GREENHOUSE GAS EMISSIONS INVENTORIES METHODOLOGY GUIDE

This guide provides an overview of procedures to develop local and regional community-scale greenhouse gas inventories in metropolitan Washington.

December 2022

Metropolitan Washington
Council of Governments

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Prepared for COG staff and the Built Environment and Energy Advisory Committee (BEEAC)
December 2022

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The Metropolitan Washington Council of Governments (COG) is an independent, nonprofit association that brings area leaders together to address major regional issues in the District of Columbia, suburban Maryland, and northern Virginia. COG's membership is comprised of 300 elected officials from 24 local governments, the Maryland and Virginia state legislatures, and U.S. Congress.

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INTRODUCTION

Purpose

This report outlines the methodologies of the Metropolitan Washington Council of Governments' (COG) greenhouse gas (GHG) inventory work, providing for completeness, consistency, accuracy, replicability, transparency, and quality control. The ability to develop relevant, robust sets of inventories supports COG's Climate, Energy and Environment Policy Committee (CEEPC) and member local governments track progress towards GHG emission reduction goals and support decision-making around policies and programs that support emission reduction.

Background

COG's Climate, Energy and Environment Policy Committee (CEEPC) was created by the COG Board in 2009 and is responsible for managing implementation of the *National Capital Region Climate Change Report* adopted by the COG Board in 2008. Since its inception, CEEPC has made it a priority to track progress towards emissions reduction and set goals for all COG members and the region to complete GHG inventories.

Over the next five years, COG supported its members on inventory development by coordinating GHG inventory work group meetings and a series of trainings with national experts from ICLEI. COG also participated in development of a national protocol for local community-scale inventories, provided consultant support for COG member local inventory development, and began working on applying consistent methodologies across jurisdictions.

Members of both CEEPC and its sub-committees requested additional support to ensure 100 percent of COG members were able to have consistent, comparable GHG inventories completed and have updates on their inventories completed to track progress towards GHG emission reduction goals. COG has completed local and regional GHG inventories for all COG members, northern Virginia, and metropolitan Washington for 2005, 2012, 2015, 2018, and 2020.

Methodology Basics

COG completes GHG community-scale inventories for all 24 local government members, northern Virginia, and metropolitan Washington. COG makes every effort to capture an accurate picture of GHG trends for each of its local government members, while also providing for a consistently applied methodology across all its members' communities. Local inventory results are added together to get the total regional GHG emissions.

COG GHG inventories are compliant with both the U.S. Communities Protocol for Accounting and Reporting Greenhouse Gas Emissions[i] (USCP) and Global Protocol for Community-Scale Greenhouse Gas Inventories[ii] (GPC). The Protocols provide guidance on what emission types should at minimum be included in all local community GHG inventories. Additional guidance on approaches to calculating emissions are offered, but not prescribed. COG mainly follows the calculation guidance from USCP as the USCP identifies sources of data widely available to communities in the US. If COG has reliable local data available that could provide more accurate results, then an alternative approach, calculation, or tool is used. For specific methodology information by emissions activity or source, see Appendix A.

COG inventories use public data readily-available on a consistent basis for all its local government members. Data sources used must be available for past, current, and potential future inventories to accurately capture trends. While both accuracy and consistency are important to GHG inventories, consistency will be given a higher priority. Consistent Global Warming Potential (GWP) Factors are applied across the inventory years. COG inventories use GWP Factors from the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4), which is consistent with the EPA MOVES model leveraged for the regional transportation plan and on-road GHG calculations. Any models used, such as the MOVES model, are applied as consistently as possible. If a new version of the model is used, it will be noted. Appendices B, C, and D have additional information on data needs and availability, emission factors, and changes to data, models, and methods.

COG inventories follow an activities-based approach, meaning emissions are calculated based on the result of an activity happening in a community. An example of this is that solid waste emissions are calculated based on the tonnage of trash the community sends to a landfill(s). Simply because they do not have a landfill within their jurisdiction's boundaries, does not mean that they are not contributing to landfill emissions.

The broad categories of emission types covered by COG's GHG inventory work include the built environment (including some process and fugitive emissions), transportation and mobile emissions, waste (solid waste and wastewater), and some land use (agriculture, forests, and trees outside of forests). Most of these are required elements to be compliant with the USCP and GPC. Neither require land use; however, it was requested for inclusion by COG member jurisdictions (Table 1).

Table 1: Emission Types in COG Inventories Compared to Protocol Requirements

Emissions Types	COG Inventory?	USCP Required?	GPC Required?
Built Environment	√	√	√
Some Process and Fugitive	√	X	√
Transportation and Mobile	√	√	√
Solid Waste Treatment	√	√	√
Wastewater Treatment	√	√	√
Agriculture	√	X	X
Forests and Trees Outside of Forests	√	X	X

These emission types are further broken down into 18 emissions activities and 28 separate inventory records that are calculated and added together to get total emissions by type and overall emissions. The gases calculated within these inventory records include carbon dioxide (CO_2), methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), and Perfluorocarbons (PFCs).

Process

STAKEHOLDER ENGAGEMENT

COG continues to work with its local government members to capture as accurate a picture as possible for each community while providing consistent data inputs and methodologies across all communities. To accomplish this, COG staff needs to help members understand the existing process and methodologies, provide opportunities for their input on methodologies and the products, and support them on how they want to communicate results to their communities. The local government stakeholder engagement process includes the following:

1. Make COG members aware of the inventory procedure at the beginning of the process and listen to and address any questions/comments/concerns. Discuss any new priorities that need to be considered, potential methodology refinements, etc. with COG members.
2. Request information and feedback as needed during the development of the inventories. For the 2020 inventory an extra session was held to discuss pandemic impacts to GHG emissions and the inventory process.
3. Present draft results to each community. Address questions/comments/concerns. Revise as needed.
4. Offer and provide one-on-one meetings, as needed, to COG local government members.
5. Provide final products to each community.
6. Support local governments, as needed, in communicating results to their communities.

CLEARPATH

ICLEI's ClearPath tool is an online tool for preparing local GHG inventories, forecasts, climate action plans, and monitoring reports. The tool is consistent with both US and global accounting protocols. COG uses the Community Scale Inventory Module to support completing its GHG inventory work for its members and the region.

COG created inventory records in ClearPath for emission activities in the inventories. Some of the tool's calculators are used to calculate emissions as inventory records are created, while in other instances, emissions are calculated outside the tool and recorded in the inventory record.

METHODOLOGY UPDATES

The practice of developing community-scale inventories is relatively new and has evolved rapidly in recent years. The practice will continue to evolve to provide for more accurate, measured results (rather than modeled). Therefore, the methodologies used in COG inventory work should continue to evolve overtime to incorporate the best available data and methods.

Some methodology updates, like a change in GWP Factors, will affect all emission calculations in the inventory. However, more often it may be refinements to the calculations for a specific activity or source. Methodology updates should be prioritized first by how much of an impact they have on the overall inventory. Priority should be given to an activity that accounts for a larger percent of the inventory. Secondly, methodology update needs should be based on current data quality confidence levels. Activities or sources with low-to-medium data quality confidence levels could be investigated to see if more accurate data or calculations methods could be applied.

If methodology changes to how an activity/source is calculated results in more than a 1-2 percent difference, if possible, COG will back cast to change the methodologies from previous years. If methodology changes result in less than a 1-2 percent difference, back casting is not typical nor is it called for by the Protocols. All changes and differences in methodologies between inventory years need to be noted. Methodology changes have been documented in Appendix D.

To ensure methodology changes are Protocol compliant, COG refers to the USCP and GPC methodologies for guidance throughout the process and requests review of methodology updates by ICLEI, COG members, and other GHG inventory experts.

COVID-19 IMPACTS

The COVID-19 pandemic has had far-reaching impacts on the global economic and social system. Pandemic impacts on GHG emissions are largely due to reduced economic and travel activity. Globally, the pandemic impacted GHG emissions by 4-5% in 2020.[iii] The state of Maryland estimates the pandemic had a 4% impact on GHG emission reduction in 2020.[iv] COG estimates the pandemic had a 4-6% impact on metropolitan Washington's 2020 GHG emissions.

The pandemic impacted the anticipated reduction in a few key sectors of metropolitan Washington's 2020 GHG emissions inventory. Emissions from the built environment were lower than projected for 2020, in part due to the pandemic; however, the grid getting cleaner and weather impacts also played a role. Emissions from the transportation sector were lower than previously projected for 2020 because less people were on the roads and flying during the height of the pandemic. Finally, solid waste emissions were overall lower than projected for 2020. However, waste that would have been generated and collected from businesses were generated within individual residences during the height of the pandemic[v] and thus it did not make a significant impact on overall GHG emissions in 2020. Recovery from the pandemic will present both challenges and opportunities for climate mitigation.

Getting Started

Setting Up the GHG Inventory

DESCRIPTION

Gathering demographic and economic data is the first step taken in developing the inventories. Some of the demographic and economic data is used to estimate GHG emissions. For instance, household and commercial building data is used to estimate non-utility fuel consumption, such as fuel oil. Also, population data may serve as a means to downscale to a local community when local data is unavailable.

The demographic and economic data can be used as a benchmark to gauge emissions per person, household, employee, etc. Therefore, it is important to gather this information at the start of the inventory process and use it as consistently as possible across all emissions activity calculations.

