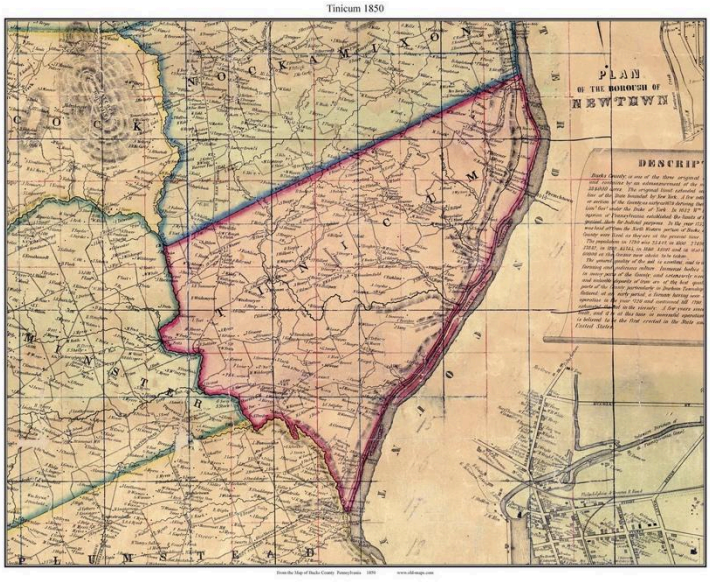
Tinicum Township

Inventory of Communitywide and LGO Greenhouse Gas Emissions – 2023



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Executive Summary

Tinicum Township recognizes that greenhouse gas (GHG) emissions from human activity are catalyzing profound climate change, the consequences of which pose substantial risks to the future health, wellbeing, and prosperity of our community.

Tinicum is a small community that faces significant vulnerabilities due to its location and the impacts of climate change. A major contributing factor to this vulnerability is the age of its residents. According to data from the Environmental Protection Agency's Environmental Justice Screening and Mapping Tool, 80% to 85% of Tinicum's population is over the age of 65 (Environmental Protection Agency). This demographic is particularly susceptible to the adverse effects of climate change, which could have serious implications on the well-being of the community.

Currently, Tinicum has not implemented any specific initiatives aimed at sustainability. With growing environmental challenges, supporting Tinicum efforts in sustainability will prove to be essential for the township's resilience.

The community-wide inventory measures and analyzes emissions from all activities within the township's boundaries. In 2023, Tinicum released 38, 138 MTCO2e. The contributing sectors were wastewater, solid waste, commercial/industrial energy, residential energy and the most emissive being transpiration. Overall, emissions were relatively low compared to the larger and more populous municipalities surrounding Tinicum. However, per capita emissions did not reflect this trend and were higher than those of some surrounding areas.

This inventory also analyzed emissions from local government operations. These values are not separate from community emissions, they are embedded within them. Government operations released 229 MTCO2, with the largest contributing sector being buildings and facilities, followed by the vehicle fleet, employee commutes, solid waste, traffic signals, and wastewater.

Key Findings

Figure 1 shows communitywide emissions by sector. The largest contributor is Transportation and Mobile Sources with 61% of emissions. The next largest contributors are the Residential Energy (21%) and Commercial/Industry Energy sectors (13%). Actions to reduce emissions in all of these sectors will be a key part of a climate action plan. Solid Waste and Water/ Wastewater were responsible for the remaining 5% of emissions.

Figure 2 displays emissions resulting from various government activities. The highest-emitting operation is buildings and facilities (52%), followed by the vehicle fleet (25%), employee commutes (17%), and the remainder from solid waste, traffic signals, and wastewater. Analyzing government emissions is important because these are areas where the local government has the most control and the greatest ability to reduce energy use and emissions.

The Inventory Results section of this report provides a detailed profile of emissions sources within Tinicum Township; information that is key to guiding local reduction efforts. These data will also provide a baseline against which the city will be able to compare future performance and demonstrate progress in reducing emissions.

