ECO-CITY ALEXANDRIA

Greenhouse Gas and Criteria Air Pollutant Emissions Inventory

April 2009

Office of Environmental Quality
Department of Transportation and Environmental Services

Greenhouse Gas and Criteria Air Pollutant Emissions Inventory

April 2009

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Acronyms and Abbreviations

AEO	Annual Energy Outlook
ASA	Alexandria Sanitation Authority
BAU	Business-as-Usual
BTU	British Thermal Unit
CACPS	Clean Air and Climate Protection Software
CAP	Criteria Air Pollutant
CNG	Compressed Natural Gas
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalents
EGU	Electric Generating Unit
GHG	Greenhouse Gas
GWP	Global Warming Potential
ICLEI	International Council on Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
LPG	Liquefied Petroleum Gas
PM_{10}	Particulate Matter less than 10 microns in diameter
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
MMBtu	Million British Thermal Units
MOBILE 6	MOBILE emissions estimation model version 6
MSW	Municipal solid waste
MWCOG	Metropolitan Washington Council of Governments
Mwh	Megawatt hours
NAS	National Academy of Science
NCRTPB	National Capitol Region Transportation Planning Board
NERC	North American Electric Reliability Council
NMIM	National Mobile Inventory Model
NONROAD	no acronym (model name)
NO_x	Oxides of Nitrogen
N_2O	Nitrous Oxide
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
T&ES	Transportation and Environmental Services
Tonnes	Metric Tons (equivalent to 1,000 kilograms or 2,204.6 pounds)
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
VADEQ	Virginia Department of Environmental Quality
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
WMATA	Washington Metropolitan Area Transit Authority

EXECUTIVE SUMMARY: GREENHOUSE GAS EMISSIONS INVENTORY

"As a lifelong resident and Mayor of Alexandria, I am very concerned about the potential impacts climate change may have on a coastal city such as Alexandria and its residents. With the potential for increased temperatures and a rising sea level as a result of global warming, the frequency and severity of damage from hurricanes and flooding will increase. Currently small localized flooding of the Potomac River in Old Town is a regular occurrence and is a manageable problem. However, with the impact of global climate change, flooding will become a significant issue impacting public safety, property damage, and the city's economy."
MAYOR WILLIAM D. EUILLE

Global warming refers to an average increase in the earth's temperature that in turn, causes changes in the global climate. Most scientists agree that the observed increase in global temperature is attributable to rise in atmospheric concentrations of greenhouse gases (GHG) such as carbon dioxide, methane, nitrous oxides, and fluorinated gases. Human activities that contribute to the release of these gases are fossil fuel combustion, industrial processes, and agricultural byproducts.

In February 2005, Mayor Euille endorsed and signed the 2005 U.S. Mayors Climate Protection Agreement along with 278 other mayors from 43 states representing a total population of 48.5 million citizens. This agreement committed Alexandria to meet or exceed the Kyoto Protocol GHG reduction targets through the use of local land use planning, urban forest restoration, public outreach campaigns, and other reduction strategies.

In November 2005, the Sierra Club recognized the City of Alexandria as a "Cool City." Being designated as a "Cool City" means the City has committed to prepare a GHG emissions inventory and a climate action plan with concrete steps for reducing GHG emissions.

In January 2007, the City government initiated the Eco-City Alexandria planning process to develop an *Eco-City Charter* (adopted June 2008) and *Environmental Action Plan* (adopted January 2009) to guide the city toward sustainability.

ECO-CITY ALEXANDRIA

Eco-Cities are places where people can live healthier and economically productive lives while reducing their impact on the environment. They work to harmonize existing policies, regional realities, and economic and business markets with their natural resources and environmental assets. Eco-Cities strive to engage all citizens in collaborative and transparent decision making, while being mindful of social equity concerns.

In 2008, the City joined the International Council on Local Environmental Initiatives (ICLEI), a group of 1000 local governments committed to advancing climate protection. The City is using ICLEI software and methodologies to create a GHG emissions inventory, a critical first step in determining the City government's GHG contribution as well as the contribution from the community. It identifies the largest sources of GHG emissions, shows trends, and provides information to inform policy decisions.

The City government has already implemented measures to reduce GHG emissions – hiring an energy manager, developing a Green Building policy, purchasing biodiesel and hybrid vehicles, distributing over 900 compact fluorescent light bulbs to citizens, and conducting outreach and educational activities.

Additional efforts to reduce GHG emissions will likely provide collateral benefits, including increased efficiency in government operations, improved air quality and public health, reduced energy costs, and continuation of climate-friendly patterns of growth and development.

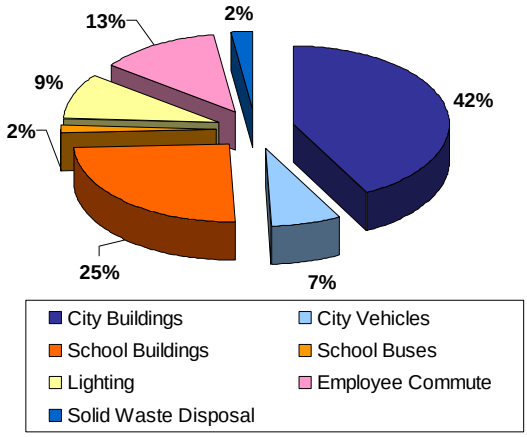
The full emissions inventory report is available at: http://alexandriava.gov/tes

CITY GOVERNMENT GHG INVENTORY, FORECAST, AND TARGETS

The City Government Operations inventory provides an estimate of GHG emissions produced by City government activities, including fuel use, electricity use, and waste production resulting from City government operations. The emissions inventory both direct emissions (for example, emissions within the city from fossil fuel combustion at City buildings) and indirect emissions (emissions generated outside the city by City employees commuting to Alexandria to work).

In FY2006, City government operations resulted in the production of about **79,820 metric tons (tonnes)** of greenhouse gas emissions, primarily from fossil fuel and electricity consumption in City buildings and schools. These emissions are a subset of the city-wide community total GHG emissions, representing approximately 3 percent of the city-wide total of 2.6 million tonnes.

The consumption of electricity and the combustion of natural gas in City government buildings resulted in the majority of emissions in FY2006 - approximately 33,729 tonnes of CO_2e. School buildings were the second largest source and made up 25 percent of the total government CO_2e emissions. Gasoline fuel used by City government employees commuting to work was the third largest category of emissions.



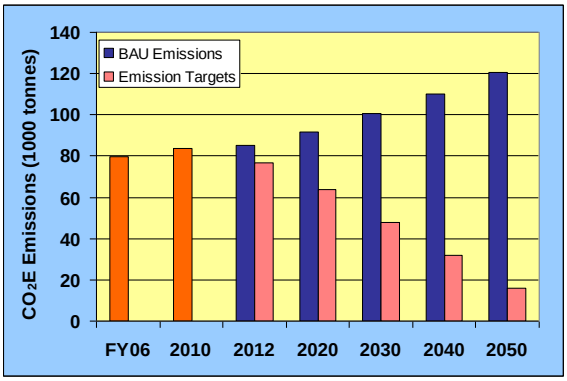
FY06 (July 1, 2005 to June 30, 2006) City Government CO_2e Emissions by Sector (79,820 tonnes)

A business-as-usual (BAU) emissions forecast scenario was developed for local government operations. Projections were made and emission reduction targets were set for the short-term (2010, 2012), medium term (2020, 2030), and long-term (2040, 2050). It was estimated that by 2020, if energy use continued to follow existing patterns, City government operations would result in approximately **91,767 tonnes**, or a 15 percent increase from the baseline year emissions.

The MWGOG Climate Change Steering Committee is recommending goals to reduce regional greenhouse gases. These targets represent the consensus of U.S. scientists who say that greenhouse gas emissions must be reduced by 50–85 percent by 2050 to avoid the possible consequences of global warming.

Year	MWCOG Proposed Reduction Target
2012	Reduce Business As Usual (BAU) Emissions by 10 Percent Below 2012 Levels
2020	20 Percent Below 2005 Levels
2050	80 Percent Below 2005 Levels

The City government is considering using the MWCOG emission reduction percentage targets for reducing the City's government operations GHG emissions. The short-term goal is to reduce greenhouse gas emissions by 10 percent below BAU levels by 2012. Measures to address the aggressive targets for 2020 and 2050 are currently under development.