DATA COLLECTION

COG's Cooperative Forecast has population, household, and employment data readily available for most COG member local governments.[vi] Some COG member Maryland city data are not available. For these cities, population data is acquired from the US Census Bureau American Community Survey (ACS).[vii]

In addition, COG uses CoStar[viii], a commercial building database, to track commercial construction in the region. It also provides readily available data for the GHG inventories.

BUILT ENVIRONMENT

Residential Energy

EMISSIONS FROM GRID ELECTRICITY

Residential Electricity

DESCRIPTION
Residential Electricity accounts for emissions resulting in electricity use in residential buildings. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY
The Residential Electricity emission calculations follow the USCP recommended methodology as outlined in Appendix C, BE.2.1 from Version 1.2 of the Protocol.

DATA COLLECTION
COG annually collects aggregated account and consumption data from the 7 electric utilities that serve metropolitan Washington.[ix]

Data Needs:

- Accounts: Number of residential electric accounts from all utilities serving metropolitan Washington.
- Consumption: Annual residential electricity use in kilowatt hours from all utilities serving metropolitan Washington.
- eGRID: U.S. Environmental Protection Agency (EPA) eGRID Subregion Output Emission Rates – Greenhouse Gases. Subregions RFC East (RFCE) and SERV Virginia/Carolina (SRVC) total output emission rates of CO_2 (lb/MWh), CH_4 (lb/GWh), and N_2O (lb/GWh).

EMISSIONS FROM STATIONARY FUEL

Residential Natural Gas

DESCRIPTION
Residential Natural Gas consumption accounts for combustion emissions from stationary fuel applications, such as furnaces. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY
The Residential Natural Gas emission calculations generally follow the USCP recommended methodology as outlined in Appendix C, BE.1.1 from Version 1.2 of the Protocol.

DATA COLLECTION
COG annually collects aggregated account and consumption data from the 3 natural gas utilities that serve metropolitan Washington.[ix]

Data Needs:
- Accounts: Number of residential natural gas accounts from all utilities serving metropolitan Washington.
- Consumption: Annual residential consumption of natural gas in Therms from all utilities serving metropolitan Washington.

Residential Fuel Oil

DESCRIPTION
Residential Fuel Oil accounts for both distillate fuel oils and kerosene used in stationary applications. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

Distillate fuel oils include both fuel oils and diesel fuels that are further classified by level of volatility, listed from least to greatest (No. 1, No. 2, and No. 4). Residential fuel oils are less volatile than gasoline and are burned for space heating or water heating by private household consumers. No.2 fuel oil (Heating Oil) is the most common type used by households for the specific purpose of heating their home, water heating, cooking, etc., excluding farmhouses, farming, and apartment buildings. No. 1 fuel oil is used by households mainly for portable outdoor stoves, portable outdoor heaters and some residential space heating. Kerosene is a distilled product of oil or coal with the generic name kerosene, having properties like those of No. 1 fuel oil.

METHODOLOGY
The Residential Fuel Oil emissions calculations follow the USCP recommended methodology as outlined in Appendix C, BE.1.2 from Version 1.2 of the Protocol. This methodology estimates residential fuel oil consumption in gallons (including distillate fuel oil and kerosene) by multiplying the estimated number of households using fuel oil as a home heating fuel in the region and each jurisdiction with residential fuel oil energy intensity data for the region. Gallons are used to estimate emissions.

DATA COLLECTION
Local data on households and consumption related to fuel oil is not readily available for all COG members. However, the Energy Information Administration (EIA) has readily available fuel oil energy intensity data for the South Atlantic region and the ACS has readily available data on number of households using fuel oil as a home heating fuel.

Data Needs:
- Households using Fuel Oil: Number of households using fuel oil data for all COG jurisdictions and states collected from the ACS' Selected Housing Characteristics.[x]
- Regional Residential Fuel Oil Consumption: EIA Residential Energy Consumption Survey (RECS) fuel oil average site energy consumption for the South Atlantic region.[xi]

Residential LPG

DESCRIPTION
Liquefied Petroleum Gas (LPG) refers to a group of hydrocarbon gases derived from crude oil refining or natural gas processing. Propane is the most common LPG. In the U.S. and Canada, commercially available propane (LPG) is not totally pure; its typically at least 90 percent propane, with the rest being ethane, propylene, butane, and odorants including ethyl mercaptan. LPGs are used as fuel in heating appliances, cooking equipment, and vehicles. It is usually delivered by tank trucks and stored near a housing unit in a tank or cylinder until used; however, propane stored in canisters can also be purchased from retail stores. For COG inventory purposes, LPG's are equated with propane, yet propane also encompasses similar fuel gases, such as butane, supplied to a residence in liquid form. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY
The Residential LPG emission calculations follows the USCP recommended methodology as outlined in Appendix C, BE.1.2 from Version 1.2 of the Protocol. This methodology estimates residential LPG consumption in gallons by multiplying the estimated number of households using fuel oil as a home heating fuel in the region and each jurisdiction with residential LPG energy intensity data for the region. Gallons are used to estimate emissions.

DATA COLLECTION
Local data on households and consumption related to fuel oil is not readily available for all COG members. However, the EIA has readily available LPG energy intensity data for the South Atlantic region and the ACS has readily available data on number of households using LPG as a home heating fuel.

Data Needs:

- Households using LPG: Number of households using LPG data for all COG jurisdictions and states collected from the ACS's Selected Housing Characteristics.[x]
- Regional Residential LPG Consumption: EIA Residential Energy Consumption Survey (RECS) propane average site energy consumption for the South Atlantic region.[xi]

Commercial Energy

EMISSIONS FROM GRID ELECTRICITY

Commercial Electricity

DESCRIPTION
Commercial Electricity accounts for emissions resulting in electricity use in commercial, government, industrial, and other non-residential buildings and facilities. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Commercial Electricity emission calculations follow the USCP recommended methodology as outlined in Appendix C, BE.2.1 from Version 1.2 of the Protocol. Consumption data and the U.S. EPA eGRID emission data are factored into the emission estimates calculated in ClearPath.

DATA COLLECTION

COG annually collects aggregated account and consumption data from the 7 electric utilities that serve metropolitan Washington.[ix]Data Needs:

- Accounts: Number of commercial electric accounts from all utilities serving metropolitan Washington.
- Consumption: Annual commercial electricity consumption in kilowatt hours from all utilities serving metropolitan Washington.
- eGRID: U.S. Environmental Protection Agency (EPA) eGRID Subregion Output Emission Rates – Greenhouse Gases. Subregions RFC East (RFCE) and SERV Virginia/Carolina (SRVC) total output emission rates of CO_2 (lb/MWh), CH_4 (lb/GWh), and N_2O (lb/GWh).

EMISSIONS FROM STATIONARY FUEL

Commercial Natural Gas

DESCRIPTION

Natural gas consumption in the non-residential setting produces combustion emissions from stationary applications, such as boilers and furnaces. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Commercial Natural Gas emission calculations generally follow the USCP recommended methodology as outlined in Appendix C, BE.1.1 from Version 1.2 of the Protocol.

DATA COLLECTION

COG annually collects aggregated account and consumption data from the 3 natural gas utilities that serve metropolitan Washington.[ix]

Data Needs:

- Accounts: Number of commercial natural gas accounts from all utilities serving metropolitan Washington.
- Consumption: Annual commercial consumption of natural gas in Therms from all utilities serving metropolitan Washington.

Commercial Fuel Oil

DESCRIPTION

Commercial Fuel Oil refers to a liquid petroleum product used as an energy source that is less volatile than gasoline. Commercial Fuel Oil is comprised of distillate fuels (No. 1, 2 and 4), residual fuels (No.5 and 6) and kerosene (No. 1). Distillate fuel oils represent the lighter petroleum fractions produced in conventional distillation processes that include both fuel oils and diesel fuels that are further classified by level of volatility, listed from least to greatest (No. 1, No. 2, and No. 4). Products known as No. 1, No. 2, and No. 4 fuel oils are lighter oils primarily used for space heating and electric power generation. Residual fuels are generally classified as heavier oils, known as No. 5 and No. 6 fuel oils, that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. Kerosene is a light petroleum distillate with properties like those of No. 1 fuel oil; primarily used in space heaters, cook stoves, and water heaters and is suitable for use as a light source when burned in wick-fed lamps. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Commercial Fuel Oil emission calculations follows the USCP recommended methodology as outlined in Appendix C, BE.1.3 from Version 1.2 of the Protocol, with one exception. This methodology calculates percent of square footage using fuel oil instead of percent of number of buildings using fuel oil.

Values for commercial building square footage using Fuel Oil were scaled locally by multiplying the local jurisdictional commercial square footage by the percentage of commercial building square footage using Fuel Oil in the broader South Atlantic Region. These values, in turn, were multiplied by the fuel energy intensity in gallons per square foot (gallons/$ft.^2$) to get total Fuel Oil consumption in gallons per locality and region. Gallons are used to estimate emissions.

DATA COLLECTION

The number of commercial buildings and total square footage for each COG member jurisdiction is readily available from the CoStar Commercial Property Records. There is not data readily available on stationary fuel use for these buildings. The Energy Information Administration (EIA) does have data available for larger regions on total commercial buildings and square footage; number and square footage of buildings using Fuel Oil; and energy intensity. EIA's South Atlantic Region in the Commercial Building Energy Consumption Survey (CBECS) includes DC, MD, VA, DE, WV, NC, SC, GA, and FL.