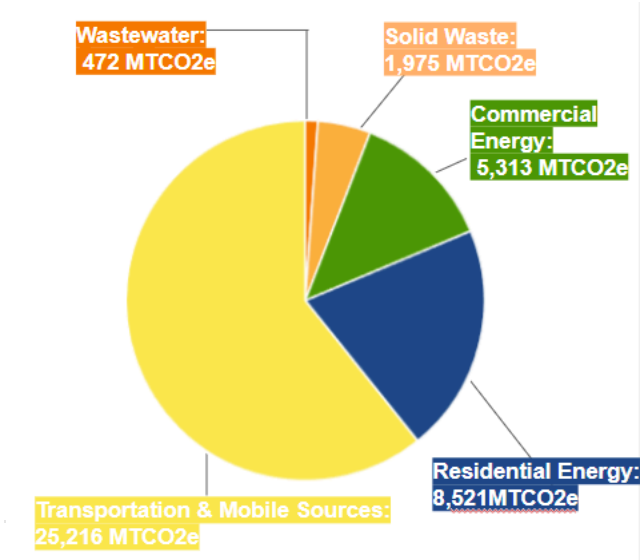


Figure 1: 2023 Emissions by Sector for Tinicum Township

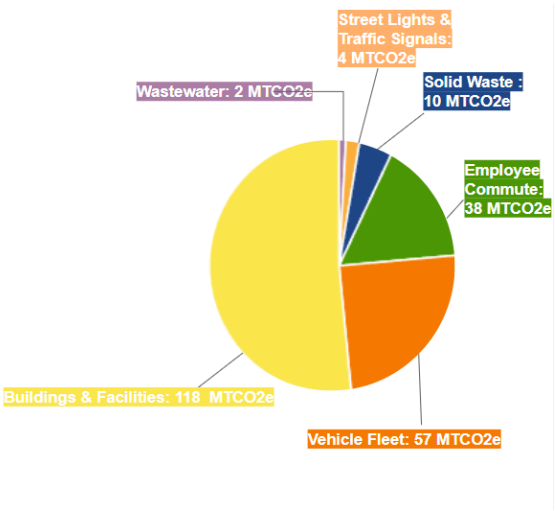


Figure 2: 2023 Emissions by sector for Tinicum's government operations

Introduction to Climate Change

Naturally occurring gases in the atmosphere trap solar radiation and influence the Earth's climate. This phenomenon is known as the **greenhouse effect**. While the greenhouse effect is a naturally occurring phenomenon that makes life on this planet possible, overwhelming evidence shows that human activities are increasing the concentration of greenhouse gases and changing the global climate. The most significant contributor is the burning of fossil fuels for transportation, electricity generation, and other purposes, which introduces large amounts of carbon dioxide and other greenhouse gases into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise, threatening the safety, quality of life, and economic prosperity of global communities. Although the natural greenhouse effect is needed to keep the Earth warm, a human-enhanced greenhouse effect with the rapid accumulation of GHG in the atmosphere leads to too much heat and radiation being trapped. The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report confirms that human activities have unequivocally caused an increase in carbon emissions[1]. Communities like Tinicum Township are already experiencing the consequences of global climate change.

Based on the IPCC report, human activities are estimated to already have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system, such as sea level rise, with associated impacts (high confidence), but these emissions alone are unlikely to cause global warming of 1.5°C (medium confidence). Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C (high confidence). These risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options [2].

[1]IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

[2]IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

Frankenfield Covered Bridge in Tinicum, PA. Retrieved from https://kids.kiddle.co/Frankenfield_Covered_Bridge.

