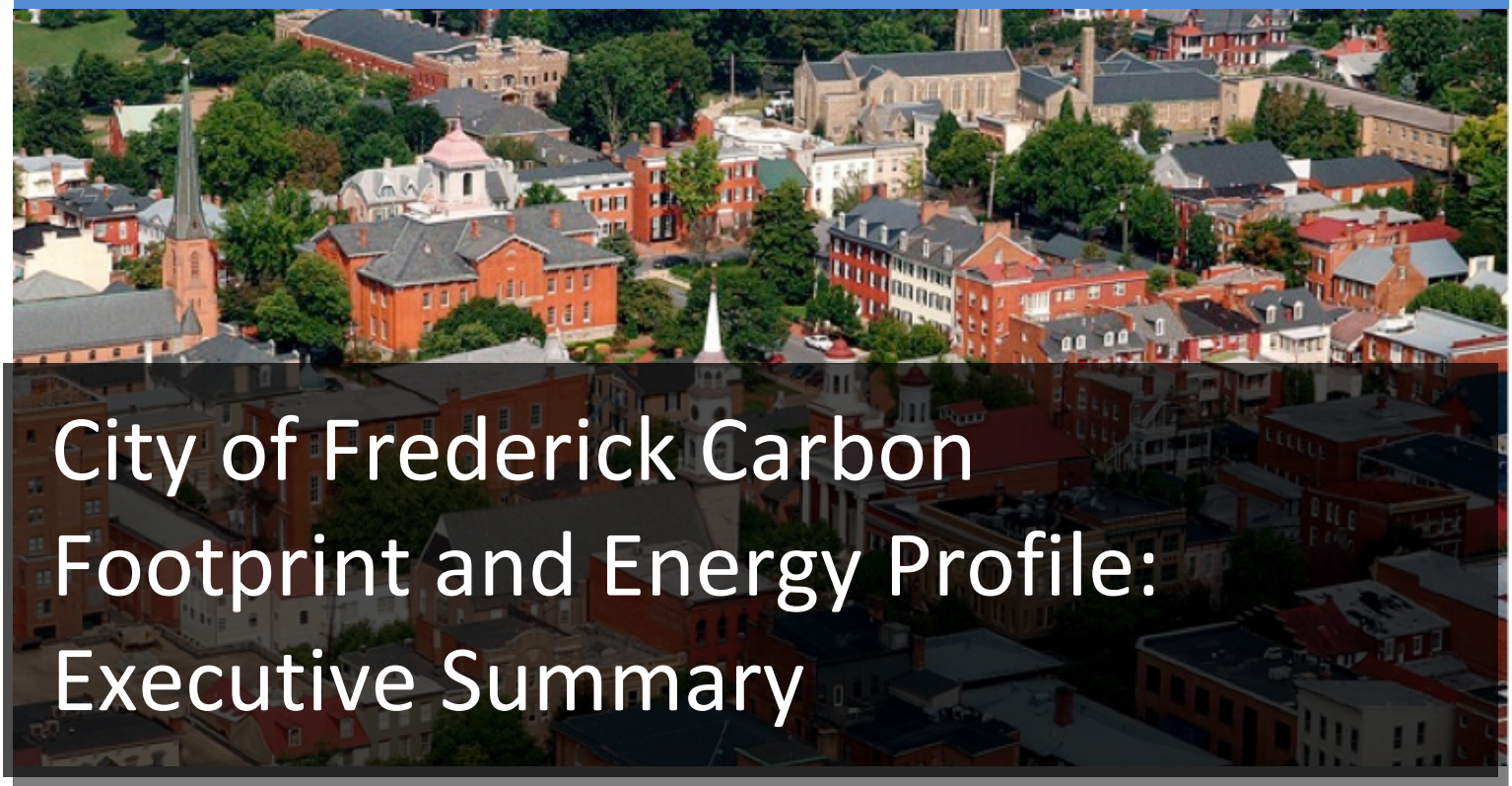

City of Frederick Carbon Footprint and Energy Profile: Executive Summary

A Local Government Greenhouse Gas (GHG) Emissions Inventory

A collaborative partnership between

PALS

The City of Frederick Maryland

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EXECUTIVE SUMMARY

As Maryland's second largest city, it is imperative that the City of Frederick begin tracking and managing its role in contributing to global greenhouse gas emissions (GHGs). This report is the City's first greenhouse gas inventory of local government operations and covers the year 2013. With the data sources, methodology, findings, and recommendations collected or generated as part of this effort, The City of Frederick is better positioned to institutionalize the process of tracking and managing greenhouse gas emissions, energy use, and other resources that will advance sustainability.

In 2013, the City's government operations and select, scope 3 sources consumed 166,155 MMBTU of energy and emitted 20,249 metric tonnes of carbon dioxide equivalent ($MTCO_2e$). Accounting for sequestered carbon dioxide from the City's urban tree canopy and composting of yard waste, the City's net greenhouse gas emissions totaled 14,215 $MTCO_2e$. Procured electricity was the leading source of emissions (54% of total). Although it is difficult to assess the City's performance over time due to limited historical data, it is possible to say that the City's energy consumption and carbon footprint are similar to peer communities in the metropolitan Washington, DC area. For example, the City of Annapolis averages approximately 100,000 MMBTU in energy consumption per year putting both Annapolis and Frederick at around 2.5 MMBTU per resident per year.[1]

This executive summary outlines key background information, methods, results, and recommendations associated with the GHG inventory. More detailed analyses and recommendations for mitigating GHGs can be found in three accompanying chapters addressing the City's building, transportation, and non-combustion activities.

ES.1. Background and Approach