Data Needs:

- Commercial buildings and total square footage: Data for all COG jurisdictions and region are collected from the CoStar Commercial Property Records. This database is available via subscription by COG's Department of Community Planning and Services Department (DCPS).[viii]
- Total Commercial Floorspace and Commercial Square Footage using Fuel Oil: Values for the South Atlantic Region (most specific region) were derived from the EIA CBECS.[xii]
- Fuel Oil Energy Intensity: A value for the South Atlantic Region was derived directly from the EIA CBECS.[xii]

Commercial LPG

DESCRIPTION

Liquefied Petroleum Gas (LPG) refers to a group of hydrocarbon gases derived from crude oil refining processing. Propane is the most common LPG. In the U.S. and Canada, commercially available propane (LPG) is not totally pure; its typically at least 90 percent propane, with the rest being ethane, propylene, butane, and odorants including ethyl mercaptan. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

In this methodology, any LPG reported was assumed to be propane. The Commercial LPG emission calculations follows the USCP recommended methodology as outlined in Appendix C, BE.1.3 from Version 1.2 of the Protocol. This methodology calculates percent of square footage using fuel oil instead of percent of buildings using fuel oil.

Values for commercial building square footage using LPG were scaled locally by multiplying the local jurisdictional commercial square footage by the percentage of commercial building square footage using LPG in the broader South Atlantic Region. These values, in turn, were multiplied by the fuel energy intensity in gallons per square foot (gallons/ft.^{2}) to get total LPG consumption in gallons per locality and region. Gallons are used to estimate emissions.

DATA COLLECTION

The number of commercial buildings and total square footage for each COG member jurisdiction is readily available from the CoStar Commercial Property Records. There is not data readily available on stationary fuel use for these buildings. The Energy Information Administration (EIA) does have data available on total commercial buildings and square footage for larger regions; number and square footage of buildings using LPG; and energy intensity. EIA's South Atlantic Region in the Commercial Building Energy Consumption Survey (CBECS) includes DC, MD, VA, DE, WV, NC, SC, GA, and FL.

Data Needs:

- Commercial buildings and total square footage: Data for all COG jurisdictions and region are collected from the CoStar Commercial Property Records. This database is available via subscription by COG's Department of Community Planning and Services Department (DCPS).[viii]
- Total Commercial Floorspace and Commercial Square Footage using LPG: Values for the South Atlantic Region (most specific region) were derived from the EIA CBECS.[xii]
- LPG Energy Intensity: A value for the South Atlantic Region was derived directly from the EIA CBECS.[xii]

Process and Fugitive Emissions

FUGITIVE EMISSIONS FROM NATURAL GAS DISTRIBUTION

Natural Gas Fugitive Emissions

DESCRIPTION

Natural Gas Fugitive Emissions accounts for emissions resulting from local natural gas system losses within the community.

METHODOLOGY

The Fugitive Emissions from Natural Gas emission calculations uses an ClearPath calculator. The fugitive emissions are calculated based on a leakage rate for total annual natural gas consumption. The ClearPath calculator uses a leakage rate of 0.3 percent.

DATA COLLECTION
Data from the Metropolitan Washington Annual Utility survey needs to first be collected and analyzed for the inventory year prior to completing these steps.

Data Needs:

- Natural Gas Consumption: Total Annual Therms for each jurisdiction from the analyzed results of the Metropolitan Washington Annual Utility Survey.[ix]

OTHER PROCESS AND FUGITIVE EMISSIONS

Hydrofluorocarbon Emissions

DESCRIPTION
Hydrofluorocarbons (HFCs) are a type of GHG and are comprised of several organic compounds composed of hydrogen, fluorine, and carbon. HFCs are produced synthetically and are commonly used in air conditioning and refrigerants in place of older halons and chlorofluorocarbons (CFCs), which were attributed to the depletion of Earth's Ozone layer. Following the implementation of the Montreal Protocol, HFCs gradually replaced CFCs because of their minimal impact on the Ozone layer, having an Ozone depletion potential of zero. However, HFCs are potent greenhouse gases (HFC's are 3,830 times more potent than CO2) with high global warming potentials.

METHODOLOGY
HFC emissions in this inventory represent GHG emissions from substitutions for Ozone depleting substances. Total U.S emissions from substitutes for Ozone depleting substances are scaled locally by population to estimate jurisdictional and regional values. Substitutions for Ozone depleting substances primarily result in HFC emissions; however, small amounts of perfluorocarbon (PFC) emissions also result from this source.

DATA INPUTS
Local data on substitutes for Ozone depleting substances is not available. It would take extensive research and local surveys to develop this data. Although emissions from these substances continues to expand, it only accounts for a small portion of emissions. The U.S. Environmental Protection Agency's (EPA) annual inventory reports on GHG emissions calculates nationwide emissions for substitutes for Ozone depleting substances.

Data Needs:

- Population: Population data for all COG jurisdictions and the regions are collected from COG Cooperative Forecasts[vi] and the ACS.[vii]
- U.S. Emission of Ozone Depleting Substances: National data for HFC emissions is recorded in Million Metric Tons of Carbon Dioxide Equivalent (MMTCO_2e) from the U.S. EPA, Inventory of U.S. GHG Emissions and Sinks.[xiii]

TRANSPORTATION AND MOBILE EMISSIONS

On Road Transportation

On Road Mobile Emissions

DESCRIPTION

On Road Mobile Emissions represent exhaust and evaporative emissions of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) from on road passenger and freight motor vehicles. On road mobile emissions account for close to one third of metropolitan Washington GHG emissions. On Road emissions can be influenced by local governments through land use and urban design decisions and transportation infrastructure investments. Advancing electrification of the transportation system, overall improvement of the fuel economy, and increasing alternative trip modes play a particularly important role in reducing On Road emissions.

METHODOLOGY

The On Road Transportation emission calculations generally follows the USCP recommended methodology as outlined in Appendix D, TR.1.A from Version 1.2 of the Protocol.

COG Department of Transportation Planning (DTP) staff prepare estimated GHG emissions and modeled vehicle miles traveled (VMT) data based on planning assumptions included in the Transportation Planning Board's (TPB) Constrained Long Range Plan (CLRP), COG Cooperative Forecasts (demographic data), vehicle registration (VIN) data, and modeling tools such as the TPB's travel demand model and the Environmental Protection Agency's (EPA) mobile emissions model, MOVES.

For 2020, Highway Performance Monitoring System (HPMS) observed VMT data was used to inform and adjust modeled VMT data inputs into the MOVES model to capture the COVID-19 pandemic impacts on VMT.

DATA COLLECTION

DTP staff provide GHG emissions estimates by state, jurisdiction, and vehicle type. Emissions are based on both travel and non-travel related inputs to the MOVES model. Additional details on MOVES model inputs are described in COG's Air Quality Conformity Analyses. Vehicle types include passenger cars, passenger trucks, motorcycles, school buses, transit buses, intercity buses, refuse trucks, light commercial trucks, motor homes, single unit short-haul trucks, single-unit long-haul truck, combination short-haul trucks, and combination long-haul trucks.

It is important to note that the modeled jurisdiction-level vehicle VMT inputs to the model are based on all travel occurring on the roadways in each jurisdiction, regardless of where the trips originate and terminate.

DTP staff provide GHG emissions estimates from EPA's MOVES model for the District of Columbia, Maryland counties, Virginia counties, and the City of Alexandria. In Maryland, data is provided for Charles, Frederick, Montgomery, and Prince George's Counties. In Virginia data is provided for City of

Alexandria, Arlington County, Fairfax County (including Fairfax City and City of Falls Church), Loudoun County, and Prince William County (including Manassas and Manassas Park).
Data Needs:

- Population: Population data for all COG jurisdictions and the region are collected from COG's Cooperative Forecasts[vi] and the ACS.[vii]
- Emissions: Emissions of Atmospheric Carbon Dioxide (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O) from the EPA MOVES model is obtained from DTP staff.[xiv]
- Vehicle Miles Traveled: Modeled VMT data by jurisdiction is obtained from DTP staff. This is not used to further calculate emissions; however, it is used as an indicator to support local jurisdictions in their understanding of resultant emissions. As noted above, HPMS observed VMT data was used to inform and adjust modeled VMT data inputs into the MOVES model for 2020 to capture the COVID-19 pandemic impacts on VMT.[xiv]

Emissions from Off Road Vehicles

Off Road Mobile Emissions

DESCRIPTION
Off Road Mobile Emissions account for nonroad equipment using gasoline, diesel, compressed natural gas, and liquified petroleum gas. Nonroad mobile sources are broken up into the following categories:

- Lawn and garden equipment
- Airport service and ground equipment
- Logging equipment
- Recreational marine equipment
- Light commercial equipment
- Industrial equipment
- Construction equipment
- Agricultural or farm equipment
- Recreational land vehicles or equipment
- Railroad maintenance equipment

METHODOLOGY
The Off Road Transportation emission calculations generally follow the USCP recommended methodology as outlined in Appendix D, TR.1.8 from Version 1.2 of the Protocol. EPA's Motor Vehicle Emissions Simulator, the MOVES model, calculates past, present, and future emission inventories (i.e., tons of pollutant) for nonroad equipment. Off Road emissions data for Atmospheric Carbon Dioxide (CO_2) and Methane (CH_4) are pulled from the model for the inventory year.

