485	19,149	0	4,906	41,788	1,412	4,763	1,851	5,248	1,071	142,672	652	143,324
West Rockhill Township	41,443	24,367	5,904	N/A	26,312	1,892	1,494	581	1,647	40	103,681	(988)	102,692
Wrightstown Township	16,720	7,656	2,450	4,635	11,921	2,063	905	352	997	90	47,790	1,608	49,398
Yardley Borough	11,909	12,496	0	7,726	14,635	-	824	320	908	238	49,055	(607)	48,449

Source: DVRPC, 2009

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Chester County, PA – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste-water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Atglen Borough	2,193	672	15,564	N/A	9,744	68	437	170	481	58	29,387	260	29,648
Avondale Borough	4,049	4,326	468	12,192	7,445	23	355	138	390	57	29,441	(166)	29,275
Birmingham Township	24,409	8,173	185	2,145	14,661	448	1,381	536	1,519	335	53,790	(1,621)	52,169
Caln Township	56,281	30,806	720	24,173	56,521	199	3,973	1,541	4,370	693	179,276	5,958	185,235
Charlestown Township	27,174	14,751	6,298	6,984	23,752	1,039	1,886	732	2,074	269	84,959	7,123	92,082
Coatesville City	46,228	13,656	7,419	293,162	31,142	-	3,721	1,444	4,093	658	401,522	3,225	404,747
Downingtown Borough	26,266	27,283	3,591	46,037	43,713	31	2,544	987	2,798	630	153,878	(358)	153,520
East Bradford Township	47,714	6,590	0	3,537	30,146	1,173	3,293	1,278	3,623	520	97,874	3,408	101,282
East Brandywine Township	30,150	5,867	0	1,658	22,171	929	2,088	810	2,297	4	65,975	1,831	67,806
East Caln Township	17,517	21,291	0	5,850	24,814	26	1,338	519	1,471	428	73,254	8,461	81,715
East Coventry Township	26,037	6,342	0	2,337	19,976	1,379	1,844	716	2,029	136	60,797	(1,122)	59,675
East Fallowfield Township	31,194	3,621	2,956	N/A	22,205	1,790	2,172	843	2,389	232	67,402	1,658	69,061
East Goshen Township	88,894	40,327	0	12,771	75,901	207	5,777	2,242	6,355	1,070	233,544	(1,031)	232,514
East Marlborough Township	36,686	21,477	2,548	11,218	32,509	2,141	2,509	974	2,760	532	113,355	2,690	116,044
East Nantmeal Township	11,271	2,645	0	N/A	8,728	1,765	604	234	664	0	25,910	2,044	27,954
East Nottingham Township	28,342	6,473	0	3,712	30,246	3,321	2,574	999	2,832	-	78,500	3,813	82,312
East Pikeland Township	32,613	12,938	1,161	4,432	26,996	868	2,207	856	2,428	393	84,893	241	85,134
Easttown Township	59,344	24,909	885	1,807	45,293	192	3,366	1,306	3,703	1,069	141,875	(2,709)	139,165
East Vincent Township	28,101	7,574	0	0	22,965	1,749	2,086	810	2,295	175	65,756	(1,550)	64,206