The methods adopted to complete the City's local government operations GHG inventory for CY 2013 followed the World Resources Institute and World Business Council for Sustainable Development GHG protocol and corporate standard. The inventory was designed to include all emissions sources and sinks directly financed by the City of Frederick. Also known as scope 1 emissions, these GHGs are produced from the combustion of natural gas and other stationary fuels used for heating, cooking, and on-site power generation as well as gasoline and diesel fuels used to power the City's fleet. Non-combustion GHGs associated with wastewater processing at the City's wastewater treatment plant are also considered scope 1 emissions. Electricity is considered a scope 2 emissions source because, although the City controls the total quantity of electricity purchased, the fuel mix used to generate electricity is out of the City's

control. In addition to directly controlled emissions, a number of scope 3 emission sources indirectly controlled by the City were captured, including GHGs from fertilizer volatilization, employee commuting, solid waste decomposition, and urban forestry (GHG sink). Only carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) were captured in the inventory and all GHGs were converted to a common unit: metric tonnes of carbon dioxide equivalent ($MTCO_2e$).[A] The following list highlights the inventory's key methodological features:

- Research Team – The City's GHG inventory was completed by 11 graduate students participating in the Partnership for Action Learning in Sustainability (PALS) program at the University of Maryland. The students specialized in one of three topic areas (transportation, buildings, and non-combustion) and were asked to evaluate activity data provided by the City, to understand the relationship between City operations and GHG emissions per the GHG calculator, and to provide analysis, context, and data visualizations within their sector.

- GHG Calculator – Calculators standardize the inventory process across time and place. Across the United States and internationally, the most common tool to estimate GHG emissions from municipal operations is the ICLEI Carbon Calculator. For The City of Frederick's inventory, the course instructor elected to use an alternative tool: the U.S. EPA's Local Government Greenhouse Inventory Tool (LGGIT). Although this tool is not yet publicly available (the research team was granted permission to use the beta version), it should prove reliable when the City conducts its next GHG inventory. There were some disadvantages with using the LGGIT calculator, which are outlined below.