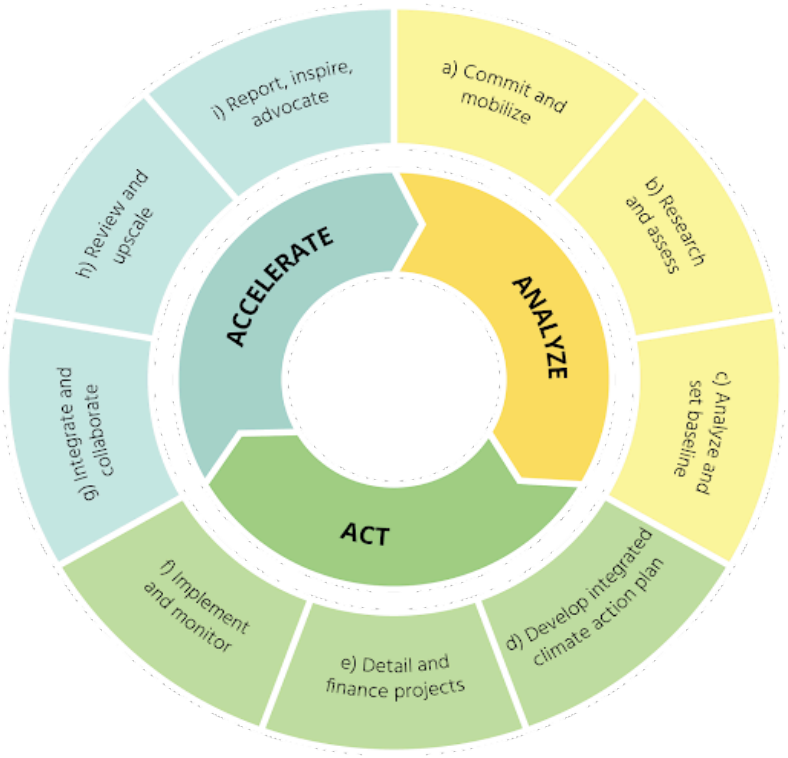
According to the 2021 Pennsylvania Climate Impacts Assessment, Pennsylvania's average temperatures are projected to rise significantly, with daily temperatures expected to increase by 4.0 to 8.0°F by mid-century and 6.4 to 12.4°F by the end of the century. The greatest warming is expected during the summer months. Days above 95°F and 100°F will also increase. These changes will extend the growing season, increase the need for air conditioning, and lower the need for heating. Annual average precipitation is also expected to rise, with an 8% increase by mid-century and a 12% increase by the end of the century compared to historical levels from 1971–2000. Rainfall will likely occur in fewer but heavier storms, leading to stronger and more frequent extreme rain events, while droughts are also expected to become more common.

Communities are often the first to feel the effects of climate change, so addressing its causes and impacts locally is both practical and effective. Many towns and cities are stepping up to act. Reducing the use of fossil fuels not only cuts greenhouse gas emissions but also brings other benefits to these places. Making homes and businesses more energy efficient lowers utility bills allowing people to save money on energy, so that they can then spend more in the local economy. Additionally, reducing fossil fuel use also improves air quality, which is especially beneficial for the health of children and the elderly in communities. By focusing on sustainable practices, communities can build stronger, healthier, and more resilient futures.

ICLEI GreenClimateCities Framework

For this inventory, Tinicum's process is informed by ICLEI's GreenClimateCities Framework for integrated climate action. The Tinicum framework follows the stepwise approach shown below in Figure 3, which involves collecting and analyzing climate data, action, implementation, leadership, and collaboration—always with an equity lens.

The Framework is organized into Analyze, Act, and Accelerate phases for communities pursuing integrated climate action. The Framework incorporates greenhouse gas emissions reductions, climate adaptation actions, and equitable, inclusive decision-making.



Over 600 U.S. communities have followed this basic Framework, previously known as ICLEI's Five Milestones for Emissions Management, and today, it is represented through the streamlined Analyze-Act-Accelerate model shown be

Figure 3: ICLEI GreenClimateCities Framework

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

Figure 3: Relationship of Community and Government Operations Inventory

The first step toward achieving tangible greenhouse gas emission reductions requires identifying baseline emissions levels and sources and activities generating emissions in the community.

This report discusses the **communitywide and government operations inventory** for Tinicum, covering emissions-generating activities for activity throughout the jurisdiction.