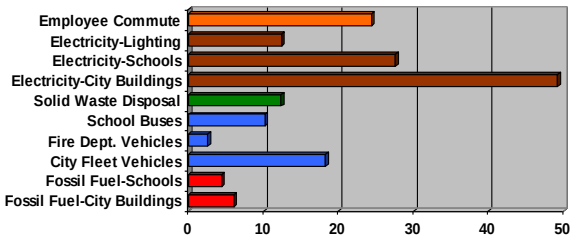


City Operations Emission Reduction Targets

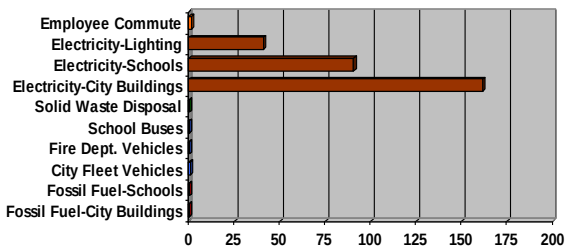
CITY GOVERNMENT CRITERIA AIR POLLUTANT INVENTORY

The City government CAP emission inventory for the 2006 fiscal year is summarized below. The orange bars on the figures below show emissions from City government employees commuting to work, the brown bars denote electricity consumed within by the City government that was generated by power plants in Virginia and nearby States; the green bar shows emissions from solid waste disposed and combusted at the Covanta energy-from-waste facility, the blue bars show emissions from City-owned vehicles, and the red bars denote fossil fuel combustion in City government buildings and schools. DASH buses are not included in the City government inventory but are not accounted for in the community inventory.

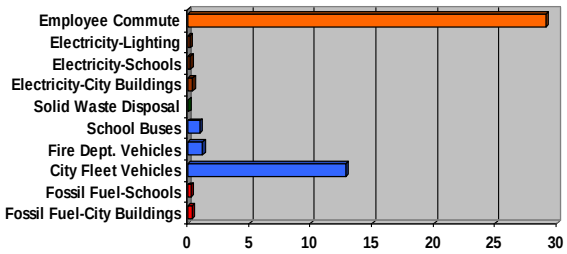
- *NO_x emissions* result from electricity consumption, employee commutes, and City vehicles.
- *SO_2 emissions* are from electricity consumed by City government buildings and lighting.
- *VOC and CO emissions* are primarily from employee commutes and City vehicles
- *PM_{10} and $PM_{2.5}$ emissions* are primarily electricity consumed by City government buildings and lighting, gasoline/diesel fuel consumed during employee commutes and City government vehicles, and fossil fuel combustion in City government buildings and schools.



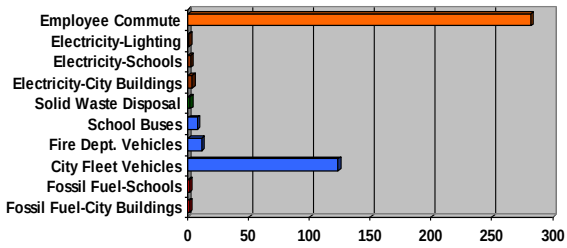
FY06 City Government NO_x Emissions (tonnes)



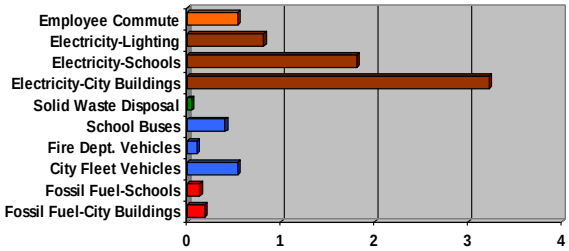
FY06 City Government SO_2 Emissions (tonnes)



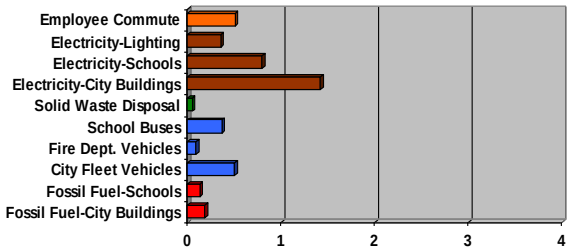
FY06 City Government VOC Emissions (tonnes)



FY06 City Government CO Emissions (tonnes)



FY06 City Government PM_{10} Emissions (tonnes)

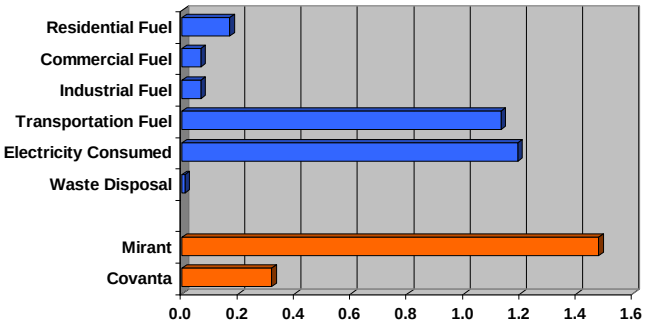


FY06 City Government $PM_{2.5}$ Emissions (tonnes)

COMMUNITY GHG INVENTORY, FORECAST AND TARGETS

The Community inventory includes emissions produced by residents, by businesses/ agencies, and by residents and commuters traveling within the city. It includes direct emissions from sources located within the city, as well as indirect emissions that result from activity within the city but the associated emissions occur outside of the city's boundary (e.g., electricity consumed in the city that is imported from coal-fired power plants outside of the city).

It useful for public awareness and target setting to frame emissions based on energy consumption. The blue bars on the figure below show the GHG emissions for fossil fuel and electricity consumption, which totaled 2.6 million metric tons (tonnes) in 2005.

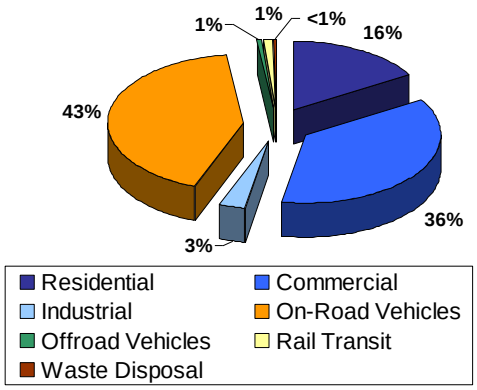


CY 2005 Community CO_2e Emissions (million tonnes)

Electricity is also generated in the city by the Mirant Potomac River Generating Station and the Covanta energy-from-waste plant. The orange bars in the graph above show the GHG emissions from electricity generation, which totaled 1.8 million tonnes in 2005. Some of this electricity is consumed within the city, while most is transmitted for sale in other areas. The total demand within the city therefore differs from the total generation.

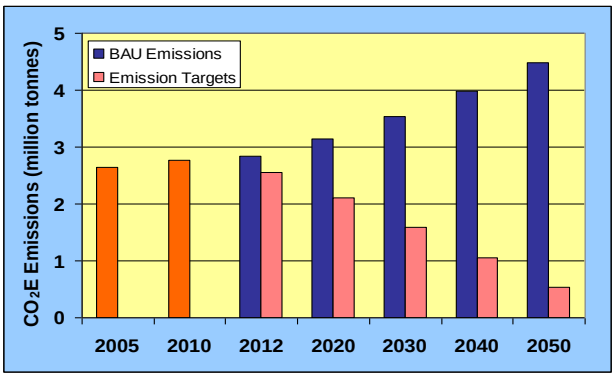
To avoid double counting, we have subtracted grid-based generation to assign responsibility for electricity usage to the end-user, which will help in targeting policies to reduce emissions. Using this formula, the total GHG consumption-based emissions for Alexandria in 2005 were **2.6 million tonnes,** which does not include emissions from Mirant and Covanta.

Onroad vehicle traffic in the city accounts for 43 percent of the 2.6 million tonnes. The operation of commercial and residential buildings account for 36 percent and 16 percent of the total, respectively.



CY05 Community Consumption-Based CO2e Emissions by Sector (2.6 million tonnes)

Future GHG emissions under a "business-as-usual (BAU)" scenario were developed to account for the anticipated growth in energy consumption resulting from projected growth in population, employment, and vehicle traffic. The City government is considering using the MWCOG emission reduction percentage targets for reducing the city's community-wide GHG emissions.