- Data Limitations – The accuracy of the GHG inventory results (as well as the quality of the supplemental analysis) is a function of the research team experience, access to analytical tools/resources, and the data provided by the City. The City of Frederick was exceedingly cooperative and timely in sharing data with the research team. However, due to internal data tracking procedures (or external procedures in the case of utilities), there were significant data gaps and uncertainties that precluded a higher quality product. These challenges and the recommendations for addressing them are outlined in further detail below and in the workgroup-specific chapters.

ES.2. Results and Context

In 2013, City of Frederick government operations and select scope 3 sources emitted 20,249 metric tonnes of carbon dioxide equivalent ($MTCO_2e$). Accounting for sequestered carbon dioxide from the City's urban tree canopy and composting of yard waste, the City's net greenhouse gas emissions totaled 14,215 $MTCO_2e$. The leading sources of emissions included

[A] E.g., methane has a global warming potential 21 times carbon dioxide due to trapped heat within the Earth's atmosphere. As a result, 1 tonne of methane equates to roughly 23 tonnes of carbon dioxide.

purchased electricity (54% of total), solid waste (16%), fleet operations (15%), and employee commuting (10%). Fuel consumed to heat buildings, among other purposes, accounted for less than 4% of total emissions while wastewater processing and fertilizer volatilization accounted for the smallest total share of emissions (~1%). Carbon dioxide sequestered by the City's trees reduces emissions by nearly 30% relative to the gross total (see table ES.1).

Table ES.1 Summary activity data and GHG emissions for The City of Frederick, 2013

Scope and Sector	Activity in 2013	$MTCO_2e$	% of Gross **
Scope 1: Building Fuel Consumption *(Buildings Workgroup)*	13,874.3 MMBTU	740	3.65
Scope 1: Transportation Fuel Consumption *(Transportation Workgroup)*	336,313 Gallons of Gas Equiv.; 41,617 MMBTU	2,991	14.77
Scope 1: Non-combustion wastewater *(Non-combustion Workgroup)*	Multiple data pieces; emissions from CH_4 and N_2O	220	1.08
Scope 2:Purchased Electricity *(Buildings Workgroup)*	23,915.9 Megawatt Hours; 81,604 MMBTU	10,924	53.95
Scope 3: Fertilizer Application *(Non-combustion Workgroup)*	24,400 Pounds; 4.08 Short Tons of N	34	.17
Scope 3: Employee Commuting *(Transportation Workgroup)*	4.7 million miles traveled; 28,637 MMBTU	1,934	9.55
Scope 3: Solid Waste *(Non-combustion Workgroup)*	19,318 Short Tons; 422 MMBTU*	3,406	16.82
Gross Total	166,155 MMBTU	20,249	N/A
Sequestration: Composted Yard Waste *(Non-combustion Workgroup)*	535 Short Tons	-66	.33
Sequestration: Urban Tree Canopy *(Non-combustion Workgroup)*	1,804 acres of urban tree canopy	-5,969	29.48
Net Total	166,155 MMBTU	14,215	N/A

* The solid waste estimate includes fuel combusted to transport solid waste.
** Values in the "% of Gross Column" sum across all emissions sources (do not include sinks).

The inventory results should be understood in light of some important context as well as the methods and assumptions employed. The chapters completed by each workgroup provide comprehensive contextual information, methods, tables, figures, and assumptions. The following list highlights the most important information and findings related to each emissions source or sink:

- Building Fuel Consumption: More than 99% of the energy consumed in this category is natural gas, most likely for space heating (the remainder is propane, oil, and other fuels). Of the City's 25 natural gas accounts with Washington Gas, three accounts consume more than 75% of the City's fuel including 111 East Airport Drive (50% of total), the Armory Building (16%), and 20 West Patrick Street (10%). A central priority for the City should be to better understand why the Department of Public Works facility (i.e., 111 East Airport Drive) is consuming so much natural gas.