Off Road categories excluded from the model include large commercial marine, passenger and freight locomotives, and aircraft. Metropolitan Washington does not have a large marine port, so excluding large commercial marine vessels is not a concern for the purposes of COG's GHG inventory work. Emissions from locomotives and aircraft are however included in separate calculations.

DATA COLLECTION
The MOVES model Off Road data outputs are available for the District of Columbia, Maryland counties, and Virginia counties and independent cities.

Data Needs:

- Population: Population data for all COG jurisdictions and the regions are collected from COG Cooperative Forecasts[vi] and the ACS.[vii]
- Emissions: Emissions in short tons of Atmospheric Carbon Dioxide (CO_2) and Methane (CH_4) from the EPA MOVES model is obtained from COG Department of Environment's Air Quality Program.[xiv]

Aviation Travel

Passenger Air Travel

DESCRIPTION
Passenger air travel emissions accounts for commercial aircraft emissions from major commercial airports serving the region and allocates those emissions to local communities based on users of the airport. The USCP states that aircraft emissions often represent more than 90 percent of airport related emissions.

METHODOLOGY
The Passenger Air Travel emission calculations generally follows the USCP recommended methodology as outlined in Appendix D, TR.6.D from Version 1.2 of the Protocol. COG's approach uses the best available data to estimate air travel passenger emissions by airport and allocates emissions by the percent of passengers traveling from a COG member jurisdiction to the airport. This includes all air passengers leaving a COG member jurisdiction to fly out of Baltimore-Washington International Thurgood Marshall Airport (BWI), Ronald Reagan Washington National Airport (DCA), and Washington Dulles International Airport (IAD). This includes personal travel and business travel by people who live, work, or were visiting a COG member jurisdiction.

To estimate emissions per airport, national aircraft emissions are downscaled based on the local to national ratio of revenue passenger miles for BWI, DCA, and IAD. Emissions are applied locally based on a community's contribution to each airport's originating passengers. This approach does not account for aircraft emissions and air passengers that are, for instance, flying into IAD and taking a connecting flight elsewhere.

In 2020, COG initiated COVID-19 Travel Monitoring Snapshots to track travel impacts from the pandemic. COG leveraged data collected for the snapshots to conduct a special analysis of air trips by jurisdiction and an air travel counts analysis to support GHG estimates that fully capture impacts from the pandemic.

DATA COLLECTION
For all originating air passengers departing from the region's three commercial airports – BWI, DCA, IAD – the biennial Washington-Baltimore Regional Air Passenger Survey provides readily available origin-destination data by mode of access, trip origination (home, non-home), resident status (resident, non-resident), and trip purpose (work, non-work), for base and forecast years. There is also

readily available data on commercial aircraft emissions and passenger miles travelled for the airports serving the region through EPA and the Bureau of Transportation Statistics, respectively.

Data Needs:

- Number of Originating Air Passengers: Data for number of originating air passengers to each airport for each COG jurisdiction is collected from the Washington-Baltimore Regional Air Passenger Survey Geographic Findings Report.[xv] Data is pulled by "Jurisdiction" for the counties, District of Columbia, and the City of Alexandria. Data for the rest of the cities is pulled by "Airport Analysis Zone." As noted above, a special analysis was conducted to capture 2020 pandemic impacts.
- Total Revenue Passenger Miles: Data for each airport and U.S. totals are from the Bureau of Transportation Statistics.[xvi]
- U.S. Total Commercial Aircraft Emissions: Values in MMTCO2e are from: U.S. Environmental Protection Agency Inventory of U.S. GHG Emissions and Sinks.[xiii]
- Total Enplanements: Volume for BWI, DCA, and IAD are from the COG Washington-Baltimore Regional Air Passenger Survey Geographic Findings Report and the special analyses for 2020.[xv]

Rail Transportation

Commuter Rail

DESCRIPTION

Rail Transportation calculates emissions resulting from MARC and Virginia Railway Express (VRE) trains carrying commuters from Maryland and Virginia. These commuter rail services serve an important role in providing a balanced intermodal transit for metropolitan Washington. Local jurisdictions may have influence on service levels in its community via supportive land use policies, infrastructure investments, and connecting transit services.

METHODOLOGY

The Commuter Rail Transportation emission calculations generally follow the USCP recommended methodology as outlined in Appendix D, TR.4 from Version 1.2 of the Protocol. In this approach, emissions are calculated from annual diesel consumption of commuter rail operators.

Maryland Transit Administration (MTA) and VRE reports diesel consumption for their full commuter rail operations, some of which occurs outside of metropolitan Washington. MTA and VRE annual diesel consumption are attributed to the region by the percent of stations located in the region – 59 percent of MTA's MARC stations and 75 percent of VRE stations are in the region.

DATA COLLECTION

Diesel consumption of commuter rail systems (code CR) is readily available via the Federal Transit Administration's (FTA) National Transit Database. Data is downscaled by station locations and population because there is no public readily available, consistent data for both MTA and VRE commuter rail passenger travel activity.

Data Needs:

- Population: Population data for all COG jurisdictions and the regions are collected from COG Cooperative Forecasts[vi] and the ACS.[vii]
- Diesel Consumption: Annual diesel consumption in gallons for the MTA and VRE as reported to the FTA National Transit Database.[xvii]

WASTE

Solid Waste

WASTE GENERATION

Landfill Waste Generation

DESCRIPTION
Landfill Waste Generation accounts for the emissions resulting from waste generated by the community in a year and disposed of at a landfill. In other words, it accounts for the resultant methane emissions from the decomposition of biologic solid waste produced by the community that year. Methane capture has a significant influence over resulting GHG emissions. If a landfill receiving waste has no methane capture, the resultant GHG emissions are much higher. According to the USCP, local jurisdictions' municipal solid waste (MSW), recycling, and composting programs can influence the amount of waste generated, the methods of disposal, and locations.

METHODOLOGY
The Landfill Waste Generation emission calculations follow the USCP recommended methodology as outlined in Appendix E, SW.4 from Version 1.2 of the Protocol. The calculations are based on tons of MSW from each jurisdiction going to a landfill and whether the receiving landfills have methane capture. It is important to make this distinction and identify how many tons are annually disposed of at these landfills.

DATA COLLECTION
The best available MWS data from local and regional sources was used to calculate these emissions. Unlike other activities in this inventory, there is not a regional, state, or federal source of MSW data that comprehensively reports data in the way that is needed for GHG inventory calculations.

Data Needs:

- Municipal Solid Waste (MSW): Annual mass in tons of MSW landfilled retrieved from local and regional sources.[xviii]
- Methane Collection: Identify landfills that regularly receive MSW from each jurisdiction and whether those landfills have methane collection using the EPA FLIGHT Tool.[xix] Gather information on landfill methane collection efficiency from jurisdictions or landfill operators.[xviii]

COMBUSTION OF SOLID WASTE GENERATED BY THE COMMUNITY

Combustion of Solid Waste

DESCRIPTION
The Combustion of Solid Waste accounts for the emissions resulting from municipal solid waste (MSW) generated by the community in a year and disposed of at a waste-to-energy (WTE) facility. WTE facilities burn garbage and typically generate steam and/or electricity from the combustion of MSW. According to the USCP, local jurisdictions' MSW, recycling, and composting programs can influence the amount of waste generated, the methods of disposal, and locations.

METHODOLOGY
The Combustion of Solid Waste Generated by the Community emission calculations follow the USCP recommended methodology as outlined in Appendix E, SW.2.2 from Version 1.2 of the Protocol. The calculations are based on tons of MSW from each jurisdiction going to a WTE.

DATA COLLECTION
The best available municipal MWS data from local and regional sources was used to calculate these emissions. Unlike other activities in this inventory, there is not a regional, state, or federal source of MSW data that comprehensively reports data in the way that is needed for GHG inventory calculations.

Data Needs:

- Municipal Solid Waste (MSW): Annual mass in tons of MSW combusted retrieved from local and regional sources.[xviii]

Water and Wastewater

FUGITIVE EMISSIONS FROM SEPTIC SYSTEMS

Septic System Emissions

DESCRIPTION
Septic Systems Emissions account for the fugitive emissions resulting from the physical settling and biologic activity during the treatment process in septic tanks. According to the USCP, local governments can influence community septic through local building codes, providing and promoting incentives, etc.

METHODOLOGY
The Fugitive Emissions from Septic Systems calculations follow the USCP recommended methodology as outlined in Appendix F.WW.11 from Version 1.2 of the Protocol. The methodology estimates GHG emissions based on the population served by septic.

The Regional Wastewater Flow Forecast Model (RWFFM) and COG Cooperative Forecasts are leveraged to estimate population served by sewer. Total population subtracted from the population served by sewer provides a population served by septic estimate.

DATA COLLECTION
The RWFFM provides data that is available to use for the purposes of the GHG inventories. COG Cooperative Forecasts are used for population estimates.