A **government operations inventory** is mostly a subset of the community inventory, as shown in Figure 3. For example, Tinicum's transportation data and vehicle miles traveled include the mileage from municipal fleet vehicles.

As local governments continue to join the climate protection movement, the need for a standardized approach to quantify GHG emissions has proven essential. This inventory uses the approach and methods provided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions, described below.

Three greenhouse gases are included in this inventory: carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Many of the charts in this report represent emissions in "carbon dioxide equivalent" (CO2e) values, calculated using the Global Warming Potentials (GWP) for methane and nitrous oxide from the IPCC 6th Assessment Report.

Table 1: Global Warming Potential Values (IPCC, 2021)

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO2)	1
Methane (CH4)	25
Nitrous Oxide (N2O)	298

Community Emissions Protocol

Version 1.2 of the U.S. Community Protocol for Accounting and Reporting GHG Emissions[3] was released by ICLEI in 2019 and represents a national standard in guidance to help U.S. local governments develop effective community GHG emissions inventories. It establishes reporting requirements for all community GHG emissions inventories, provides detailed accounting guidance for quantifying GHG emissions associated with a range of emission sources and community activities, and provides a number of optional reporting frameworks to help local governments customize their community GHG emissions inventory reports based on their local goals and capacities.

The community inventory in this report includes emissions from the five Basic Emissions Generating Activities required by the Community Protocol. These activities are:

- Use of electricity by the community
- Use of fuel in residential and commercial stationary combustion equipment
- Transportation
- Septic tanks
- Generation of solid waste by the community

Quantifying Greenhouse Gas Emissions

Sources and Activities

Communities contribute to greenhouse gas emissions in many ways. Two central categorizations of emissions are used in the community inventory: 1) GHG emissions that are produced by "sources" located within the community boundary, and 2) GHG emissions produced as a consequence of community "activities".

Source	Activity
Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere	The use of energy, materials, and/or services by members of the community that result in the creation of GHG emissions.

By reporting on both GHG emissions sources and activities, local governments can develop and promote a deeper understanding of GHG emissions associated with their communities. A purely source-based emissions inventory could be summed to estimate total emissions released within the community's jurisdictional boundary. In contrast, a purely activity-based emissions inventory could provide perspective on the efficiency of the community, even when the associated emissions occur outside the jurisdictional boundary. The division of emissions into sources and activities replaces the scopes

[3] ICLEI. 2012. US Community Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/tools/ghg-protocol/community-protocol

framework that is used in government operations inventories, but that does not have a clear definition for application to community inventories.

Base Year

The inventory process requires the selection of a base year with which to compare current emissions. Tinicum's community greenhouse gas emissions inventory utilizes **2023** as its baseline year, because it is the most recent year for which the necessary data are available.

Quantification Methods

Greenhouse gas emissions can be quantified in two ways:

- **Measurement-based methodologies** refer to the direct measurement of greenhouse gas emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.
- **Calculation-based methodologies** calculate emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:

Activity Data x Emission Factor = Emissions

Most emissions sources in this inventory are quantified using calculation-based methodologies. Activity data refer to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see appendices for a detailed listing of the activity data used in composing this inventory.

Known emission factors are used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g. lbs CO2/kWh of electricity). For this inventory, calculations were made using ICLEI's ClearPath tool.

Inventory Results

Table 2: Communitywide Emissions Inventory

Sector	Fuel or source	2023 Usage	Usage unit	2023 Emissions ($MTCO_2e$)
Residential energy	Electricity (MetEd)	44,556,386	kWh	8521
	Natural Gas	9090	MMBtu	483
	Wood	50428	MMBtu	491
	LPG	23136	MMBtu	1471
	Distillate Fuel Oil	12498	MMBtu	931
	Kerosene	160	MMBtu	12
Residential energy total				**8521 MTCO2e**
Commercial/ industrial energy	Electricity (MetEd)	4073891	MMBtu	1220
	LPG	7000	MMBtu	445
	Distillate Fuel Oil	49000	MMBtu	3648
Commercial energy total				**5313 MTCO2e**
On-road transportation	Gasoline	49879013	VMT	19392
	Diesel	4596367	VMT	5824
Transportation total				**25216 MTCO2e**
Solid Waste	Waste Generated	4315	Tons	1975
Solid waste total				**1975 MTCO2e**
Septic	Fugitive Emissions	3995	Pop. Served	47
Septic total				**472 MTCO2e**
			Total community-wide emissions	**41497 MTCO2e**