- Transportation Fuel Consumption: The analysis performed on City fleet fuel consumption and subsequent GHGs was constrained by data availability. While total fuel consumption records were available (i.e., on and off road, diesel and gas fuel totals), high-resolution, vehicle-specific information was not available (i.e., fuel economy, annual mileage associated with individual vehicles). Using case studies, literature, and multiple assumptions, the fuel totals were disaggregated to the departmental and individual vehicle level. The results of this exercise matched-up reasonably well against the original aggregate data provided by the City and reveal that the Department of Public Works emitted approximately 44% of total fleet-based emissions, followed by the Police Department, which emitted 40% of the total.

- Non-combustion Wastewater: Emissions from the City's wastewater plant excludes electricity usage (in purchased electricity) and includes methane and nitrous oxide from the decomposition of sewage. The methods used to estimate GHGs from wastewater were rudimentary and the results are the most uncertain of all sources in the City's inventory. The multiple variables and complex biochemical reactions exceeded the expertise of the research team and the initial results generated by the LGGIT calculator could not be reconciled by staff at the City's wastewater treatment plant. Further study of the plant and its GHG impact should be completed with assistance from experts.

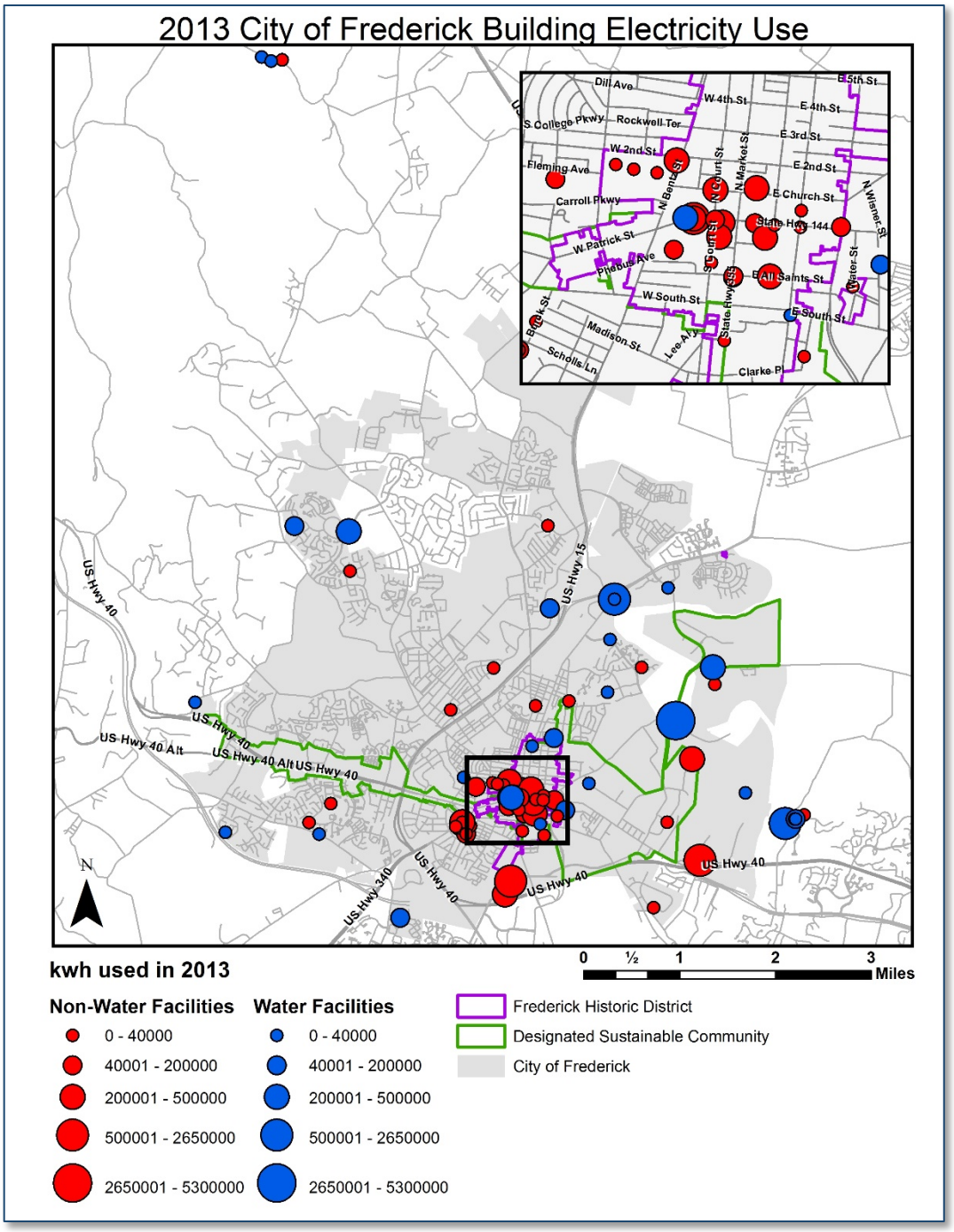
- Purchased Electricity: GHG emissions from purchased electricity are a function of the quantity of electricity purchased and the fuel mix of primary energy used to generate that electricity (e.g., coal, wind, nuclear). The inventory applies the RFC-East regional fuel mix from the US EPA eGRID for 2010 (the most current) to the City's purchased electricity to arrive at an estimate of GHG emissions.[B] Water facilities (44%) and streetlights (25%) are the two largest end uses of electricity (see Figure ES.1 below).