East Whiteland Township	37,140	144,547	15,879	99,894	145,642	211	3,336	1,294	3,669	919	452,531	3,244	455,775
Elk Township	8,249	621	0	0	8,809	1,589	478	185	526	2	20,459	1,101	21,560
Elverson Borough	1,009	667	0	N/A	21,884	51	377	146	415	-	24,549	(141)	24,408
Franklin Township	20,126	1,820	0	2,625	16,733	1,641	1,384	537	1,523	40	46,431	(577)	45,854
Highland Township	7,327	1,623	0	N/A	6,792	3,781	387	150	426	4	20,491	1,921	22,411
Honey Brook Borough	2,063	1,015	332	N/A	7,875	28	449	174	494	51	12,481	(221)	12,260
Honey Brook Township	23,666	13,967	499	N/A	27,248	4,082	2,209	857	2,430	66	75,026	4,902	79,928
Kennett Township	39,932	33,375	2,292	19,531	35,118	1,419	2,341	908	2,575	367	137,857	(544)	137,313
Kennett Square Borough	19,495	17,602	1,125	22,058	27,390	15	1,713	665	1,884	337	92,283	(391)	91,892
London Britain Township	9,996	344	0	0	12,987	867	976	379	1,073	-	26,622	182	26,804
Londonderry Township	8,313	1,717	0	1,658	8,079	2,240	597	232	657	6	23,500	2,065	25,565
London Grove Township	29,364	13,761	0	3,190	23,019	2,530	2,022	785	2,225	370	77,265	(1,035)	76,230
Lower Oxford Township	3,627	1,032	0	0	20,200	3,246	1,589	616	1,748	-	32,057	1,233	33,289
Malvern Borough	13,230	12,651	2,594	13,506	19,484	6	1,003	389	1,104	319	64,286	177	64,464
Modena Borough	2,355	439	4,116	5,516	2,091	4	195	76	214	2	15,008	(84)	14,924
New Garden Township	45,736	80,558	4,763	28,343	50,106	1,713	3,568	1,384	3,925	742	220,839	4,312	225,151
Newlin Township	4,558	204	0	0	5,258	1,684	401	156	441	-	12,702	2,350	15,053
New London Township	23,853	4,180	0	281	20,489	1,468	1,774	688	1,952	8	54,693	1,732	56,426
North Coventry Township	35,264	17,488	0	11,725	52,063	970	2,465	957	2,712	318	123,963	2,236	126,200
Oxford Borough	10,920	6,696	0	6,661	19,479	160	1,516	588	1,667	0	47,687	(685)	47,003
Parkesburg Borough	13,737	3,950	0	N/A	14,362	52	1,115	433	1,227	113	34,988	(484)	34,504
Penn Township	20,762	14,270	863	5,834	19,045	1,405	1,492	579	1,641	317	66,208	(579)	65,629
Pennsbury Township	19,315	4,410	0	3,899	17,220	901	1,251	485	1,375	153	49,009	1,059	50,068
Phoenixville Borough	61,682	33,689	2,394	19,739	52,072	27	4,991	1,936	5,490	1,122	183,143	1,830	184,972
Pocopson Township	15,761	5,361	3,784	4,632	11,882	1,071	1,091	423	1,201	128	45,334	44	45,378
Sadsbury Township	15,023	9,004	0	N/A	13,138	841	1,048	407	1,153	232	40,845	502	41,348