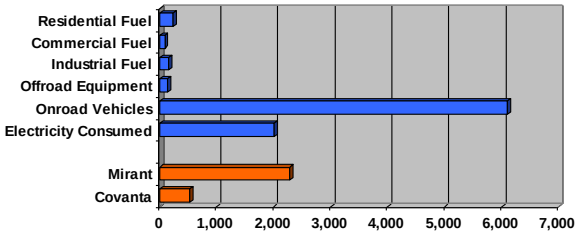


Community-Wide Consumption-Based Business-as-Usual Emissions and MWCOG Reduction Targets

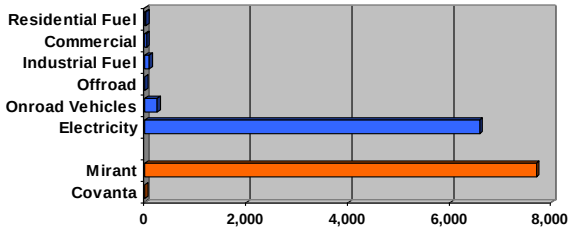
COMMUNITY CRITERIA AIR POLLUTANT INVENTORY

The Community CAP emission inventory for the 2005 calendar year is summarized below. The blue bars on the figures below show the CAP emissions for fossil fuel/electricity consumption and other sources within the city; the orange bars show the CAP emissions from electricity generation (e.g.., Mirant and Covanta).

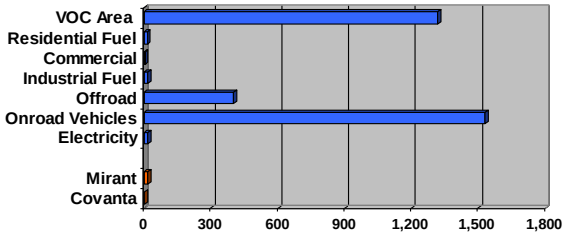
- *NO_x emissions* are primarily from gasoline/diesel fuel consumed by on-road vehicles, electricity consumed within the city that was generated by power plants in Virginia and nearby States, and electricity generated by Mirant and Covanta.
- *SO_2 emissions* are from electricity consumed within the city and electricity generated by Mirant's coal-fired power plant.
- *VOC emissions* are primarily from VOC area sources (gasoline service stations, paints, cleaning solvents, consumer products), onroad vehicles, and offroad equipment.
- *CO emissions* are from gasoline/diesel fuel consumed by on-road vehicles and offroad equipment.
- *PM_{10} and $PM_{2.5}$ emissions* are primarily from gasoline/diesel fuel consumed by on-road vehicles, electricity consumed within the city, and electricity generated by Mirant's coal-fired power plant.



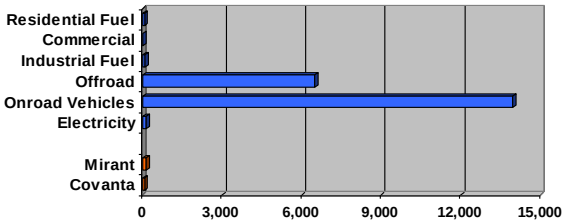
CY05 Community NO_x Emissions (tonnes)



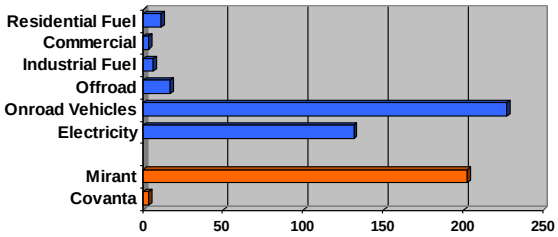
CY05 Community SO_2 Emissions (tonnes)



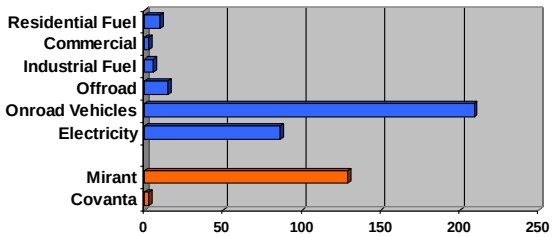
CY05 Community VOC Emissions (tonnes)



CY05 Community CO Emissions (tonnes)



CY05 Community PM_{10} Emissions (tonnes)



CY05 Community $PM_{2.5}$ Emissions (tonnes)

GREENHOUSE GAS IMPLEMENTATION AND NEXT STEPS

The City government has already implemented measures to reduce GHG emissions, including:

- ✓ Hired Energy Manager and established Energy Conservation Committee
- ✓ Developed Internal Green Building Policy and Established Green Building Committee
- ✓ Green City Fleet (purchase biodiesel and hybrids)
- ✓ Distributed CFLs to citizens at Earth Day Event
- ✓ Expanded Outreach and Education

The City government has committed to the following five milestone framework of the Cities for Climate Protection Protocol for further reducing GHG emissions.

Next Steps:

Milestone 1 (April 2009). Finalize baseline emissions inventory and forecast.

Milestone 2 (April 2009). Finalize emission reduction targets and identify potential emission reduction measures.

Milestone 3 (June 2009). In consultation with the Environmental Policy Commission, develop a Climate Action Plan and incorporate it into the Environmental Action Plan.

Milestone 4. Implement policies and measures in the Climate Action Plan.

Milestone 5. Monitor and verify progress on the implementation of measures.

How Do We Reduce GHG and CAP Emissions?	
The *Phase One Environmental Action Plan* includes goals and action steps that cover all ten principles of the Eco-City Charter. Listed below are but a few of the more promising measures that the City government and community may undertake to reduce greenhouse gas emissions.	
Government Operations	**Community Activities**
Energy – energy audits; lighting retrofits; policy to shut down computers at end of day; purchase green energy; purchase renewable energy.	**Energy** – City Energy Master Plan; energy audits for home owners and businesses; energy conservation outreach.
Building Green – LEED silver status for new construction/renovation; green roof for City Hall.	**Building Green** – green building standards as part of Special Use Permit process.
Land Use – Urban Forestry Master Plan; open space and green infrastructure; low impact landscaping practices; green roofs and parking lots.	**Land Use** – City Bikeway and Trail network; increase density near Metro and transportation hubs; pedestrian friendly neighborhoods.
Solid Waste – recycling bins in City-run facilities; optimize trash truck routing to reduce fuel use.	**Solid Waste** – expanded multi-family/condominium recycling and household hazardous waste program
Transportation – encourage carpooling, transit, and telecommuting for employees; fuel efficient or hybrid government vehicles; bio-diesel for vehicles.	**Transportation** – Green taxi fleet; improved facilities for cyclists; improve access to mass transit; "no idling" near Metro stations.

Implementation of these measures will require capital investment, but many measures offer a substantial return on investments in terms of reduced energy consumption and energy costs. In addition reducing the city's emissions, staff will also coordinate efforts with regional, state, and national policies to meet greenhouse gas emission reduction targets.

For more information, please contact:

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Alexandria, VA 22314
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www.alexandriava.gov/oeq

1.0 Introduction to Climate Change

The Earth's climate has changed many times during the planet's history, with events ranging from ice ages to long periods of warmth. Historically, natural factors such as volcanic eruptions, changes in the Earth's orbit, and the amount of energy released from the Sun have affected the Earth's climate. While not all scientists agree, evidence indicates that human activities may be accelerating climate by the dramatic increase in man-made greenhouse gases. The consensus of the Intergovernmental Panel on Climate Change (IPCC), the National Academy of Sciences (NAS) and other scientific organizations is that there is little doubt climate will continue to change in the 21st century and is likely to bring harmful effects across the globe and in particular to people in coastal communities.

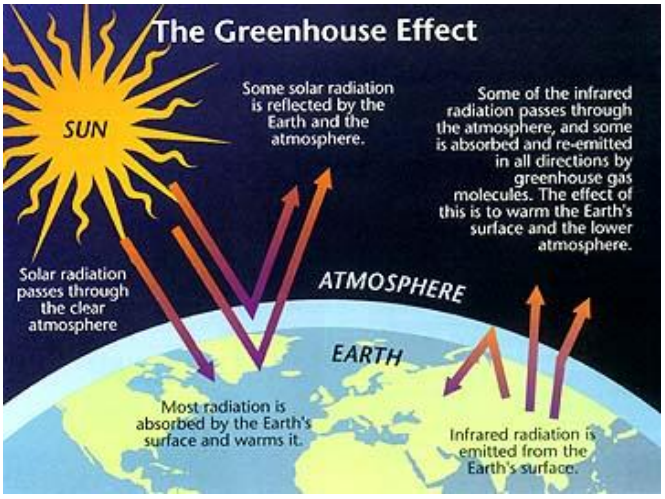
Global Warming or Climate Change?

The term climate change is often used interchangeably with the term global warming, but according to the National Academy of Sciences, "the phrase 'climate change' is growing in preferred use to 'global warming' because it helps convey that there are changes in addition to rising temperatures."

Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer).

Global warming is an average increase in the temperature of the atmosphere near the Earth's surface which can contribute to changes in global climate patterns.