[B] See US EPA eGRID information online here: http://www.epa.gov/cleanenergy/documents/egridzips/eGRID_9th_edition_V1-0_year_2010_GHG_Rates.pdf.

- Solid Waste: Emissions from solid waste are primarily from methane, a highly potent GHG compared to carbon dioxide. Solid waste GHGs are considered scope 3 emissions because the County landfill, which employs methane capture and energy generation, is not owned or operated by the City. The EPA's WARM model was used to estimate GHGs and assumes a fraction of methane produced at the landfill escapes resulting in relatively high GHG emissions. High-resolution waste data (e.g., by sector, by time) and more comprehensive

information about the landfill could be incorporated into a subsequent inventory to improve accuracy.

Figure ES.1 kWh of electricity purchased mapped across City, by water and non-water facilities



- Employee Commuting: GHG emissions from employee commuting were calculated using employee home zip codes and GIS-mapping technology to estimate the most efficient road-

networked path. A number of assumptions were made concerning mode choice (i.e., all employees outside of ZIP 21701 drive single-occupancy vehicles, all employees within ZIP 21701 produce zero GHGs) and trip frequency. The median distance traveled by City employees in 2013 was 7.63 miles (one-way), the mean distance was 13.6 miles, and the maximum distance was 166 miles. Additionally, 43 percent of employees travel less than three miles to work, and the 36% of employee with commutes greater than the mean commute distance account for 72% of all GHG emissions (see Figure ES.2 below).