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste-water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Schuylkill Township	41,743	16,954	6,376	49,935	31,406	294	2,473	960	2,720	716	153,577	328	153,904
South Coatesville Borough	5,314	2,226	0	58,959	4,955	40	344	133	378	63	72,412	604	73,016
South Coventry Township	11,644	4,847	0	3,027	11,644	719	772	299	849	56	33,857	1,074	34,931
Spring City Borough	14,440	9,730	422	7,323	12,746	19	1,063	412	1,169	265	47,591	(159)	47,432
Thornbury Township	15,081	4,186	5,156	8,329	13,187	196	949	368	1,044	242	48,738	(1,019)	47,719
Tredyffrin Township	143,984	158,286	13,683	145,191	225,145	165	9,413	3,652	10,355	2,551	712,425	(2,619)	709,806
Upper Oxford Township	8,042	331	0	0	11,417	3,386	767	298	844	-	25,086	1,722	26,808
Upper Uwchlan Township	49,435	14,426	0	1,967	31,115	592	2,606	1,011	2,867	552	104,573	10,377	114,950
Uwchlan Township	78,886	77,709	3,525	35,866	71,540	371	5,929	2,300	6,522	1,297	283,944	1,945	285,890
Valley Township	27,659	11,717	1,344	3,661	21,344	317	1,956	759	2,152	283	71,192	4,699	75,891
Wallace Township	4,012	762	0	N/A	13,369	868	1,101	427	1,211	-	21,750	1,526	23,277
Warwick Township	9,183	1,997	0	N/A	15,203	1,628	872	338	959	-	30,180	3,653	33,834
West Bradford Township	55,947	7,880	0	3,940	35,121	1,561	3,785	1,468	4,163	165	114,030	5,716	119,746
West Brandywine Township	32,361	8,612	226	N/A	27,844	1,238	2,472	959	2,720	145	76,577	1,163	77,739
West Caln Township	39,756	6,374	0	N/A	32,412	2,033	2,528	981	2,781	79	86,943	10,973	97,916
West Chester Borough	53,182	58,389	862	50,189	66,102	-	5,841	2,266	6,425	1,546	244,801	(913)	243,888
West Fallowfield Township	13,780	4,693	330	N/A	13,459	3,795	839	326	923	7	38,152	517	38,669
West Goshen Township	86,659	101,878	12,399	94,977	123,666	99	6,854	2,659	7,539	2,095	438,825	(827)	437,998
West Grove Borough	9,653	5,943	0	2,604	10,878	10	854	332	940	133	31,347	(251)	31,096
West Marlborough Township	3,535	350	0	0	5,035	3,842	281	109	309	-	13,462	307	13,769
West Nantmeal Township	8,142	2,814	0	N/A	11,297	1,988	710	275	781	-	26,008	5,503	31,511
West Nottingham Township	17,264	5,196	0	17,880	18,136	1,535	892	346	981	0	62,231	2,106	64,337
West Pikeland Township	23,921	2,093	0	0	15,027	900	1,291	501	1,420	101	45,253	2,713	47,966
West Sadsbury Township	8,498	6,748	0	N/A	14,446	1,807	809	314	890	114	33,626	1,399	35,025
Westtown Township	48,827	16,150	190	3,657	40,346	430	3,434	1,332	3,777	451	118,595	(1,132)	117,464
West Vincent Township	21,548	3,985	0	0	14,900	2,217	1,258	488	1,384	54	45,833	6,313	52,146
West Whiteland Township	82,944	102,810	282	41,657	144,735	455	5,938	2,304	6,531	1,838	389,493	1,174	390,667
Willistown Township	59,226	22,575	2,823	11,472	57,347	1,575	3,477	1,349	3,825	512	164,181	4,985	169,165