Data Needs:

- Population served by septic[xx]

NITRIFICATION/DENITRIFICATION PROCESS N2O EMISSIONS FROM WASTEWATER

Sewer System Emissions

DESCRIPTION

This calculation of Sewer System Emissions accounts for N_2O emissions during the treatment process at wastewater treatment plants (WWTPs). All WWTPs in the region operate with nitrification (converting ammonia to nitrate) and denitrification (converting nitrate into nitrogen gas) processes to remove nutrients from wastewater. This process protects the water quality of local waterways. More than 90 percent of the population in the region is served by a WWTP.

According to the USCP, wastewater utilities can potentially offset GHG emissions through renewable energy generation from biogas and/or biosolids, using reclaimed water to displace imported water, or producing biosolids as fertilizer for use.

METHODOLOGY

The Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment calculations follow the USCP recommended methodology as outlined in Appendix F.WW.7 from Version 1.2 of the Protocol. The methodology estimates GHG emissions based on the population served by sewer. The Regional Wastewater Flow Forecast Model (RWFFM) and COG Cooperative Forecasts are leveraged to estimate population served by sewer.

DATA COLLECTION

The RWFFM is processed annually by COG staff and outputs data that is available to use for the purposes of the GHG inventories. COG Cooperative Forecasts are used for population estimates. For cities that do not have Cooperative Forecast data available ACS population estimates are leveraged.

Data Needs:

- Population served by sewer[xx]

PROCESS N2O FROM EFFLUENT DISCHARGE TO RIVERS AND ESTUARIES

N2O Effluent Discharge Emissions

DESCRIPTION

N_2O Effluent Discharge Emissions account for the emissions resulting from treated wastewater that flows out of a treatment facility and is discharged into waterways. Most of the nitrogen content is removed in the treatment process; however, when effluent containing nitrogen reaches the natural watershed a reaction occurs that releases N_2O emissions.

METHODOLOGY

The Process N_2O from Effluent Discharge to Rivers and Estuaries calculations follow the USCP recommended methodology as outlined in Appendix F.WW.12 from Version 1.2 of the Protocol. The methodology estimates GHG emissions based on the population served by sewer and daily Nitrogen loads.

The Regional Wastewater Flow Forecast Model (RWFFM) and COG Cooperative Forecasts are leveraged to estimate population served by sewer. Data inputs on Nitrogen loads are downloaded from CAST for inventories 2018 and beyond. For previous inventories they were provided via personal communication from Chesapeake Bay Program staff. Loads are converted from pounds/year to kg/day. This data represents a simple average of the annual loads recorded by the Bay Program.

DATA COLLECTION

The RWFFM is processed by COG staff and outputs data that is available to use for the purposes of the GHG inventories. COG Cooperative Forecasts are used for population estimates. For cities that do not have Cooperative Forecast data available ACS population estimates are leveraged.

Data Needs:

- Population served by sewer[xx]
- Daily Nitrogen Load: Values in kg N/day are retrieved from COG Department of Environmental Programs Wastewater Modeler.[xx]

LAND USE

Agriculture

EMISSIONS FROM AGRICULTURAL ACTIVITIES

Enteric Fermentation

DESCRIPTION
Enteric Fermentation accounts for the methane produced from animal digestion in cows, sheep, goats, swine, and horses. According the USCP, enteric fermentation accounts for 25 percent of nationwide methane emissions from anthropogenic activities. The U.S. EPA report titled 'User's Guide for Estimating Methane and Nitrous Oxide Emissions from Agriculture Using the State Inventory Tool' states that a higher quality of feed produces lower emissions from these animals.[xxi]

METHODOLOGY
The U.S. EPA's Emission Inventory Improvement Program developed a series of Excel-based State GHG Inventory Tools, which include an Agriculture Module. The Ag Module calculates methane (CH4) and nitrous oxide (N2O) emissions from the agricultural sources. Agricultural sources and activities relevant to metropolitan Washington were calculated using this tool including Enteric Fermentation, Manure Management, and Ag Soils. The module takes data inputs and applies state-specific data and factors to calculate emissions. The methodologies applied in the tool are generally consistent with EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

The USCP does offer similar suggested calculations for enteric fermentation and manure management, where national default factors are applied. While Ag emissions calculated offline can be documented in ClearPath, it does not currently offer a calculator that estimates emissions. At this time, EPA's State Inventory Tool offers the most streamlined calculation process with the most locally relevant default factors for COG's GHG inventory work.

DATA COLLECTION
Metropolitan Washington data inputs into the EPA's State GHG Inventory Tool are pulled at the county-scale from the EPA Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST). CAST is a web-based nitrogen, phosphorus, and sediment load estimator tool that streamlines environmental planning.

Data Needs:

- Livestock: Livestock population ('000 head) for dairy cows, beef cattle, sheep, goats, swine, horses derived from the CAST Tool.[xxii]

Manure Management

DESCRIPTION
Manure Management accounts for emissions from management systems that stabilize or store livestock manure. It accounts for manure from dairy cows, beef cattle, sheep, goats, swine, horses,

and poultry operations. Methane (CH_4) is a natural by-product of manure decomposition and nitrous oxide (N_2O) is also produced during the storage and treatment of animal manure.

The U.S. EPA report titled 'User's Guide for Estimating Methane and Nitrous Oxide Emissions from Agriculture Using the State Inventory Tool' states that the greater energy content of the feed results in an increased capacity to produce CH_4 in manure. In addition, the report states that the amount of N2O released depends on the system and duration of waste management.

METHODOLOGY

EPA's Emission Inventory Improvement Program developed a series of Excel-based State GHG Inventory Tools, which include an Agriculture Module. The Ag Module calculates CH4 and N2O emissions from the agricultural sources. Agricultural sources and activities relevant to metropolitan Washington were calculated using this tool including Enteric Fermentation, Manure Management, and Ag Soils. The module takes data inputs and applies state-specific data and factors to calculate emissions. The methodologies applied in the tool are generally consistent with EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

The USCP does offer similar suggested calculations for enteric fermentation and manure management, where national default factors are applied. While Ag emissions calculated offline can be documented in ClearPath, it does not currently offer a calculator that estimates emissions. At this time, EPA's State Inventory Tool offers the most streamlined calculation process with the most locally relevant default factors for COG's GHG inventory work.

DATA COLLECTION

Metropolitan Washington data inputs into the EPA's State GHG Inventory Tool are pulled at the county-scale from the EPA Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST). CAST is a web-based nitrogen, phosphorus, and sediment load estimator tool that streamlines environmental planning.

Data Needs:

- Livestock: Livestock population ('000 head) for dairy cows, beef cattle, sheep, goats, swine, horses, pullets, chickens, broilers, and turkeys from CAST.[xxii]

Ag Soils

DESCRIPTION

Ag Soils account for nitrous oxide (N_2O) emissions from animals, crop production, and fertilizer application. The U.S. EPA report titled 'User's Guide for Estimating Methane and Nitrous Oxide Emissions from Agriculture Using the State Inventory Tool' states that N_2O is naturally produced in soils; however, animal and crop management practices and fertilizer application increase the amount of N_2O emitted. Higher levels of N_2O are a result of:

- The type of animal waste management systems used;
- Cultivation of certain types of nitrogen-fixing crops;
- Crop residues remaining on agricultural fields; and
- The use of synthetic and organic fertilizer in ag and urban soils.

METHODOLOGY
The U.S. EPA's Emission Inventory Improvement Program developed a series of Excel-based State GHG Inventory Tools, which include an Agriculture Module. The Ag Module calculates methane (CH4) and N2O emissions from the agricultural sources. Agricultural sources and activities relevant to metropolitan Washington were calculated using this tool including Enteric Fermentation, Manure Management, and Ag Soils. The module takes your data inputs and applies state-specific data and factors to calculate emissions. The methodologies applied in the tool is generally consistent with EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

The USCP does offer similar suggested calculations for enteric fermentation and manure management, where national default factors are applied. While Ag emissions calculated offline can be documented in ClearPath, it does not currently offer a calculator that estimates emissions. At this time, EPA's State Inventory Tool offers the most streamlined calculation process with the most locally relevant default factors for COG's GHG inventory work.

DATA COLLECTION
Metropolitan Washington data inputs into EPA's State GHG Inventory Tool are pulled at the county-scale from the EPA Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST). CAST is a web-based nitrogen, phosphorus and sediment load estimator tool that streamlines environmental planning.

Data Needs:
- Livestock: Livestock population ('000 head) for dairy cows, beef cattle, sheep, goats, swine, horses, layers (pullets and chickens), broilers, and turkeys from CAST.[xxii]
- Crops: Crop production ('000 bushels) for corn for grain, all wheat, and soybeans from CAST.[xxii]
- Fertilizer: Fertilizer applied (kg N) for synthetic fertilizers, manure, and biosolids.[xxii]

Forests and Trees Outside Forests

FORESTS

Emissions and Removals from Forests

DESCRIPTION
Forests sequester CO2 during the process of photosynthesis and store this carbon in leaves, roots, branches, trunks, soil, and woody debris and other plant litter. Through this process, forests can curb atmospheric GHG emissions. Land use activities can impact emissions. For example, conversion of forested land to urban areas can contribute significantly to carbon emissions. Thus, forests can act as a sink for carbon emissions, and if removed they can be a source of emissions. Increasing carbon sequestration and reducing emissions from local forests and trees supports climate change mitigation.