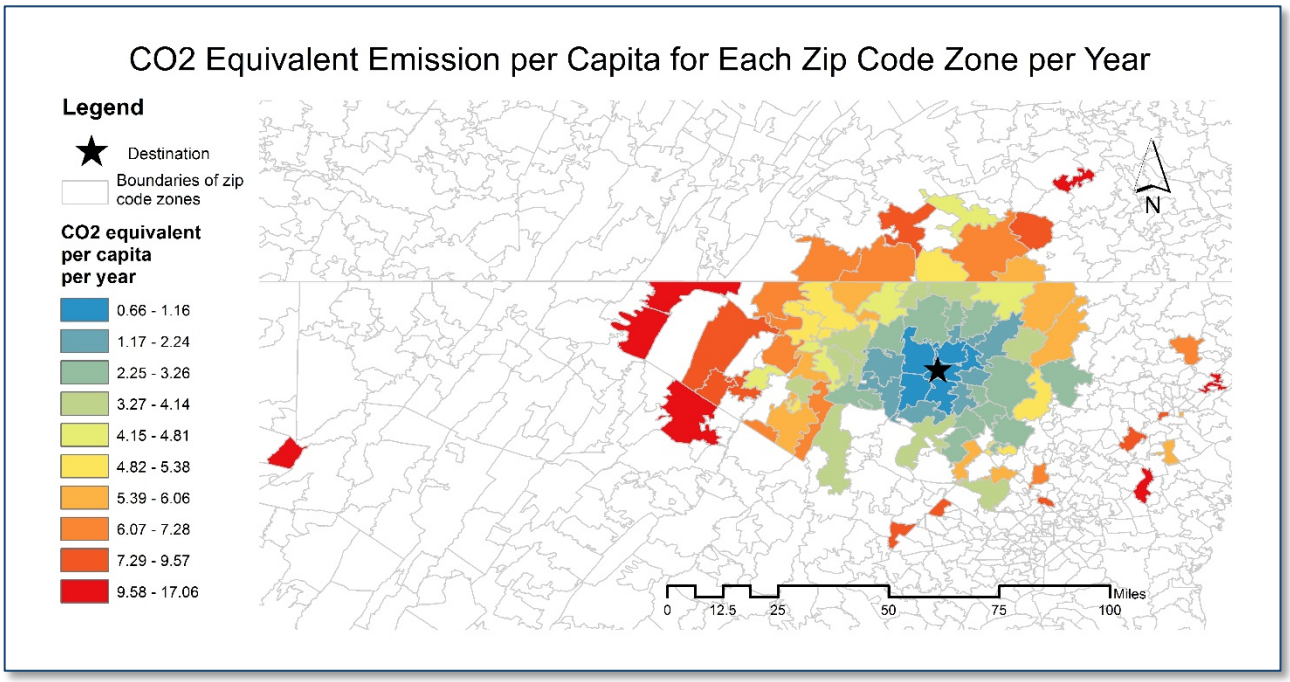


Figure ES.2 GHG emissions from City of Frederick employee commuting per capita by ZIP code

- Carbon Sequestration from Composted Yard Waste and Urban Tree Canopy: Sequestered GHGs from composted yard waste are calculated using the EPA WARM model. Similar to solid waste, yard waste analysis would benefit from higher resolution data and a closer examination of the composting processing. While composted yard waste is a relatively small sink for carbon dioxide, the City's urban tree canopy has a significant impact on total GHGs in the City, and net GHG emissions are very sensitive to the results. Sequestered emissions are calculated using the standard emissions factor in the LGGIT tool, but carbon sequestration from trees varies based on weather, soil conditions, tree type, and other factors. It is also worth noting that the current estimate of GHGs sequestered omits trees located in the City's municipal forest (outside the City boundary). A generalized estimate such as the one used should be taken with a grain of salt. Excluding carbon dioxide sequestration from the City's urban tree canopy, total GHGs would be 42% higher.

ES.3. Overview, Lessons Learned, and Recommendations

The City of Frederick has demonstrated its leadership by initiating a process to examine municipal contributions to global climate change. The City is not required by State or Federal

entities to conduct a GHG inventory nor is it required to take the difficult steps of planning, financing, and implementing actions to reduce emissions. Instead, the City is pursuing this work because it aspires to better understand and manage energy and carbon pollution as a means to find efficiencies in government operations and secure a healthier, more stable environment for its citizens.

Supported by our time in Frederick and in discussions with City staff and residents, we believe the City of Frederick is on track to reduce its carbon footprint. The City has laid the groundwork for success—Frederick recently adopted ambitious goals to reduce electricity consumption and increase on-site renewable energy generation, it has dedicated staff time to completing sustainability work, and its elected officials are eager to learn and passionate about making an impact. Moreover, the City has several high-profile projects in development that will have an immediate impact on GHG emissions. These include the installation of a methane capture and combustion co-generation facility at the wastewater treatment plant, and a large-scale solar photovoltaic facility.