Source: DVRPC, 2009

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Delaware County, PA – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste-water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Aldan Borough	17,554	2,064	0	2,406	9,665	-	1,389	539	1,528	367	35,511	(331)	35,181
Aston Township	69,991	30,336	1,530	25,119	65,756	16	5,440	2,111	5,984	1,148	207,430	3,757	211,187
Bethel Township	37,937	4,696	0	14,809	80,222	66	2,947	1,143	3,242	523	145,587	5,859	151,446
Brookhaven Borough	34,571	10,048	160	4,037	28,692	530	2,539	985	2,793	622	84,978	1,845	86,824
Chadds Ford Township	25,286	23,642	0	5,644	44,873	-	1,038	403	1,142	359	102,385	(722)	101,663
Chester City	113,027	54,787	122,907	90,413	100,401	-	11,989	4,652	13,188	2,960	514,323	(2,115)	512,208
Chester Township	16,186	13,591	12,650	8,706	16,198	-	1,457	565	1,603	440	71,397	16,015	87,411
Chester Heights Borough	12,092	5,439	0	1,344	14,172	50	802	311	882	107	35,199	(12,816)	22,383
Clifton Heights Borough	25,068	7,861	0	1,477	17,573	-	2,144	832	2,358	516	57,829	(364)	57,465
Collingdale Borough	29,740	10,552	0	262	14,977	-	2,750	1,067	3,026	715	63,089	(478)	62,611
Colwyn Borough	7,749	1,578	0	0	4,421	-	774	300	852	200	15,875	(135)	15,740
Concord Township	61,246	57,724	4,450	27,237	87,091	346	4,924	1,911	5,416	1,251	251,596	4,582	256,178
Darby Borough	30,968	10,217	3,591	11,841	18,726	-	3,250	1,261	3,575	789	84,218	(32)	84,186
Darby Township	30,480	10,329	0	9,609	21,550	-	3,122	1,211	3,434	741	80,479	(309)	80,170
East Lansdowne Borough	9,464	2,102	0	0	4,047	-	814	316	896	219	17,857	(118)	17,739
Eddystone Borough	8,949	16,165	10,232	16,629	13,203	-	770	299	847	332	67,426	(329)	67,098
Edgmont Township	19,174	13,349	0	678	19,901	348	1,343	521	1,477	96	56,888	1,159	58,047
Folcroft Borough	21,269	16,408	235	3,832	20,700	-	2,234	867	2,458	650	68,653	(499)	68,155
Glenolden Borough	24,009	14,407	1,422	10,245	21,036	-	2,365	917	2,601	684	77,685	(454)	77,231
Haverford Township	199,482	56,063	684	17,064	133,828	15	15,777	6,121	17,354	4,769	451,157	(4,629)	446,528
Lansdowne Borough	40,120	13,747	508	12,428	27,067	-	3,490	1,354	3,839	1,085	103,639	(668)	102,971
Lower Chichester Township	12,793	6,943	0	3,311	33,731	-	1,131	439	1,244	236	59,828	(475)	59,354
Marcus Hook Borough	8,742	10,374	0	399,247	32,198	-	733	284	806	175	452,559	(617)	451,942
Marple Township	99,171	56,262	646	22,196	93,520	27	7,625	2,959	8,388	2,267	293,060	(1,566)	291,494
Media Borough	21,558	34,174	2,703	15,650	36,732	-	1,764	684	1,940	614	115,818	(369)	115,449
Middletown Township	59,030	29,534	6,154	72,520	83,134	327	5,215	2,023	5,736	735	264,407	(1,087)	263,320
Millbourne Borough	2,235	1,145	0	0	1,866	-	297	115	327	68	6,053	(152)	5,901
Morton Borough	10,220	7,292	0	775	10,111	-	862	335	948	248	30,792	(207)	30,585
Nether Providence Township	62,321	10,961	261	3,492	41,883	5	4,303	1,670	4,734	951	130,581	(1,408)	129,173
Newtown Township	59,391	42,617	6,553	37,584	64,274	321	3,834	1,488	4,218	900	221,177	3,572	224,750
Norwood Borough	21,928	4,908	0	0	13,644	-	1,893	735	2,082	449	45,639	(357)	45,283
Parkside Borough	8,779	1,357	0	0	6,286	-	716	278	787	139	18,342	(108)	18,234
Prospect Park Borough	22,650	11,167	3	0	18,695	-	2,086	810	2,295	537	58,242	(379)	57,863
Radnor Township	129,485	(18,807)	16,562	109,501	155,744	271	10,029	3,891	11,032	3,603	421,311	(6,251)	415,060
Ridley Township	111,885	46,156	465	73,337	100,261	-	9,780	3,794	10,757	2,450	358,887	(7,324)	351,563
Ridley Park Borough	27,532	10,351	1,215	6,191	22,823	-	2,285	886	2,513	614	74,410	5,217	79,627
Rose Valley Borough	5,489	(143)	0	0	2,709	-	300	116	330	53	8,854	(292)	8,562
Rutledge Borough	3,435	233	0	0	1,777	-	271	105	298	57	6,176	(89)	6,087
Sharon Hill Borough	19,298	15,162	0	1,466	14,749	-	1,733	672	1,906	591	55,579	(379)	55,201
Springfield Township	97,803	50,451	3,689	32,053	93,716	-	7,471	2,899	8,218	2,558	298,855	(2,020)	296,835
Swarthmore Borough	21,850	8,457	0	11,572	24,840	-	1,988	771	2,187	562	72,228	(176)	72,051
Thornbury Township	29,704	4,452	0	0	24,613	342	2,229	865	2,452	344	65,001	105	65,105
Tinicum Township	17,339	34,232	3,284	25,834	86,958	16	1,376	534	1,514	604	171,692	(2,834)	168,858
Trainer Borough	7,532	4,850	13,979	279,945	10,773	-	602	234	662	108	318,686	(296)	318,390
Upland Borough	10,932	6,245	0	21,093	15,834	-	942	365	1,036	226	56,673	(257)	56,416