METHODOLOGY
ICLEI's Land Emissions And Removals Navigator (LEARN) tool[xxiii] estimates the local GHG impacts of forests and trees in a local community. This tool provides information on land cover, including forest cover and change. Emissions and removals from forests were calculated using this tool for each

jurisdiction and the region. LEARN combines methods outlined in the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions[i] Appendix J with national data sources to derive a first-order approximation of annual GHG impacts over a given time period. The base time period analyzed for forest is 2001-2011 and is applied to the 2005 inventory. The next time period analyzed for forests is 2011-2016 and is applied to the 2012 and 2015 GHG inventories. Lastly, forests were analyzed for 2016-2019 and applied to the 2018 and 2020 GHG inventories.

DATA INPUTS

The LEARN Tool can produce average annual emissions and removals from forests and trees outside of forests for local jurisdictions and the region leveraging local community boundary GIS layers, land use/landcover data, and emission and removal factors.

Data Needs:

- ArcGIS boundary shapefiles for all 24 COG member jurisdictions.
- National Land Cover Dataset (NLCD) 30-meter resolution land use/land cover for 2001-2011, 2011-2016, 2016-2019.[xxiii]

TREES OUTSIDE OF FORESTS

Emissions and Removals from Trees Outside of Forests

DESCRIPTION

Like forests, trees outside of forests sequester CO2 during the process of photosynthesis and act as a carbon sink and if removed they can be a source of emissions. Trees outside forests may be individual trees or trees in small patches (less than 1 acre). Increasing carbon sequestration and reducing emissions from local forests and trees supports climate change mitigation.

METHODOLOGY

Emissions and removals from trees outside of forests were calculated for each COG member jurisdiction with the i-Tree Canopy tool for the periods between 2006-2011 and 2011-2016 and the LEARN tool for the period between 2016-2019. The World Resources Institute's (WRI) *Guide to calculating tree canopy and canopy change outside of forests for US communities using i-Tree Canopy*[xxiv] was followed to develop emissions and removals for trees outside of forests. This guide is available on the LEARN tool website under Resources. GIS shapefiles are created for non-forested areas by jurisdiction and uploaded into the i-Tree Canopy tool to develop statistical estimates using 650 data points for tree canopy outside of forests maintained, gained, or lost. Google Earth Pro is leveraged for assessing historical aerial imagery. The LEARN tool incorporates Chesapeake Watershed (CBW) 1-meter resolution data used to analyze 2016-2019. These analyses provide the outputs needed to calculate emissions and removals from trees outside of forests for each jurisdiction and the region.

DATA INPUTS

The base time period analyzed for trees outside of forests is 2006-2011 and is applied to the 2005 inventory. Google Earth Pro imagery available for the region is not reliable prior to 2006 for the estimates required of this analysis. The next time period analyzed for trees outside of forests is 2011-2016 and is applied to the 2012 and 2015 GHG inventories. Lastly, trees outside of forests were analyzed for 2016-2019 and applied to the 2018 and 2020 GHG inventories.

Data Needs:

- ArcGIS boundary shapefiles for all 24 COG member jurisdictions.
- ArcGIS shapefiles of non-forested areas for all 24 COG member jurisdictions.
- Google Earth Pro satellite imagery in conjunction with i-Tree Canopy tool[xxv]
- Chesapeake Bay Watershed (CBW) 1-meter resolution land use/land cover ArcGIS shapefiles, 2013/4 – 2017/8.[xxiii]

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APPENDIX A: 2020 METHODOLOGY SUMMARY TABLE

Emissions Type	Emissions Activity or Source	GHG Types (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6)	Methodology (From US Communities Protocol, v 1.2)	Data Quality Confidence Levels (High, Medium, Low)
BUILT ENVIRONMENT				
Residential Energy	Emissions from Grid Electricity *	CO_2, CH_4, N_2O	Appendix C, BE.2.1	High
	Emissions from Stationary Fuel (Natural Gas) *		Appendix C, BE.1.1	High
	Emissions from Stationary Fuel (Fuel Oil, LPG) *		Appendix C, BE.1.2	Medium
Commercial and Industrial Energy	Emissions from Grid Electricity *	CO_2, CH_4, N_2O	Appendix C, BE.2.1	High
	Emissions from Stationary Fuel (Natural Gas) *		Appendix C, BE.1.1	High
	Emissions from Stationary Fuel (Fuel Oil, LPG) *		Appendix C, BE.1.3	Medium
	Industrial Point Source Emissions from Stationary Fuel Combustion	Any GHG	IE in commercial and industrial stationary fuel and solid waste	N/A
	Consumption of District Energy	CO_2, CH_4, N_2O	IE in commercial and industrial grid electricity and stationary fuel	N/A
Process and Fugitive Emissions	Fugitive Emissions from Natural Gas Distribution	CO_2, CH_4	ClearPath calculator	High
	Fugitive Emissions from Oil Systems, Mining, Processing, Storage, and Transportation of Coal	CO_2, CH_4, N_2O	NE	N/A
	Other Process and Fugitive	HFCs, PFCs, Refridgerant Blends	Alternate Method - Downscale from national inventory	Medium
TRANSPORTATION AND MOBILE EMISSIONS				
Transportation and Mobile Emissions	On Road Transportation *	CO_2, CH_4, N_2O	Appendix D, TR.1.A	High
	Emissions from Off Road Vehicles *		Appendix D, TR.8	High
	Aviation Travel		Appendix D, TR.6.D	Medium
	Rail Transportation *		Appendix D, TR.4	Medium
	Emissions from Public Transit *		IE in On Road	N/A
	Water Transportation *		IE in Off-Road	N/A
WASTE				
Solid Waste	Waste Generation (Landfill) *	Fugitive CH_4	Appendix E, SW.4 with updated ClearPath calculator that aligns with EPA Warm Model, version 14	High
	Process Emissions Associated with Landfilling	CO_2e	NE	N/A
	Combustion of Solid Waste Generated by the Community *	Fossil CO_2, N_2O, CH_4 (biologic CO_2 optional)	Appendix E, SW.2.2	Medium
	Biologic Treatment of Solid Waste (Composting)	CO_2, CH_4, N_2O	NE	N/A
Water and Wastewater	Emissions from Wastewater Treatment Energy Use *	CO_2, CH_4, and N_2O from electricity and fuels	IE in commercial and industrial energy	N/A
	Emissions from the Supply of Potable Water *	CO_2, CH_4, and N_2O from electricity and fuels	IE in commercial and industrial energy	N/A
	Fugitive Emissions from Septic Systems*	Fugitive CH_4	Appendix F, WW.11	High
	Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment *	Process N_2O	Appendix F, WW.7	High
	Process N2O from Effluent Discharge to Rivers and Estuaries *	Fugitive N_2O	Appendix F, WW.12	High

Emissions Type	Emissions Activity or Source	GHG Types (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6)	Methodology (From US Communities Protocol, v 1.2)	Data Quality Confidence Levels (High, Medium, Low)
LAND USE				
Agriculture	Emissions from Agricultural Activities	CH_4, N_2O	Alternate Method - EPA State Inventory Tool, AG Module	Medium
	Emissions from Stationary Fuel Combustion	CO_2, CH_4, N_2O	IE in commercial and industrial grid electricity and stationary fuel	N/A
	Emissions from Grid Electricity			
Forests and Trees Outside Forests	Forests	CO_2e	Appendix J, L.4	Medium
	Trees Outside Forests	CO_2e	Appendix J, L.5	Medium
OTHER				
Upstream Impacts of Activities	Upstream Impacts of Electricity Used by the Community	CO_2, CH_4, N_2O	NE	N/A
	Upstream Impacts of Fuels Used in Stationary Combustion by the Community			
	Emissions from Electric Power Transmission and Distribution Losses			
Consumption Based	Consumption Based Emissions, Previously Calculated	Any GHG	NE	N/A

Column Header	Description
Emissions Type	This column lists the main tabs in the online ClearPath tool's GHG inventory entry pages.
Emissions Activity/Source	This column lists the ClearPath calculators that are used to calculate or record emissions from activities/sources. * Indicates that reporting for this activity or source is required by the U.S. Community Protocol or Global Protocol for Communitiy-Scale GHG Inventories (BASIC). Those without a * are not requirements of the protocols.
GHG Types	Summarizes the leading GHG emission types that result from each activity or source, including carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
Methodology	The methodologies and calculations generally follow ICLEI's US Community Protocol for Accounting and Reporting GHG Emissions Version 1.2. Modified approaches to the ICLEI methodology are used based on data availability. In addition, notations are made in accordance with the Notation Keys legend below.

Notation Keys	Description
IE = Included Elsewhere	Emissions for this activity are estimated and presented in another category of the inventory. The category where these emissions are included should be noted in explanation.
NE = Not Estimated	Emissions occur but have not been estimated or reported (e.g., data unavailable, effort required not justifiable).
NA = Not Applicable	The activity occurs but does not cause emissions; explanation should be provided.
NO = Not Occurring	The source or activity does not occur or exist within the community.

Note: These notations were developed by the Global Communities Protocol and are also used by the U.S. Communities Protocol. See Version 1.2, 2019, Appendix B.