1.1 Climate Change Science

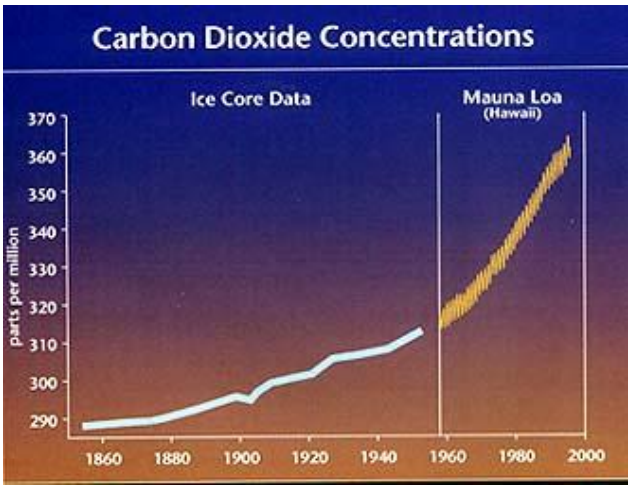


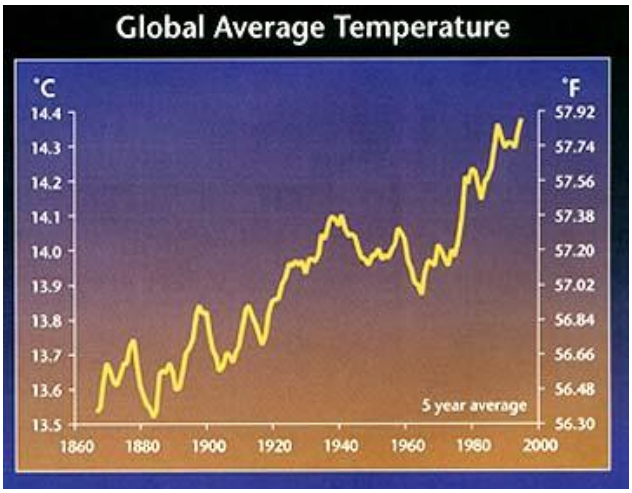
As shown in the diagram to the right, the Earth's temperature is regulated by a natural system known as the greenhouse effect (FAS, 2008). Delicate balances of naturally-occurring gases trap some of the sun's radiation near the earth's surface. Carbon dioxide (CO_2) and other gases, primarily methane and nitrous oxide, are always present in the atmosphere. They create an effect similar to the warming inside a greenhouse.

According to the NAS, temperatures have already risen 1.4°F since the start of the 20th century—with much of this warming occurring in just the last 30 years—and temperatures will likely rise at least another 2°F, and possibly more than 11°F, over the next 100 years (NAS, 2008). Most scientists agree that the warming in recent decades has been caused primarily by human activities that have increased the amount of greenhouse gases in the atmosphere. Greenhouse gases, such

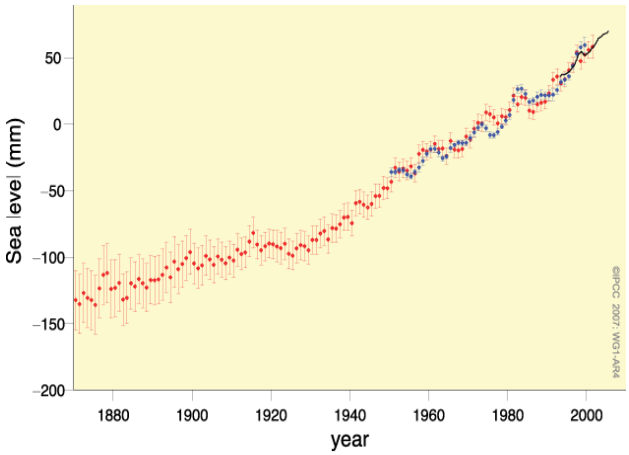
as CO_2, have increased significantly since the Industrial Revolution, mostly from the burning of fossil fuels for energy, industrial processes, and transportation. Other human activities may increase the rate of global change. One activity now grabbing attention is deforestation, whereby humans slash and burn, or just clear-cut, huge tracts of trees to use the land for agriculture or the wood for building shelters. The trees that once removed CO_2 from the atmosphere in the process of photosynthesis are no longer present.

CO_2 levels are at their highest in at least 650,000 years and continue to rise. The following two graphs provide more details on the increasing levels of CO_2 during the last 140 years (FAS, 2008). The top shows CO_2 concentration increases, based on ice core measurement until 1960 and Mauna Loa Observatory measurements thereafter. Below it is the measured temperature changes averaged for the entire world; the trend upwards, amounting to about 1.5° F, shows some irregularities (not smoothly cyclic) that result from other climatic factors.





Rises in sea level are expected to accompany increases in temperature. NOAA data shown to the right indicate that global mean sea level has been rising over the past 100 years at an average rate that is significantly larger than the rate averaged over the last several thousand years (NASA, 2008). Sea-level rise is projected to be anywhere from 7 to 23 inches in the next century. Such a rise in sea level can lead to increased flooding of Alexandria's low-lying areas and waterfront infrastructure.



The NAS makes the following observations with respect to climate change science:

- *The Earth is warming* - Temperature readings from around the globe show a relatively rapid increase in surface temperature during the past century. These data show an especially pronounced warming trend during the past 30 years—in fact, 9 of the 10 warmest years on record have occurred during the past decade. Furthermore, the surface temperature data are consistent with other evidence of warming, such as increasing ocean temperatures, shrinking mountain glaciers, and decreasing polar ice cover.

- *Human activities are changing climate* - The concurrent increase in surface temperature with CO_2 and other greenhouse gases during the past century is one of the main indications of human impact. Prior to the Industrial Revolution, the amount of CO_2 released to the atmosphere by natural processes was almost exactly in balance with the amount absorbed by plants and other "sinks" on the Earth's surface. The burning of fossil fuels (oil, natural gas, and coal) releases additional CO_2 to the atmosphere. About half of this excess CO_2 is absorbed by the ocean, plants, and trees, but the rest accumulates in the atmosphere, amplifying the natural greenhouse effect.

- *The Earth is likely to continue warming* - The IPCC concluded that average global surface temperatures will likely rise by an additional 2.0–11.5 °F by 2100. This temperature increase will be accompanied by a host of other environmental changes, such as an increase in global sea level of between 0.59 and 1.94 feet. Estimates of future climate change are typically called projections and are expressed as a range of possible outcomes. One reason for this uncertainty is because it is difficult to predict how human populations will grow, use energy, and manage resources, all of which will have a strong influence on future greenhouse gas emissions. There are also uncertainties about how the climate system will respond to rising greenhouse gas concentrations.

In short, a growing number of scientific analyses indicate, but cannot prove, that rising levels of greenhouse gases in the atmosphere are contributing to climate change (as theory predicts). Important scientific questions remain about the relative contribution of human activities and natural causes, as well as how much warming will occur, how fast it will occur, and how the warming will affect the rest of the climate system.

1.2 Potential Impacts of Climate Change

Climate change will have many kinds of impacts – both positive and negative – and will vary from region to region. Warmer temperatures may bring longer growing seasons in some regions, benefiting those farmers who can adapt to the new conditions but potentially harming native plant and animal species. In general, the larger and faster the changes in climate are, the more difficult it will be for human and natural systems to adapt. For example, Arctic sea ice cover is

decreasing rapidly and glaciers are retreating and thinning - some Alaskan villages have been moved to higher ground in response to increasing storm damage, and the thawing of permafrost is undermining infrastructure, affecting houses, roads, and pipelines in northern communities around the world (NAS, 2008).

Substantial assessments have been made of the potential impacts of climate change in the mid-Atlantic region. These potential impacts have been summarized as follows (MWCOG, 2008d):

- *Higher Sea Levels* ⇨ increased flooding and shoreline loss, especially in populated areas such as Alexandria that have seen flooding damage from water inundation and are at greater risk due to sea level rise; salt water intrusion that will degrade both surface and groundwater sources
- *Higher Air Temperatures* ⇨ increased air pollution and health risks, changing plant and animal species, more frequent forest fires.
- *Higher Water Temperatures* ⇨ decrease in some living resources, increase in harmful algal blooms, degraded water quality.
- *Changes in Precipitation Patterns* ⇨ heavier rainfall, flooding, erosion, prolonged droughts, increased pollutant runoff, degraded water quality.

The Virginia Commission on Climate Change (VGCCC, 2008) reports that air and sea temperature changes would cause more frequent tropical storms with increased damage to Virginia communities. Estimates are that the mid-Atlantic sea-level will rise between four and twelve inches by 2030, threatening coastal islands and low-lying areas. Virginia is at particular risk from sea level rise. The Commonwealth has a much longer coastline than most states with Atlantic, Chesapeake Bay, and tidal river coastal areas. The Hampton Roads region is considered to be the second most populated region at risk from sea level and related storm damage after the New Orleans region. Other populated areas such as Alexandria have seen flooding damage from water inundation and are at greater risk due to sea level rise.