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

	Stationary Energy						Waste						
Municipality	**Residential**	**Commercial**	**Industrial Gas**	**Industrial Electricity**	**Mobile Energy**	**Agri-culture**	**Landfill**	**Waste-water**	**Industrial Processes**	**Fugitive Methane**	**Gross Emissions**	**LULUCF**	**Net Emissions**
Upper Chichester Township	70,308	37,450	447	20,722	128,502	19	5,622	2,181	6,184	1,258	272,693	2,361	275,054
Upper Darby Township	268,157	115,572	12,885	47,566	192,474	-	25,985	10,082	28,584	7,538	708,844	(3,681)	705,163
Upper Providence Township	49,764	15,339	702	1,234	38,367	5	3,608	1,400	3,968	776	115,162	(1,324)	113,838
Yeadon Borough	40,111	20,477	2,435	6,692	28,018	-	3,722	1,444	4,095	1,282	108,276	(843)	107,433

Source: DVRPC, 2009

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

Montgomery County, PA – 2005 Greenhouse Gas Emissions Allocated to Municipality ($MTCO_2E$)

	Stationary Energy						Waste						
Municipality	Residential	Commercial	Industrial Gas	Industrial Electricity	Mobile Energy	Agri-culture	Landfill	Waste water	Industrial Processes	Fugitive Methane	Gross Emissions	LULUCF	Net Emissions
Abington Township	245,121	84,324	18,923	85,885	200,775	179	18,066	7,010	19,872	5,996	686,149	(9,664)	676,485
Ambler Borough	25,784	11,228	636	20,847	21,338	-	2,088	810	2,297	560	85,588	(339)	85,248
Bridgeport Borough	18,542	12,125	0	38,761	16,176	-	1,434	556	1,577	429	89,601	(982)	88,619
Bryn Athyn Borough	5,138	4,919	1,707	3,336	5,800	143	441	171	485	78	22,218	(712)	21,506
Cheltenham Township	151,560	57,774	3,149	52,939	122,001	2	11,834	4,592	13,017	4,269	421,137	(2,774)	418,363
Collegeville Borough	19,114	12,990	0	8,756	21,688	35	1,538	597	1,692	463	66,872	(72)	66,799
Conshohocken Borough	31,733	40,634	7,848	13,431	34,471	-	2,671	1,036	2,938	909	135,672	(900)	134,772
Douglass Township	31,067	2,579	0	0	50,679	3,091	3,328	1,291	3,661	-	95,696	(761)	94,935
East Greenville Borough	4,418	1,877	0	0	13,403	10	1,005	390	1,106	88	22,297	(132)	22,165
East Norriton Township	55,176	46,738	1,480	15,906	58,745	246	4,401	1,708	4,842	1,087	190,330	(581)	189,749
Franconia Township	46,096	34,039	18,292	N/A	48,944	2,451	3,950	1,533	4,345	237	159,886	(4,101)	155,785
Green Lane Borough	2,339	1,888	0	972	3,668	3	191	74	210	33	9,378	(16)	9,363
Hatboro Borough	26,498	18,726	365	4,082	31,990	-	2,374	921	2,611	524	88,092	(613)	87,479
Hatfield Borough	7,365	6,414	7,664	N/A	12,898	10	935	363	1,029	182	36,860	(526)	36,333
Hatfield Township	65,917	70,253	9,815	N/A	84,351	732	5,691	2,208	6,260	974	246,201	(5,557)	240,644
Horsham Township	106,518	138,886	7,158	N/A	146,876	837	8,166	3,169	8,983	2,378	422,971	(7,178)	415,793
Jenkintown Borough	16,445	25,729	2,408	25,786	24,000	-	1,434	557	1,578	647	98,583	(391)	98,192