APPENDIX B: DATA NEEDS AND AVAILABILITY SUMMARY TABLE

Emissions Type	Emissions Activity or Source	Data Needs	Data Source	Data Availability
BUILT ENVIRONMENT				
Residential Energy	Emissions from Grid Electricity	Number of Residential Electricity Accounts	COG Annual Utility Data Survey	Annually available for previous year typically in Sept
		Residential Electricity Consumption		
		eGRID Emission Rates	U.S. Environmental Protection Agency (EPA)	Available every 1-2 years with a 2-year lag
	Emissions from Stationary Fuel (Natural Gas, Fuel Oil, LPG)	Number of Residential Natural Gas Accounts	COG Annual Utility Data Survey	Annually available for previous year typically in Sept
		Residential Natural Gas Consumption		
		Households using Fuel Oil and LPG	American Community Survey (ACS)	Annually available by Dec. for previous year
		Residential Fuel Oil and LPG Statewide Consumption	U.S. Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS)	RECS is not completed in standardized cycles (i.e. every x years); it depends on budget and funding. COG inventories use the 2005, 2009, and 2015 RECS.
Commercial and Industrial Energy	Emissions from Grid Electricity	Number of Non-Residential Electricity Accounts	COG Annual Utility Data Survey	Annually available for previous year typically in Sept
		Non-Residential Electricity Consumption		
		eGRID Emission Rates	U.S. EPA	Available every 1-2 years with a 2-year lag
	Emissions from Stationary Fuel (Natural Gas, Fuel Oil, LPG)	Number of Non-Residential Natural Gas Accounts	COG Annual Utility Data Survey	Annually available for previous year typically in Sept
		Non-Residential Natural Gas Consumption		
		Number of Local Commercial Buildings and Total Square Footage	COG's CoStar Database Account	Annually available for previous year in spring/summer
		South Atlantic Region's Total Commercial Floorspace and Square Footage using Fuel Oil and LPG	EIA Commercial Building Energy Consumption Survey (CBECS)	CBECS is not completed in standardized cycles (i.e. every x years); it depends on budget and funding. COG inventories use the 2003, 2012, and 2018 CBECS.
		Fuel Oil and LPG Energy Intensity	EIA CBECS	
Process and Fugitive Emissions	Fugitive Emissions from Natural Gas Distribution	Total Natural Gas Consumption	COG Annual Utility Data Survey	Annually available for previous year typically in Sept
	Other Process and Fugitive	Population	COG Cooperative Forecasts and ACS	COG - Every 1-2 years ACS - Annually available by Dec. for previous year
		U.S. Emissions of Ozone Depleting Substances	U.S. EPA Inventory of U.S. GHG Emissions and Sinks	Annually available by April 15
TRANSPORTATION AND MOBILE EMISSIONS				
Transportation and Mobile Emissions	On Road Transportation	Population	COG Cooperative Forecasts and ACS	COG - Every 1-2 years ACS - Annually available by Dec. for previous year
		Emissions	EPA MOVES and travel demand models	Completed for regional transportation plan updates every 4 years and by data request to Transportation Planning Board (TPB) modeling team
		Vehicle Miles Travelled		
	Emissions from Off Road Vehicles	Population	COG Cooperative Forecasts and ACS	COG - Every 1-2 years ACS - Annually available by Dec. for previous year
		Emissions	EPA MOVES2014/ NONROAD 2008	Only develop new off-road emissions SIP or base year air quality emissions inventory due for EPA submittal.
	Aviation Travel	Number of Originating Air Passengers	TPB's Washington-Baltimore Regional Air Passenger Survey	Biennal, special analysis for 2020 pandemic impacts
		Total Enplanements for BWI, DCA, IAD		
		Total Revenue Passenger Miles	Bureau of Transportation Statistics	Monthly, available 10 weeks after end of the month
		U.S. Total Commercial Aircraft Emissions	U.S. EPA Inventory of U.S. GHG Emissions and Sinks	Annually available by April 15
	Rail Transportation	Population	COG Cooperative Forecasts and ACS	COG - Every 1-2 years ACS - Annually available by Dec. for previous year
		MTA and VRE Diesel Consumption	FTA National Transit Database	Annually available in Oct for previous year

Emissions Type	Emissions Activity or Source	Data Needs	Data Source	Data Availability
WASTE				
Solid Waste	Waste Generation (Landfill)	Municpal Solid Waste (MSW)	Northern Virginia Regional Commission (NVRC) Solid Waste Reports, local and state plans and sources	Local MSW data reported to state annually in May (state publishing times vary; collect directly from localities). Biennally NVRC reports
	Combustion of Solid Waste Generated by the Community	MSW		
Water and Wastewater	Fugitive Emissions from Septic Systems	Population Served by Septic	COG Regional Wastewater Flow Forecast Model (RWFFM), COG Cooperative Forecasts, and ACS	RWFFM - Dec after COG Cooperative Forecast adoption COG Cooperative Forecast - Every 1-2 years ACS - Annually available by Dec. for previous year
	Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment	Population Served by Sewer		
	Process N2O from Effluent Discharge to Rivers and Estuaries	Population Served by Sewer		
		Daily Nitrogen Load		
LAND USE				
Agriculture	Emissions from Agricultural Activities	Livestock - dairy cows, beef cattle, sheep, goats, swine, horses, layers (pullets and chickens), broilers, and turkeys	Chesapeake Assessment Scenario Tool (CAST)	Annually, ongoing
		Fertilizer - synthetic, manure, biosolids		
		Crops acreage - corn for grain, all wheat, soybeans		
		Crop yields - bushels/acre for corn, wheat and soybeans by state (MD and VA)	AG Census	Every 5 years
Forests and Trees Outside Forests	Forest Land	ArcGIS boundary shapefiles for COG member jurisdictions and the region	ICLEI's LEARN tool, COG, and some local jurisdictions	Varies
		National Land Cover Dataset (NLCD) 30-meter resolution land use/land cover		Every few years
	Trees Outside Forest Land	ArcGIS boundary shapefiles for COG member jurisdictions and the region	ICLEI's LEARN tool, COG, and some local jurisdictions	Varies
		ArcGIS boundary shapefiles that exclude forested areas for COG member		
		2006-2019 satellite imagery	Google Earth Pro	Monthly, as available
		Chesapeake Bay Watershed 1-meter resolution land use/land cover data	ICLEI's LEARN tool	2013-2018 currently available, planned to be updated every few years

APPENDIX C: 2020 EMISSIONS FACTOR LIBRARY

Emissions Type	Emissions Activity or Source	Inventory Records	2020 Emissions Factors				Source
			CO2	CH4	N2O	Units	
BUILT ENVIRONMENT							
Residential Energy	Emissions from Grid Electricity	Residential Electricity - EPA eGRID RFCE	0.086713	0.000005981	0.000000797	MT/MMBtu	ClearPath
		Residential Electricity - EPA eGRID SRVC	0.082813	0.000006645	0.00000093	MT/MMBtu	
	Emissions from Stationary Fuel	Residential Natural Gas	53.02	0.005	0.0001	kg/MMBtu	
		Residential Fuel Oil	73.96	0.010869565	0.000724638	kg/MMBtu	
		Residential LPG	62.98	0.010869565	0.001086957	kg/MMBtu	
Commercial Energy	Emissions from Grid Electricity	Commercial Electricity - EPA eGRID RFC East	0.086713	0.000005981	0.000000797	MT/MMBtu	
		Commercial Electricity - EPA eGRID SERC Virginia/ Carolina	0.082813	0.000006645	0.000000930	MT/MMBtu	
	Emissions from Stationary Fuel Combustion	Commercial Natural Gas	53.02	0.005	0.0001	kg/MMBtu	
		Commercial Fuel Oil	73.96	0.010869565	0.000724638	kg/MMBtu	
		Commercial LPG	62.98	0.010869565	0.001086957	kg/MMBtu	
Process and Fugitive Emissions	Hydrofluorocarbon & Refrigerant Emissions	HFCs	Multiple emission factors not readily available to the public.				EPA US Inventory of Emissions and Sinks
	Fugitive Emissions from Natural Gas Distribution	Natural Gas Fugitive Emissions	0.000000663	0.000061939	N/A	MT/MMBtu natural gas used	ClearPath
TRANSPORTATION AND MOBILE EMISSIONS							
Transportation and Mobile Emissions	On Road Transportation	On Road Mobile Emissions	Multiple emission factors embedded into the MOVES2014b model inventory mode is not available to users.				EPA MOVES
	Aviation Travel	Passenger Air Travel	Multiple emission factors not readily available to the public.				EPA US Inventory of Emissions and Sinks
	Rail Transportation	Rail Transportation	0.073934483	0.000005793	0.000001883	MT/MMBtu	ClearPath
	Emissions from Off Road Vehicles	Off Road Mobile Emissions	Multiple emission factors embedded into the MOVES2014b nonroad model not available to users.				EPA MOVES
WASTE							
Solid Waste	Waste Generation	Landfill Waste Generation	N/A	0.648	N/A	MT CH4/wet short ton (mixed MSW)	ClearPath
	Combustion of Solid Waste Generated by the Community	Combustion of Solid Waste	0.032652	0.000032	0.0000042	MT/MMBtu	
			0.058048	N/A	N/A	MT/MMBtu (for biogenic CO2)	
Water and Wastewater	Fugitive Emissions from Septic Systems	Septic System Emissions	N/A	0.048213	N/A	MT CH4/daily kg BOD5	ClearPath
	Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment	Sewer System Emissions	N/A	N/A	7	g/person	
	Process N2O from Effluent Discharge to Rivers and Estuaries	N2O Effluent Discharge Emissions	N/A	N/A	0.005	kg N2O/kg N	
LAND USE							
Agriculture	Emissions from Agricultural Activities	Enteric Fermentation	N/A	143.3	N/A	kg CH4/head/day (for dairy cows in MD)	EPA State Inventory Tool, AG Module
			N/A	161.3	N/A	kg CH4/head/day (for dairy cows in VA)	
			N/A	94.4	N/A	kg CH4/head/day (for beef cows in MD and VA)	
			N/A	8	N/A	kg CH4/head/day (for sheep in MD and VA)	
			N/A	5	N/A	kg CH4/head/day (for goats in MD and VA)	
			N/A	1.5	N/A	kg CH4/head/day (for swine in MD and VA)	
			N/A	18	N/A	kg CH4/head/day (for horses in MD and VA)	
		Manure Management	N/A	0.24	N/A	m3 CH4/ kg Volatile Solids (VS) (for dairy cows in MD and VA)	
			N/A	0.17	N/A	m3 CH4/ kg VS (for beef cows in MD and VA)	
			N/A	0.48	N/A	m3 CH4/ kg VS (for swine in MD and VA)	
			N/A	0.39	N/A	m3 CH4/ kg VS (for layers in MD and VA)	
			N/A	0.36	N/A	m3 CH4/ kg VS (for broilers, turkeys, and sheep in MD and VA)	
			N/A	0.17	N/A	m3 CH4/ kg VS (for goats in MD and VA)	
			N/A	0.33	N/A	m3 CH4/ kg VS (for horses in MD and VA)	
			N/A	N/A	0.001	kg N20-N/kg N (for liquid manure management systems)	
			N/A	N/A	0.2	kg N20-N/kg N (for dry manure management systems)	
		AG Soils	N/A	N/A	0.02	kg N2O-N/kg N (for pasture, range, and paddock)	
			N/A	N/A	0.0075	kg N2ON/kg N (from leaching)	
			N/A	N/A	0.01	kg N2O N/kg N (from N-fixing crops)	
			N/A	N/A	0.01	kg N2O N/kg N (from residues)	
			N/A	N/A	0.01	kg N2O-N/kg N (from direct N2O emissions from AG soils-fertilizers)	
			N/A	N/A	0.001	kg N2O-N/kg N (from indirect N2O emissions from AG soils-fertilizers)	