In addition, there are many ways in which climate change might directly affect human health (NAS, 2008), including heat stress, increased air pollution, and food scarcities due to drought or other agricultural stresses.

1.3 Need for Action

According to the NAS, the scientific understanding of climate change is now sufficiently clear to justify taking steps to reduce the amount of greenhouse gases in the atmosphere, despite remaining unanswered questions (NAS, 2008). Because CO_2 and other greenhouse gases can

remain in the atmosphere for many decades, centuries, or longer, the climate change impacts from greenhouse gases emitted today will likely continue well beyond the 21st century.

Citizens, business, and all levels of government play an important role in reducing greenhouse gas emissions. Local governments control the day-to-day activities that determine the amount of energy used and waste generated as well as the long-term planning for the community – from land use and zoning decisions to control over building codes and licenses, infrastructure investment, municipal service delivery and management of schools, parks and recreation areas. Local government leaders are also uniquely positioned to influence citizen behaviors – their transportation options, energy consumption patterns and general consumer decisions.

States and local agencies are currently developing emission reduction targets for greenhouse gas emissions. The Virginia Energy Plan (VEP) contained four broad goals, one of which was to reduce greenhouse gas emissions by 30 percent by 2025. The VEP also recommended the creation of a Commission on Climate Change to develop a plan for how to reach the GHG reduction goal (VGCCC, 2008).

The Metropolitan Washington Council of Governments (MWCOG, 2008d) voluntarily adopted stringent goals for reducing the region's greenhouse gas emissions. MWCOG's decision, one of the few in the country to affect a multi-state region, proposes to return to 2005 levels of regional greenhouse gas emissions by 2012. The mid-range goal is for a reduction of 20 percent below the 2005 levels by 2020, and the long-term goal is for a reduction of 80 percent below the 2005 levels by 2050.

The Virginia Governor's Commission on Climate Change released its final Climate Change Action Plan in December of 2008. Based on the Governor's Executive Order 59, the Commonwealth set a greenhouse gas emission target of 30 percent below the business-as-usual projection of emissions by 2025 (e.g., the targeted emissions in 2025 will be equivalent to the 2000 emission level).

The City of Alexandria has developed a draft Environmental Action Plan (EAP) that establishes general policy goals, identifies specific action steps, sets tentative timelines and develops measures of success (EPC, 2008). These goals serve as the bridge between the City government's sustainability vision/principles and the specific actions (e.g., policies, programs and projects) that may be undertaken by the City government and the community in the coming years. Phase I actions have been developed and involve a wide array of policies, management actions, programs and projects undertaken by the City government and the community. Additional Phase II actions will be incorporated into the final EAP that is due in June, 2009.

2.0 General Emissions inventory Methodology

This report contains the results of two separate analyses: an inventory of all greenhouse gases emitted in the city and an inventory of just those emissions resulting from the operations of the Alexandria City government. The City government inventory results represent a subset of the larger community-wide total. We used a standardized set of inventory guidelines and computer software for identifying, quantifying and reporting greenhouse gas emissions.

2.1 Inventory Protocol

We used the *Local Government Operations Protocol* (ICLEI, 2008) that provides a standardized set of guidelines to assist local governments in quantifying and reporting GHG emissions associated with their government operations. The *Protocol* was developed in partnership by the California Air Resources Board, California Climate Action Registry, and the International Council on Local Environmental Initiatives (ICLEI) - Local Governments for Sustainability, in collaboration with The Climate Registry and dozens of stakeholders. Through the *Protocol*, the partners have sought to enable local governments to develop emissions inventories following internationally recognized GHG accounting and reporting principles.

2.2 Clean Air and Climate Protection Software

We used the Clean Air and Climate Protection (CACP) software to develop a greenhouse gas emissions inventory and forecast. This product has been developed by the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials, ICLEI, and Torrie Smith Associates.

The software translates data on energy use, transportation patterns, solid waste disposal, and other inputs into greenhouse gas emissions. The software takes data on energy use and converts it to emissions using specific emission factors (coefficients) that relate the emissions of a particular gas (e.g., carbon dioxide) to the quantity of the fuel used (e.g., kilograms of coal). For electricity, the emission factors are based on end-use energy consumption, meaning that emissions per kilowatt hour (kWh) are based on kWh consumed, not produced. This way a jurisdiction can account for emissions resulting from its consumption patterns and therefore be in a better position to design effective strategies to alter or reduce these emissions. In addition, the software quantifies the benefit of actions that have the effect of avoiding or reducing CO_2e emissions.

2.3 Greenhouse Gases and Criteria Pollutants Included in the Inventory

The principal greenhouse gases that enter the atmosphere because of human activities are:

- *Carbon Dioxide (CO2)*: Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- *Methane (CH4)*: Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- *Nitrous Oxide (N2O)*: Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- *Fluorinated Gases*: Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., CFCs, HCFCs, and halons).

ICLEI guidance also specifies that emissions be reported in metric tons (tonnes), which is the common international measurement for the quantity of GHG emissions and is equivalent to about 2,204.6 pounds or 1.1 short tons. All outputs from the CACP software used in this report are in units of metric tons of carbon dioxide equivalent (CO_2e). CO_2 equivalent is a common unit for combining emissions of greenhouse gases of different strengths. Each greenhouse gas is weighted according to its relative heat trapping ability. For example, methane and nitrous oxide are much less abundant than carbon dioxide in the atmosphere, but because they have a greater potential to trap heat, conversion into CO_2e accords them much more weight than their abundance may suggest. Non- CO_2 gases are converted to CO_2e using internationally recognized Global Warming Potential (GWP) factors. GWPs were developed by the Intergovernmental Panel on Climate Change (IPCC) to represent the heat-trapping ability of each GHG relative to that of CO_2.

In addition to greenhouse gases, this inventory also includes Criteria Air Pollutants (CAP) that have been determined to be hazardous to human health and are regulated under USEPA's National Ambient Air Quality Standards. The criteria pollutants are carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) and sulfur dioxide (SO_2), Ozone is not directly emitted to the atmosphere, but is caused by the chemical reaction of oxides of nitrogen (NO_x)and volatile organic compounds (VOC) in the presence of sunlight.

2.4 Sources Included in the Inventory

There are different ways to account for the city's GHG footprint.

- *Community Activities vs. Government Operations* - The Community inventory estimates GHG emissions produced by residents, by businesses and agencies, and by residents and commuters traveling within the city; the City Government Operations inventory includes emissions from fuel use, electricity use, and waste production resulting from City government operations.
- *Consumption-based vs. Generation-based* - GHG emissions estimates can be presented in terms of the GHG emissions associated with the electricity sources used to meet Alexandria's demands – this is a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the city, but not necessarily consumed in the city. We are tracking both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.
- *Direct vs. Indirect* - Direct emissions are from sources within the city's geographical boundaries, such as natural gas consumption for home heating and gasoline combustion for cars, trucks, and buses. Indirect emissions are a consequence of activities that take place within the city, but the emissions physically occur at sources outside of the city. For example, biosolid waste collected at the Alexandria wastewater treatment plant may be disposed of at a landfill outside of the city where methane is generated as the waste decomposes.

To promote consistency in the reporting of GHG emissions and to avoid double-counting of emissions by multiple reporting entities, direct and indirect emissions are typically categorized into "scopes" as follows:

- Scope 1: All direct GHG emissions.
- Scope 2: Energy imports that include indirect GHG emissions associated with facilities outside of the city that generate electricity for use within the city.
- Scope 3: All other indirect emissions not covered in Scope 2, such as emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity waste disposal, etc.

ICLEI guidance specifies that Scope 1 and 2 emissions must be accounted for separately. This differentiation into scopes helps to avoid the possibility of double counting emissions and misrepresenting emissions when reporting but allows all policy relevant information to be

captured. Together the three scopes provide a comprehensive accounting framework for managing and reducing direct and indirect emissions.

2.5 Inventory Base and Projection Years

The typical base year for greenhouse gas inventories is 1990 (since the Kyoto Protocol is based on calendar year 1990). However, required data from 1990 is prohibitively difficult or impossible to collect. Since data for 1990 were not available, the 2005 base year was chosen because data were readily available, and 2005 was consistent with the base years selected by the Metropolitan Washington Council of Governments and the Virginia Department of Environmental Quality. For the community inventory, the base year is calendar year 2005. For the government operations inventory, the base year is fiscal year 2006 (July 1, 2005 to June 30, 2006). Emissions were forecasted for 2012, 2020, 2030, and 2050 to be consistent with MWCOG's short-term, medium-term, and long-term emission reduction targets.