Lansdale Borough	68,294	23,367	9,311	N/A	58,444	4	5,183	2,011	5,701	1,243	173,559	(2,397)	171,162
Limerick Township	72,811	47,511	1,376	31,343	72,452	2,695	5,344	2,074	5,879	1,353	242,838	(1,019)	241,819
Lower Frederick Township	19,739	5,887	0	1,225	18,057	823	1,591	617	1,750	81	49,771	(1,201)	48,570
Lower Gwynedd Township	60,529	28,544	18,882	61,003	56,721	252	3,578	1,388	3,935	1,371	236,202	(5,730)	230,472
Lower Merion Township	323,102	161,097	21,626	172,482	267,051	35	18,963	7,358	20,859	8,740	1,001,313	(18,375)	982,938
Lower Moreland Township	61,850	26,688	2,310	10,689	44,545	175	3,815	1,480	4,196	1,352	157,099	(1,658)	155,441
Lower Pottsgrove Township	38,373	20,732	0	7,142	47,294	328	3,924	1,522	4,316	453	124,085	(663)	123,422
Lower Providence Township	95,307	61,814	4,170	57,142	90,325	580	8,062	3,128	8,868	1,536	330,931	(4,671)	326,260
Lower Salford Township	63,879	30,730	559	N/A	59,471	1,721	4,630	1,797	5,093	616	168,496	(2,696)	165,800
Marlborough Township	21,447	6,440	0	0	12,872	914	1,065	413	1,172	33	44,356	(35)	44,321
Montgomery Township	103,394	94,212	3,638	N/A	127,479	301	7,887	3,060	8,675	2,300	350,944	(6,770)	344,174
Narberth Borough	17,937	8,915	848	474	15,378	-	1,353	525	1,488	491	47,409	(301)	47,108
New Hanover Township	26,709	1,342	0	0	33,418	2,830	2,914	1,131	3,205	-	71,548	4,033	75,582
Norristown Borough	107,276	62,192	3,919	48,158	97,722	34	10,100	4,004	11,352	2,882	347,637	(2,537)	345,100
North Wales Borough	14,814	7,670	2,060	0	13,401	-	1,075	417	1,182	203	40,822	(377)	40,445
Pennsburg Borough	4,715	3,389	0	0	14,886	22	1,098	426	1,208	126	25,870	51	25,921
Perkiomen Township	33,381	8,854	0	2,659	30,209	360	2,701	1,048	2,971	468	82,651	33	82,684
Plymouth Township	61,686	108,932	82,168	134,108	136,076	172	5,291	2,053	5,820	1,818	538,123	(6,693)	531,430
Pottstown Borough	90,768	71,279	11,565	51,778	108,256	-	7,020	2,724	7,721	1,320	352,431	(1,453)	350,978
Red Hill Borough	7,185	1,347	0	0	9,658	36	768	298	844	66	20,202	(254)	19,948
Rockledge Borough	9,725	3,801	0	0	9,342	<0.5	827	321	909	246	25,170	(85)	25,085
Royersford Borough	17,387	13,903	533	4,331	18,141	-	1,410	547	1,551	290	58,094	(301)	57,793
Salford Township	21,226	6,106	0	N/A	9,196	855	831	323	915	22	39,475	(6,876)	32,598
Schwenksville Borough	5,956	6,363	0	17,796	7,644	6	443	172	488	66	38,933	133	39,066
Skippack Township	42,279	14,653	1,782	10,393	37,755	2,002	4,020	1,560	4,422	457	119,322	844	120,166
Souderton Borough	15,035	9,467	0	N/A	25,923	5	2,179	846	2,397	289	56,141	(710)	55,432
Springfield Township	86,601	38,875	4,487	24,204	70,970	140	6,285	2,439	6,914	2,892	243,807	(2,616)	241,191
Telford Borough	1,580	852	0	N/A	9,420	<0.5	797	309	877	61	13,896	(287)	13,609