Emissions Type	Emissions Activity or Source	Inventory Records	2020 Emissions Factors				Source
			CO2	CH4	N2O	Units	
Forests and Trees Outside of Forests	Emissions and Removals from Forests	Forested Land	Multiple emission factors embedded into ICLEI LEARN Tool and Reports that varies for each jurisdiction. Region values presented in this table.				US Community Protocol, ICLEI LEARN Tool
		Forest Change to Cropland	39.10	N/A	N/A	emission factor (t C/hectare)	
		Forest Change to Grassland	39.05	N/A	N/A	emission factor (t C/hectare)	
		Forest Change to Settlement	63.09	N/A	N/A	emission factor (t C/hectare)	
		Forest Change to Wetland	69.66	N/A	N/A	emission factor (t C/hectare)	
		Forest Change to Other	73.93	N/A	N/A	emission factor (t C/hectare)	
		Reforestation	(2.29)	N/A	N/A	removal factor (t C/hectare/year)	
		Forests Remaining Forests	(1.83)	N/A	N/A	removal factor (t C/hectare/year)	
		Disturbed Forests (i.e. harvest, weather, etc.)	69.25	N/A	N/A	emission factor (t C/hectare)	
	Emissions and Removals from Trees Outside of Forests	Trees Outside Forest Land	103.00	N/A	N/A	emission factor (t C/hectare)	
			(3.21)	N/A	N/A	removal factor (t C/hectare/year)	

Column Header	Description
Emissions Type	This column lists the main tabs in the online ClearPath tool's GHG inventory entry pages.
Emissions Activity/Source	This column lists the ClearPath calculators that are used to calculate or record emissions from activities/sources.
Inventory Records	This column lists COG's inventory record entries according to which calculator was used to create that entry.
Emission Factors	A factor expressing an amount of GHG emissions produced per a unit of activity data (e.g., tons of CO2 per ton of fuel consumed), which permits GHG emissions to be estimated for various activity types.
Source	Identifies the source for the emissions factors.

APPENDIX D: INVENTORY CHANGE LOG

Built Environment

EMISSIONS FROM GRID ELECTRICITY (RESIDENTIAL AND COMMERCIAL)

2005, 2012, 2015, 2018 Inventories
Added 2012 and 2015 BGE Frederick County data to consumption and re-estimated 2012 and 2015 inventories. Consumption was averaged from 2012, 2015, and 2018 for a 2005 consumption estimate and 2005 inventory was updated. Previously, BGE had not provided data for Frederick County. The additions have a minimal impact on county emissions.

EMISSIONS FROM RESIDENTIAL FUEL OIL & LPG CONSUMPTION

2005, 2012, 2015, 2018, 2020 Inventories
Previously, COG Community-wide GHG Inventories calculated Residential Fuel Oil and LPG Consumption by multiplying the number of households in each jurisdiction that use Fuel Oil and LPG as Home Heating Fuel from the American Community Surveys (ACS) by the statewide per household Fuel Oil and LPG consumption from the three states. The statewide per household consumption of Fuel Oil and LPG was calculated by dividing the total Fuel Oil and LPG use in the state from the Energy Information Administration's (EIA) State Energy Data System (SEDS) database by the state-level household numbers that use Fuel Oil and LPG from the ACS.

Research was conducted by technical consultant, Cadmus, to provide an updated methodology recommendation for Residential Fuel Oil and LPG Consumption. The recommendation was to multiply the annual number of households using Fuel Oil and LPG in each COG jurisdiction from ACS 5-year data with EIA's Residential Energy Consumption Survey (RECS) energy intensity data for the South Atlantic region. All inventory years have been updated using energy intensity data from EIA.

PROCESS AND FUGITIVE EMISSIONS – HYDROFLUOROCARBONS (HFCS)

2005, 2012, 2015, 2018, 2020 Inventories
Per the request of COG members, the COG Cooperative Forecast population data is used, where available, instead of ACS population data to downscale national HFCs to local estimates. This results in a small difference in HFC emissions between inventory rounds.

Transportation

ON ROAD TRANSPORTATION

2005, 2012, 2015, 2018, 2020 Inventories
To ensure modeling consistency and reduce potential error, all years of the inventory use EPA MOVES 2014b. Previously, 2005, 2012 and 2015 inventories were completed with earlier versions of EPA models.

For 2020, Highway Performance Monitoring System (HPMS) observed VMT data was used to inform and adjust modeled VMT data inputs into the MOVES model to capture the COVID-19 pandemic impacts on VMT.

OFF ROAD TRANSPORTATION

2005, 2012, 2015, 2018, 2020 Inventories

To ensure modeling consistency and reduce potential error, all years of the inventory use EPA MOVES 2014b. Previously, 2005, 2012 and 2015 inventories were completed with earlier versions of EPA models.

AIR PASSENGER TRAVEL

2005, 2012, 2015, 2018, 2020 Inventories

Originating air passenger travel is derived from data available at the Airport Analysis Zones (AAZ) scale. The Airport Analysis Zones (AAZ) for the Cities of Greenbelt, Hyattsville, Bladensburg, Falls Church, Manassas, and Manassas Park are significantly larger than the COG member city boundaries. Previously, originating air passengers were downscaled from the AAZ to city boundaries by American Community Survey (ACS) population and Falls Church was not downscaled. COG members requested a more accurate way to downscale.

A one-time analysis was completed by DTP's air traffic data team to determine the appropriate downscale factors using Transportation Analysis Zones (TAZ) population data. TAZs are small area planning zones with demographic data assigned in line with the COG Cooperative Forecasts. When grouped together, TAZ zones generally geographically align with cities and AAZs. Therefore, TAZ demographic data were analyzed to determine the percent to downscale the AAZ number of originating air passengers to city-scale. This is a more unified and accurate approach to downscaling that has been applied to all years of the inventory.

In 2020, COG initiated COVID-19 Travel Monitoring Snapshots to track travel impacts from the pandemic. COG leveraged data collected for the snapshots to conduct a special analysis of air trips by jurisdiction and an air travel counts analysis to support GHG estimates that fully capture impacts from the pandemic.

RAIL TRANSPORTATION

2005, 2012, 2015, 2018, 2020 Methodology

Per the request of COG members, the COG Cooperative Forecast population data is used, where available, instead of ACS population data to downscale regional rail emissions to local estimates. This results in a small difference in HFC emissions between inventory rounds.

Waste

LANDFILL WASTE GENERATION

2005, 2012, 2015, 2018, 2020 Methodology

ICLEI's ClearPath tool updated the Landfill Waste Generation calculator to better align with advancements to the EPA Waste Reduction Model (WARM). All years of the inventory were updated using the updated calculator, which resulted in a significant increase in landfill emissions.

Land Use

FORESTS AND TREES OUTSIDE OF FORESTS

2005, 2012, 2015, 2018, 2020 Methodology

All years of COG GHG inventories have been updated to include emissions and removals from Forests and Trees Outside of Forests. This has not been reported in previous inventory rounds.

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