3.0 Base Year Community Inventory

The Community inventory provides an estimate of all of the greenhouse gas (GHG) and criteria air pollutant (CAP) emissions produced within the City of Alexandria, both by residents in their homes and by local businesses and agencies as they carry out their operations in the baseline 2005 calendar year. The Alexandria community inventory consists of the following sectors:

Sector	Description
Scope 1 Emissions – All direct emissions sources located within the city's geopolitical boundary	
Residential Buildings	Natural gas and fuel oil used in residential buildings
Commercial/government Buildings	Natural gas and fuel oil used in commercial/government buildings
Industrial Facilities	Natural gas and fuel oil used in industrial facilities
Onroad Vehicles	Gasoline and diesel fuel used by vehicles traveling on roads within the city's boundaries
Offroad Equipment	Gasoline and diesel fuel used by off-road equipment (landscaping, construction, etc.)
Locomotive Engines	Diesel fuel used by Amtrak and other locomotive engines
Wastewater Treatment	Direct emissions from wastewater treatment facilities
Electric Generating Units	Coal consumption to generate electricity
Solid Waste Disposal	Direct emissions from energy-from-waste
VOC Area Sources	VOC emissions from architectural coatings, degreasing, graphic arts, consumer products, and gasoline service stations
Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city's boundary	
Residential Buildings	Electricity consumption in residential buildings
Commercial/government Buildings	Electricity consumption in commercial/government buildings
Industrial Facilities	Electricity consumption in industrial facilities
Locomotive Engines	Electricity consumption associated with Metro trains
Scope 3 Emissions – Indirect emissions that result as a consequence of activity within the city, but the associated emissions occur outside of the city's boundary	
Solid Waste Disposal	Indirect emissions from disposing of city-generated solid waste outside of the city

ICLEI guidance specifies that Scope 1 and 2 emissions must be accounted for separately. This differentiation into scopes helps to avoid the possibility of double counting emissions and misrepresenting emissions when reporting. Exhibit 3-1 provides a summary of GHG and CAP community emissions inventory. There are two dominant sources of direct GHG emissions in Alexandria. The Mirant Potomac River Generating Station accounts for nearly 50% of the total GHG emissions directly emitted in the city, while onroad vehicle travel accounts for about 37% of the total. Emissions from fossil fuel combustion in residential, commercial, and industrial buildings account for over 10% of the total.

Exhibit 3-1

Base Year Community GHG/CAP Emissions (tonnes)

	GHG	CAP					
Source Category	**Equiv CO_2**	**NO_x**	**SO_2**	**CO**	**VOC**	**PM_{10}**	**$PM_{2.5}$**
Scope 1 Emissions – All direct emissions sources located within the city's boundary							
Fossil Fuel – Residential	169,816	243	26	68	14	11	10
Fossil Fuel - Comm/Govt	67,520	91	36	23	4	3	3
Fossil Fuel – Industrial	74,020	151	96	89	17	6	6
Onroad Vehicles	1,111,724	6,100	257	13,956	1,529	227	209
Offroad Equipment	19,766	139	9	6,506	402	17	15
Locomotives – Diesel	145	3	1	0	0	0	0
VOC Area Sources	0	0	0	0	1,318	0	0
Scope 1 Consumption Based Emissions:	**1,442,991**	**6,727**	**425**	**20,642**	**3,284**	**264**	**243**
Mirant Potomac River Generating Station	1,478,301	2,284	7,694	136	16	202	129
Covanta Energy-from-Waste Facility	318,092	535	9	69	3	3	3
Scope 1 Generation Based Emissions:	**1,796,393**	**2,819**	**7,703**	**205**	**19**	**205**	**132**
Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city's boundary							
Electricity – Residential	264,490	445	1,460	34	4	29	13
Electricity – Commercial	889,242	1,496	4,910	113	13	98	24
Electricity – Industrial	8,737	15	48	1	0	1	46
Electricity - Rail Traffic	29,310	52	163	5	1	3	3
Scope 2 Emissions:	**1,191,779**	**2,008**	**6,581**	**153**	**18**	**131**	**86**
Scope 3 Emissions – Indirect emissions that result as a consequence of activity within the city, but the associated emissions occur outside of the city's boundary							
Municipal Solid Waste sent to landfills outside of Alexandria	1,388	Not calculated; presumed to be small.					
Wastewater Sludge sent to landfill or incinerator, or used as fertilizer outside of Alexandria	3,481	Not calculated; presumed to be small.					
Scope 3 Emissions:	**4,869**						

Note: the CACP software does not calculate emissions for particulate matter less than 2.5 microns in diameter ($PM_{2.5}$); see Exhibit B-10 for the methodology to estimate $PM_{2.5}$ emissions.

ICLEI believes that the most accurate description of emissions requires separate accounting of emissions by scope. This is robust and ensures no double counting, but it also misses significant policy relevant GHG sources. It useful for public awareness and target setting to frame emissions based on electricity consumption rather than electricity generation. In the following graphs, total emissions are presented in terms of energy consumption based on the following formula:

Total Emissions = All Scope 1 (except Mirant/Covanta) + All Scope 2 + All Scope 3

Total Emissions = 1,442,991 + 1,191,779 + 4,869

Total Emissions = 2,639,639 metric tons (tonnes)

To avoid double counting, we have subtracted grid-based generation to assign responsibility for electricity usage to the end-user which will help in targeting policies to reduce emissions. Using this formula, the total GHG consumption-based emissions for the community in 2005 totaled 2.6 million tonnes.

Exhibit 3-2 shows that 43 percent of the 2.6 million tonnes result from onroad vehicle traffic in the city. The operation of commercial and residential buildings accounts for 36 and 16 percent of the total, respectively.

Exhibit 3-3 shows that 45 percent of the 2.6 million tonnes result from electricity consumption in buildings within the city. Transportation fuels – gasoline and diesel – account for 43 percent of the total. The remainder of the emissions is from fossil fuel combustion in buildings.

Exhibit 3-2

2005 Community CO_2e Emissions by Sector (2.6 million tonnes)

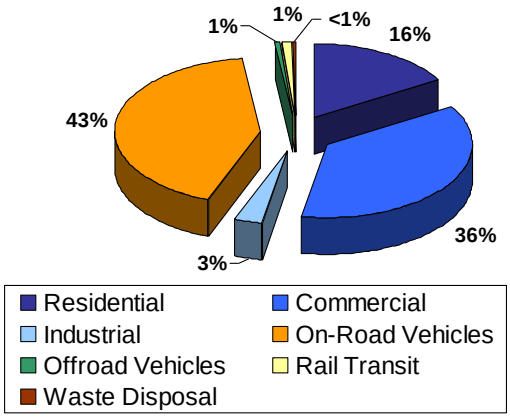
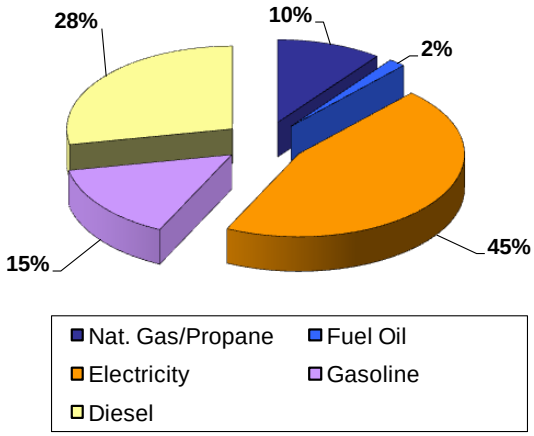


Exhibit 3-3

2005 Community CO_2e Emissions by Energy Source (2.6 million tonnes)



3.1 Stationary Energy Consumption

Stationary combustion includes all fuels, either utility delivered or decentralized, used in residences, commercial and institutional buildings, or industrial facilities within the city's geographic boundaries. Within the residential sector, energy is consumed for such end-uses as space and water heating, appliances, lighting and space cooling. The commercial sector consists of office buildings, retail outlets, institutions (hospitals, schools, universities, etc.) and government facilities. The industrial sector includes manufacturing facilities but excludes fuel used to generate electricity for the grid (see Section 3.3 for fuel consumption at electric generating facilities). Exhibit 3-4 provides a summary of energy consumption and emissions produced by each sector and fuel type in 2005. The remainder of this section discusses the activity data and emission factors by fuel type used to develop the information in Exhibit 3-4.