See Table 22 for information on emissions included in and excluded from municipality level inventory allocation.

	Stationary Energy						Waste						
Municipality	**Residential**	**Commercial**	**Industrial Gas**	**Industrial Electricity**	**Mobile Energy**	**Agri-culture**	**Landfill**	**Waste water**	**Industrial Processes**	**Fugitive Methane**	**Gross Emissions**	**LULUCF**	**Net Emissions**
Towamencin Township	70,191	39,999	373	N/A	60,301	634	5,856	2,272	6,441	1,153	187,221	(4,187)	183,034
Trappe Borough	16,079	7,021	949	9,272	15,954	229	1,115	433	1,226	206	52,484	(195)	52,289
Upper Dublin Township	120,774	64,594	3,567	67,307	126,460	193	8,451	3,279	9,296	2,672	406,593	(7,509)	399,084
Upper Frederick Township	15,430	1,981	0	0	13,735	1,689	1,197	465	1,317	11	35,825	(1,140)	34,685
Upper Gwynedd Township	62,137	41,031	227,942	159,390	71,081	348	4,754	1,844	5,229	1,275	575,032	(8,235)	566,797
Upper Hanover Township	41,007	15,983	17,588	0	37,299	3,479	1,818	706	2,000	17	119,896	(1,844)	118,053
Upper Merion Township	103,212	198,967	51,915	350,413	277,676	10	8,871	3,442	9,759	3,511	1,007,778	(18,141)	989,637
Upper Moreland Township	91,530	89,817	4,846	47,703	104,475	75	8,065	3,129	8,871	2,618	361,130	(4,797)	356,333
Upper Pottsgrove Township	13,614	4,241	133	1,460	18,615	437	1,605	623	1,765	185	42,677	1,425	44,102
Upper Providence Township	83,808	54,223	31,402	122,152	83,839	1,694	5,955	2,310	6,550	1,553	393,486	2,007	395,493
Upper Salford Township	16,412	4,662	0	N/A	12,729	1,457	1,014	394	1,116	6	37,790	(2,708)	35,082
West Conshohocken Borough	6,744	16,435	312	10,693	19,055	-	492	191	542	219	54,683	(1,545)	53,138
West Norriton Township	64,505	35,834	9,563	20,915	64,008	154	5,002	1,856	5,261	1,433	208,529	(1,594)	206,935
West Pottsgrove Township	15,238	9,449	1,093	3,736	20,506	32	1,248	484	1,373	122	53,281	(373)	52,909
Whitemarsh Township	82,050	72,130	11,206	62,717	99,822	747	5,588	2,168	6,147	2,121	344,696	6,694	351,390
Whitpain Township	94,416	60,283	2,025	31,110	119,242	473	6,123	2,376	6,735	1,824	324,606	(9,042)	315,564
Worcester Township	46,652	20,663	2,203	30,668	38,037	2,525	2,865	1,112	3,152	591	148,467	(4,429)	144,038

Source: DVRPC, 2009

APPENDIX B: INVENTORY ADVISORY GROUP AND OTHER STAKEHOLDERS

APPENDIX B: INVENTORY ADVISORY GROUP AND OTHER STAKEHOLDERS

The individuals listed below participated in one or more meetings of the Greenhouse Gas Emissions Inventory Advisory Group or otherwise provided or facilitated feedback and guidance as the inventory was being prepared.

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Geographic Area Covered: DVRPC's nine member counties (Bucks, Chester, Delaware, Montgomery, and Philadelphia counties in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer counties in New Jersey).

Key Words: Greenhouse gas; climate change; energy; emissions; inventory.

Abstract: The *Regional Greenhouse Gas Emissions Inventory* provides an accounting of greenhouse gas emissions for the nine-county DVRPC region for 2005. This inventory was carried out in close consultation with the US EPA to assure the protocol used conforms where possible to the agency's current thinking on MPO-level inventories. DVRPC also consulted with both the Commonwealth of Pennsylvania and the State of New Jersey, as well as with ICLEI—Local Governments for Sustainability. The protocol used drew on the state inventories developed using the state inventory tool, as well as local data where available. This work was carried out with the consulting support of ICF International.

The inventory allocates emissions to the each of the nine counties and 352 municipalities in the region. This sub-regional allocation excludes several emissions categories which were not feasible to allocate with available data, including emissions from aircraft, through highway traffic, some industrial fuel use, and livestock. Nonetheless, 90 percent of all emissions for the region are allocated to the county level, and 84 percent to the municipal level.

Electricity and natural gas use information was collected at either the municipal or ZIP code level by customer class (residential, commercial, industrial) from each of the dozen or so utilities that serve the region. Vehicle miles traveled (VMT) in the region was allocated to municipalities by assigning half of each trip to the municipality of origin and half to the destination municipality.

The results clearly demonstrate that municipalities with higher density tend to produce lower per capita emissions.

DVRPC will use this inventory in its work to develop policies and programs for the region to reduce greenhouse gas emissions. DVRPC will also use this inventory to support inventory efforts at the county and municipality level, as well as to support regional analysis of where investments in energy conservation and efficiency might be most productively made.

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