Residents in Tinicum Township drive frequently due to limited nearby businesses, services, and public transportation, resulting in high vehicle miles traveled. Most homes rely on distillate fuel oil or kerosene for heating, followed by LP gas, wood, utility gas, and electricity. The electricity is generated from fossil fuels, contributing to significant stationary energy emissions. The township's commercial and industrial sectors are small, with few businesses and low energy use. Solid waste emissions are hard to estimate because residents' contract with private waste haulers, and the destination and makeup of their waste is unknown. Septic systems are used instead of centralized wastewater treatment, and they produce fugitive emissions like methane and nitrous oxide as waste breaks down and gases escape.

Table 3: Government Operations Emissions Inventory

Operation	Fuel or source	2023 Usage	Usage unit	2023 Emissions ($MTCO_2e$)
Buildings & Facilities	Electricity (MetEd)		kWh	18
	Reusable Oil		Gallons	54
	Propane		Gallons	26
	Fuel Oil		Gallons	20
Building & Facilities total				118
Vehicle Fleet	Gasoline		Gallons	0
	Diesel		Gallons	37
	Propane		Gallons	20
Vehicle Fleet total				57
Employee Commute	Gasoline	106704	VMT	38
Employee Commute total				38
Solid Waste	Waste Generated		Tons	10
Solid Waste total				10
Traffic Signals	Electricity (MetEd)	11443	kWh	4
Traffic Signals total				4
Septic	Fugitive Emissions		Pop. Served	2
Water and wastewater total				2

Tinicum Township's municipal building and public works garage use the most electricity, while the community park uses very little. The township operates a mixed fleet of gas and diesel vehicles, including heavy equipment, with fuel use varying by vehicle type. Employees commute over 2,000 miles weekly, contributing significantly to emissions. Waste data was estimated due to a lack of specific records. There is one traffic light, contributing minimally to emissions and shared in cost with another township and the state. Two septic tanks are in use and emptied on a schedule.

For future inventories, Tinicum should consider tracking the specific contents of solid waste and identifying the destinations of all trash. Additionally, keeping utility bills on file will reduce the need for estimations and eliminate delays in obtaining data directly from the electricity provider. Lastly, if vehicle miles traveled by community members were documented, the emissions values would be more accurate.

Conclusion

Congratulations! This inventory marks the completion of Milestone One of the Five ICLEI Climate Mitigation Milestones. Tinicum s taking important and necessary steps to reduce climate changing emissions and build a more resilient community. Keep the momentum moving! Whether this inventory marks the very first attempts at climate action in your community or is a continuation of ongoing efforts, we have more work to do.

Next Steps:

1. **Use the findings of this inventory to focus and prioritize actions to reduce emissions**. Based on the inventory results, the following areas have the greatest potential for emissions reduction:
    i. Transportation and mobile sources
    ii. Residential energy
    iii. Commercial/industrial energy

2. To forecast emissions, consider setting a target, and work toward the development of a robust climate action plan that identifies specific quantifiable strategies to reduce emissions and meet any targets it sets.

It is recommended that communities update their inventories regularly, especially as plans are implemented to ensure measurement and verification of impacts. Regular inventories also allow for "rolling averages" to provide insight into sustained changes and can help reduce the change of an anomalous year being incorrectly interpreted. This inventory shows that transportation, residential energy, and commercial/industrial energy will be particularly important to focus on. Through these efforts and others, Tinicum can achieve environmental, economic, and social benefits beyond reducing emissions.