3.1.1 Natural Gas Consumption

Washington Gas is the only natural gas provider to consumers in Alexandria. Washington Gas provided natural gas usage data for 2005 to the Metropolitan Washington Council of Governments (MWCOG 2008a). Usage amounts within the legal boundaries of the City of Alexandria were provided by four rate schedules – residential, group metered apartments, commercial/industrial, and interruptible. Interruptible gas service is typically offered to commercial and industrial customers at a lower price with the condition that interruptions may sometimes occur when natural gas is in short supply or when physical constraints prevent gas deliveries.

The CACPS requires data to be supplied for three categories – residential, commercial, and industrial. To calculate the CACPS residential consumption, we added the consumption for the WG residential and group metered apartment categories. For the CACPS commercial consumption, we assumed 50 percent of the consumption for the WG commercial/industrial category and 50 percent of the WG interruptible consumption. For the CACPS industrial consumption, we added 50 percent of the consumption for the WG commercial/industrial category and 50 percent of the WG interruptible consumption. Exhibit B-1 summarizes the data provided by Washington Gas and shows how it was apportioned the CACPS categories.

The CACPS uses a set of CAP emission factors for each of the residential, commercial and industrial sectors that are based on average technologies found in these sectors. These emissions factors represent the typical emissions of air pollutants associated with the burning of natural gas and vary by sector. The CACPS uses a separate common set of carbon dioxide emission factors for all sectors (residential, commercial, and industrial), since carbon dioxide emissions vary only with the amount of fuel consumption and do not have significant technology dependence.

Exhibit 3-4

Base Year Community Energy Use and GHG/CAP Emissions (tonnes)

Energy Source/ Sector	Energy (MMBtu)	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$
Electricity								
Residential	1,357,336	264,490	445	1,460	34	4	29	13
Commercial	4,563,509	889,242	1,496	4,910	113	13	98	44
Industrial	44,840	8,737	15	48	1	<1	1	<1
	5,965,685	**1,162,469**	**1,956**	**6,418**	**148**	**17**	**128**	**57**
Fuel Oil								
Residential	268,805	20,158	32	18	7	1	4	3
Commercial	86,839	6,512	10	33	2	<1	1	1
Industrial	218,302	16,332	15	32	51	10	1	1
	573,946	**43,002**	**57**	**83**	**60**	**11**	**6**	**5**
Natural Gas								
Residential	2,592,432	145,300	206	8	51	11	6	6
Commercial	1,001,696	56,143	76	3	20	4	2	2
Industrial	1,001,696	56,143	134	64	38	7	5	5
	4,595,824	**257,586**	**416**	**75**	**109**	**22**	**13**	**13**
Propane								
Residential	66,081	4,339	5	<1	1	<1	<1	<1
Commercial	74,097	4,865	5	<1	1	<1	<1	<1
Industrial	23,535	1,545	2	<1	<1	<1	<1	<1
	163,713	**10,749**	**12**	**<1**	**2**	**<1**	**<1**	**<1**
Wood								
Residential	2,355	19	<1	<1	9	2	1	1
Commercial	0	<1	<1	<1	<1	<1	<1	<1
Industrial	0	<1	<1	<1	<1	<1	<1	<1
	2,355	**19**	**<1**	**<1**	**9**	**2**	**1**	**1**
Total by Sector								
Residential	4,287,009	434,306	688	1,486	102	18	40	23
Commercial	5,726,141	956,762	1,587	4,946	136	17	101	46
Industrial	1,288,373	82,757	166	144	90	17	7	6
Total	**11,301,523**	**1,473,825**	**2,441**	**6,576**	**328**	**52**	**148**	**76**

Note: coal and heavy fuel oil (i.e., residual oil) are not used in the city by residential, commercial, or light industrial sources.

3.1.2 Electricity Consumption

Dominion Virginia Power is the only provider of electricity to consumers in the City of Alexandria. Dominion provided electricity usage for 2005 to MWCOG (MWCOG, 2008b). Usage amounts within the City's legal boundary,were provided by four categories – residential, commercial, large industrial/commercial, and government. These data represent consumption of electricity.

The CACPS requires data to be supplied for three categories – residential, commercial, and industrial. The CACPS residential consumption was equal to the Dominion residential category. For the CACPS commercial consumption, we assumed 100 percent of the Dominion commercial category, 100 percent of the Dominion government category, and 50 percent of the Dominion large industrial/commercial category. For the CACPS industrial consumption, we assumed 50 percent of the consumption for the Dominion large industrial/commercial category. Exhibit B-2 summarizes the data provided by the electric utilities and shows how it was apportioned the CACPS categories.

While there are no emissions associated with electricity at the point of use, there are significant emissions at the fossil fuel plant that generates the electricity. The CACPS uses emission factors to account for the upstream emissions created by these plants. The emission factors depend on the mix of fuel types used to generate electricity in the region in which the municipality is located in any given year. The CACPS uses the regions that are defined by the North American Electric Reliability Council (NERC) to determine regional variations in electricity emissions. These regions correspond to the grid-connected electricity-producing regions of the country. Alexandria is located within NERC region 09 - Southeastern Electric Reliability Council/Excluding Florida. CAP emissions are calculated using activity levels with emission factors. The CAP emission factors used are provided in the CACPS.

The City of Alexandria also has two electric generators – Mirant and Covanta – that generate electricity for the electric power grid. The electricity generated by Mirant and Covanta is not necessarily consumed in the city (see Section 3.3 for fuel consumption at electric generating facilities).

3.1.3 Other Fuel Consumption (Coal, Fuel Oil, Kerosene, Propane, Wood)

In addition to electricity and natural gas, other fuels including light fuel oil, propane, kerosene, and wood are used to power homes, businesses and institutions within the community. Based on discussions with City government environmental officials, coal and heavy fuel oil (i.e., residual oil) are not used in the city.

Unlike natural gas and electricity, which are provided by centralized utilities, other fuels are provided by a diverse set of decentralized fuel suppliers. Generally, the vast majority of these fuel providers do not track fuel sales within the city or by sector.

Accordingly, we collected State-level fuel sales data from the U.S. Energy Information Administration (EIA, 2008). Sales of distillate fuel oil, kerosene, propane, and wood by end-use in Virginia were available for the 2005 calendar year for the residential, commercial, and industrial sectors. We developed scaling factors to apportion the State-level energy use by fuel type to the city. The scaling factors varied by sector as follows:

- Residential Scaling Factor – we used the U.S. Census Bureau's 2000 Census Detailed Housing Information (Census, 2008a) that provides the number of housing units using a specific type of fuel for residential heating for the entire State as well as for the City of Alexandria.
- Commercial Scaling Factor – we used the U.S. Census Bureau's 2005 County Business Patterns (Census, 2008b) that provides employment for the commercial sector (NAICS codes 42, 44, 51, 52, 53, 54, 55, 56, 61, 62, 71, 72, and 81) for the entire State as well as for the City of Alexandria.
- Industrial Scaling Factor – we used the U.S. Census Bureau's 2005 County Business Patterns (Census 2008b) that provides employment for the industrial sector (NAICS code 33) for the entire State as well as for the City of Alexandria.

Exhibits B-3, B-4, and B-5 show the data used to estimate energy consumption for other fuel types for the residential, commercial, and industrial sectors, respectively.

The CACPS uses a set of CAP emission factors for each of the residential, commercial and industrial sectors that are based on average technologies found in these sectors. These emissions factors represent the typical emissions of air pollutants associated with the burning of each type of fuel and vary by sector. The CACPS uses carbon dioxide emission factors that vary by fuel type but not sectors (residential, commercial, and industrial), since carbon dioxide emissions vary only with the amount of fuel consumption and do not have significant technology dependence.

3.2 Mobile Source Energy Consumption

The mobile source sector includes privately and publicly owned passenger vehicles, transport trucks, public transit vehicles, and all other on-road vehicles associated with personal, commercial, industrial and government activities. This sector also includes emissions produced by off-road engines such as lawn and garden equipment, construction equipment, portable generators, and forklifts. Finally, this sector also includes air, marine and rail travel

3.2.1 Onroad Vehicles

The onroad vehicle category includes all privately and publicly owned passenger vehicles, trucks, public transit vehicles, and all other vehicles traveling on the region's road transportation network. The CACPS uses a simple equation for estimating emissions from onroad vehicles:

Emissions (lbs/yr) = VMT (1000 miles/yr) x EF (lbs/1000 mile)

VMT – vehicle miles traveled

EF – emission factor

The National Capitol Region Transportation Planning Board is the lead agency responsible for developing VMT estimates using a comprehensive travel demand modeling process. The results of the modeling process were provided by MWCOG for calendar year 2002 (MWCOG, 2008c). VMT data were provided for the City of Alexandria for five road types (interstate, principal arterial, minor arterial, collector, and local), 16 vehicle types and two fuel types (gasoline and diesel). See Exhibits B-6 and B-7 for the road and vehicle type definitions, respectively.