This was the City's first GHG inventory as well as a first-of-its-kind student-led research project under the PALS program. As such, there were multiple challenges to overcome and many lessons learned. Energy and GHG tracking should be performed regularly and it is the intention of the authors to share our experiences, methods, and other resources, which will enable the City to replicate this effort. The following list outlines specific challenges, lessons learned, and recommendations for the benefit of the City of Frederick and/or subsequent PALS courses:

- Omissions and Oversights: The research team did not capture GHG emissions from City-financed personal travel (i.e., air, rail, and reimbursed personal vehicle travel). Because the inventory sources were selected via the LGGIT calculator design, which excluded this source, the instructor failed to request City-financed travel data and takes full responsibility for its omission. This is an important scope 1 source of emissions that should be captured in subsequent GHG inventories.

- Selecting a GHG Calculator: As stated above, the LGGIT tool was used to guide data collection and was integral to converting activity data into GHG emissions. The calculator had some weaknesses related to excluded emission sources (i.e., City-financed travel), and the quality of its estimates. For example, in the case of sequestered carbon dioxide from the City's urban tree canopy, the calculator generates a single estimate without consideration of uncertainty. A more accurate estimate could be generated with a devoted study of the City's tree species, soil type, and weather conditions. More troubling, the City's wastewater treatment plant operations could not be reconciled with the calculator framework, which assumed emissions from facultative lagoons not present at the City's plant. For the most part, the calculator served its purpose and should be useful to the City going forward. However, selecting an alternative calculator or deviating from generalized calculators altogether to conduct a more refined study (e.g., wastewater and urban forest) are options worth considering.

- Data Availability and Quality: The task of data collection was shared between the City and the research team. The process was relatively straightforward and minimally time-consuming. However, the quality and breadth of the data was a major issue. For example, electricity and gas accounts were more difficult to allocate to specific addresses or had duplicate addresses. Gas usage was also only available at the annual level. Ongoing and careful organization of energy invoices at the monthly level, by account number and address would greatly enhance future analyses and allow the City to find and remedy anomalies in building performance much earlier. The most significant data gap is in the City's fleet. Here only aggregate totals of fuel consumption were available when vehicle-specific information would have been more useful. As part of their recommendations to the City, the Transportation Workgroup developed a detailed work plan for conducting a fleet-wide assessment of vehicles and retirement/replacement schedule, which if adopted by the City, will significantly improve data quality.

- Community Scale Inventory: The effort undertaken here only captures a portion of the City's carbon footprint—government operations. It is common practice to supplement an inventory of City operation emissions with community scale emissions inclusive of all residential and business property within the City, but not owned or financed by the City. There are multiple case studies, tools, and data sources available to the City of Frederick when it is ready to take this step.

The remainder of the report is broken into three chapters: buildings, transportation, and non-combustion. Each is composed of two sections—the first providing a descriptive analysis of that sector, and the second a prescriptive recommendation for reducing GHG emissions. In the first chapter, the Buildings Workgroup presents their analysis along with *"Creating a Pathway to Sustainability for Harry Grove Stadium,"* a package of carbon-mitigating projects focused on a high-profile City facility. In chapter two, the Transportation Workgroup presents their analysis along with, *"A Smart Fleet Program for the City of Frederick,"* a work plan for advancing the City's fleet tracking and long-term planning. Last, in chapter three, the Non-combustion Workgroup presents their analysis and, *"Growing Green: Tree Planting on Residential Property,"* a rebate program for encouraging City of Frederick residents to plant trees on their property.

Citations

[1] City of Annapolis, 2006. *Energy Consumption and Greenhouse Gas Emissions of the Facilities and Operations of the City of Annapolis in Fiscal Year 2006*.