Appendix: Methodology Details

Energy

The following tables show each activity, related data sources, and notes on data gaps.

Table 4: Energy Data Sources for Communitywide Inventory

Activity	Data Source	Data Gaps/Assumptions
Communitywide		
Residential, commercial, and industrial electricity consumption	MetEd electricity usage data for Tinicum	Data is based on the percentage of the given zip codes that falls within Tinicum's boundaries. Not based on population.
Residential, commercial, and industrial natural gas consumption	Appendix C BE.1.2 and 2023 5 year ACS values	Values are estimated and based on methodology from protocol
Residential LPG Consumption	Appendix C BE.1.2 and 2023 5 year ACS values	Values are estimated and based on methodology from protocol
Residential Kerosene Consumption	Appendix C BE.1.2 and 2023 5 year ACS values	Values are estimated and based on methodology from protocol
Residential Distillate Fuel Oil Consumption	Appendix C BE.1.2 and 2023 5 year ACS values	Values are estimated and based on methodology from protocol

Table 5: Emissions Factors for Electricity Consumption

Year	CO_2 (lbs./MWh)	CH_4 (lbs./GWh)	N_2O (lbs./GWh)
2023	657.4	0.045	0.006

Transportation

Table 6: Transportation Data Sources

Activity	Data Source	Data Gaps/Assumptions
Communitywide		
Vehicle Miles Travelled	(Community) PennDOT county level data and national default vehicle mix (LGO) Vehicle energy use document provided by Tinicum	Data was downscaled to represent Tinicum. Values may not be exact.

For vehicle transportation, it is necessary to apply average miles per gallon and emissions factors for CH4 and N2O to each vehicle type. The factors used are shown in Table 6.

Table 7: MPG and Emissions Factors by Vehicle Type

Fuel	Vehicle type	MPG	CH_4 g/mile	N_2O g/mile
Gasoline	Passenger car	22.2	0.0084	0.0069
Gasoline	Light truck	17.5	0.0117	0.0087
Gasoline	Heavy truck	6.5	0.0719	0.0611
Gasoline	Motorcycle	44	0.0672	0.0069
Diesel	Passenger car	45	0.0302	0.0192
Diesel	Light truck	19	0.029	0.0214
Diesel	Heavy truck	6.6	0.0095	0.0431

Waste and Wastewater

Table 8: Wastewater Data Sources

Activity	Data Source	Data Gaps/Assumptions
Communitywide Operations		
Septic Systems	2023 5 year ACS population values	Values are estimated

Solid Waste

Table 9: Solid Waste Data Sources

Activity	Data Source	Data Gaps/Assumptions
Communitywide		
Landfill Waste	Bucks County Municipal Waste Management Plan	Values are estimated; based on data in the BCMWMP

Table 10: Sources for Government Operations

Activity	Data Source	Data Gaps/Assumptions
Buildings and Facilities Electricity Consumption	MetEd electricity usage data for Tinicum	n/a
Building and Facilities propane, reusable oil, and fuel oil consumption	Tinicum Township Municipal Office	n/a
Vehicle Fleet	Tinicum Township Municipal Office	n/a
Employee Commute	Tinicum Township Municipal Office	Assumed all employees drove gasoline-powered vehicles
Solid Waste	Tinicum Township Municipal Office	n/a
Traffic Signals	Tinicum Township Municipal Office	The bill for this light is shared between 3 entities. The emission value provided in this inventory is not representative of total emissions produced by the traffic light.
Septic	2023 5 year ACS population values	Values are estimated

Inventory Calculations

The 2023 inventory was calculated following the US Community Protocol and ICLEI's ClearPath software. As discussed in Inventory Methodology, the IPCC Sixth Assessment was used for global warming potential (GWP) values to convert methane and nitrous oxide to CO2 equivalent units. ClearPath's inventory calculators allow for input of the sector activity (i.e. kWh or VMT) and emission factor to calculate the final CO2e emissions.