The breakdown of VMT provided by MWCOG is consistent with the USEPA's MOBILE6 on-road emission modeling software. Most of the vehicle classes used by MOBILE6 correspond with the vehicle classes used within the CACPS, except for the MOBILE6 classes Light Duty Gas Vehicle (LDGV) and Light Duty Diesel Vehicles (LDDV). In MOBILE6 a LDDV or LDGV is defined as a passenger car with a gasoline or diesel engine up to 6000 lbs gross vehicle weight. The CACPS further divides light duty gasoline-fueled vehicles into the classes Auto-Full-Size, Auto Mid-Size and Auto – Sub-Compact/Compact and assigns specific fuel efficiencies and emission factors to each of these classes. The CACPS divides LDDV into Auto Full-Size and Auto-Sub-Compact/Compact.

The size characteristics of the U.S., on road automobile fleet were used to apportion the LDGV VMT to each of the CACP gasoline automobile classes. This distribution was derived USDOE data (USDOE 2007). Using a weighted average of automobile sales by size-class in the U.S. for 1975 to 2006, it was estimated that the following distribution of automobiles by size in the U.S.: 51% sub-compact/compact autos, 27% mid-size autos and 22% large autos. This distribution was applied to the LDGV VMT estimates provided by MWCOG. For the LDDV fleet, it was assumed that 51% of the LDDV VMT would be by sub-compact or compact automobiles, and 49% by full-size automobiles.

VMT data were not available for calendar year 2005. However, the NCRTPB was able to provide projected VMT for the City of Alexandria for 2008 (NCRTPB, 2007). We performed a linear interpolation of the 2002 and 2008 VMT to derive the VMT for 2005. The annual growth rate during the 6-year period was 0.71% per year.

Exhibit 3-5 summarizes GHG and CAP emissions from onroad vehicles for calendar year 2005. In 2005, motor vehicles traveled approximately 945,586,000 miles within the City of Alexandria. The model used to estimate VMT cannot separate resident traffic from non-resident through-traffic. The model does include through-traffic on the portions of I-95, I-395, and I-495 located within the boundaries of the City of Alexandria.

CAP emissions in this report were produced using the CACPS. MWCOG, as part of the State Implementation Plan and transportation conformity processes, also produces CAP emission estimates from the transportation sector using the EPA's MOBILE6 model. Due to differences in the CACPS and MOBILE6 models, the emissions do not match. This report uses emissions produced by the CACPS in order to ensure consistency with the emissions from other sectors and to ensure that the emissions inventory can be easily reproduced and updated by the local governments.

Exhibit 3-5

Base Year Community Onroad Vehicles GHG/CAP Emissions (tonnes)

VehicleType	VMT	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$
Interstate Roads								
Gas: Auto - Compact	29,403	11,275	43.4	2.3	465.2	47.7	1.0	0.9
Gas: Auto - Mid-Size	15,563	7,590	23.0	1.2	246.2	25.2	0.5	0.5
Gas: Auto - Full-Size	12,462	6,505	18.4	1.0	197.2	20.2	0.4	0.4
Gasoline: SUV/Pickup	67,508	47,839	97.2	7.1	1,165.9	120.9	2.0	1.8
Gasoline: Heavy Truck	19,086	37,829	79.7	3.5	774.2	74.9	1.9	1.8
Gasoline: Motorcycle	855	325	0.7	<0.1	20.1	2.5	<0.1	<0.1
Diesel: Auto - Compact	178	45	0.2	<0.1	0.2	0.1	<0.1	<0.1
Diesel: Auto - Full-Size	170	87	0.2	<0.1	0.2	0.1	<0.1	<0.1
Diesel: SUV/Pickup	1,430	845	1.6	0.2	1.7	0.6	0.3	0.3
Diesel: Heavy Truck	177,639	311,604	2,216.8	86.6	1,698.9	218.0	87.8	80.8
	324,294	**423,943**	**2,481.1**	**102.0**	**4,569.8**	**510.2**	**94.0**	**86.6**
Principal Arterial Roads								
Gas: Auto - Compact	21,768	8,347	32.1	1.7	344.4	35.3	0.7	0.7
Gas: Auto - Mid-Size	11,522	5,620	17.0	0.9	182.3	18.7	0.4	0.4
Gas: Auto - Full-Size	9,226	4,816	13.6	0.7	146.0	15.0	0.3	0.3
Gasoline: SUV/Pickup	48,863	34,626	70.3	5.1	843.9	87.5	1.4	1.3
Gasoline: Heavy Truck	13,061	25,887	54.5	2.4	529.8	51.2	1.3	1.3
Gasoline: Motorcycle	505	192	0.4	<0.1	11.9	1.5	<0.1	<0.1
Diesel: Auto - Compact	103	26	0.1	<0.1	0.1	<0.1	<0.1	<0.1
Diesel: Auto - Full-Size	98	50	0.1	<0.1	0.1	<0.1	<0.1	<0.1
Diesel: SUV/Pickup	823	486	0.9	0.1	1.0	0.3	0.2	0.1
Diesel: Heavy Truck	89,253	156,562	1,113.8	43.5	853.6	109.5	44.1	40.6
	195,222	**236,612**	**1,303.0**	**54.5**	**2,913.0**	**319.2**	**48.5**	**44.7**

Exhibit 3-5 (continued)

VehicleType	VMT	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$
Minor Arterial Roads								
Gas: Auto - Compact	24,895	9,546	36.7	2.0	393.8	40.4	0.8	0.8
Gas: Auto - Mid-Size	13,177	6,427	19.4	1.0	208.5	21.4	0.4	0.4
Gas: Auto - Full-Size	10,551	5,508	15.6	0.8	166.9	17.1	0.4	0.3
Gasoline: SUV/Pickup	55,881	39,599	80.4	5.8	965.1	100.1	1.6	1.5
Gasoline: Heavy Truck	14,938	29,607	62.4	2.8	606.0	58.6	1.5	1.4
Gasoline: Motorcycle	578	219	0.5	<0.1	13.6	1.7	<0.1	<0.1
Diesel: Auto - Compact	117	30	0.1	<0.1	0.2	0.1	<0.1	<0.1
Diesel: Auto - Full-Size	112	57	0.1	<0.1	0.2	0.1	<0.1	<0.1
Diesel: SUV/Pickup	941	556	1.0	0.1	1.1	0.4	0.2	0.2
Diesel: Heavy Truck	102,074	179,052	1,273.8	49.7	976.2	125.3	50.5	46.4
	223,264	**270,602**	**1,490.1**	**62.4**	**3,331.5**	**365.1**	**55.5**	**51.1**
Collector Roads								
Gas: Auto - Compact	4,403	1,688	6.5	0.3	69.7	7.1	0.1	0.1
Gas: Auto - Mid-Size	2,331	1,137	3.4	0.2	36.9	3.8	0.1	0.1
Gas: Auto - Full-Size	1,866	974	2.8	0.1	29.5	3.0	0.1	0.1
Gasoline: SUV/Pickup	9,884	7,004	14.2	1.0	170.7	17.7	0.3	0.3
Gasoline: Heavy Truck	2,642	5,236	11.0	0.5	107.2	10.4	0.3	0.3
Gasoline: Motorcycle	102	39	0.1	<0.1	2.4	0.3	<0.1	<0.1
Diesel: Auto - Compact	21	5	0.0	<0.1	<0.1	<0.1	<0.1	<0.1
Diesel: Auto - Full-Size	20	10	0.0	<0.1	<0.1	<0.1	<0.1	<0.1
Diesel: SUV/Pickup	166	98	0.2	<0.1	0.2	0.1	<0.1	<0.1
Diesel: Heavy Truck	18,055	31,671	225.3	8.8	172.7	22.2	8.9	8.2
	39,490	**47,863**	**263.6**	**11.0**	**589.2**	**64.6**	**9.8**	**9.0**
Local Roads								
Gas: Auto - Compact	31,793	12,191	46.9	2.5	503.0	51.6	1.1	1.0
Gas: Auto - Mid-Size	16,828	8,207	24.8	1.3	266.2	27.3	0.6	0.5
Gas: Auto - Full-Size	13,475	7,034	19.9	1.1	213.2	21.9	0.5	0.4
Gasoline: SUV/Pickup	66,875	47,390	96.3	7.0	1,154.9	119.8	1.9	1.8
Gasoline: Heavy Truck	3,092	6,128	12.9	0.6	125.4	12.1	0.3	0.3
Gasoline: Motorcycle	509	193	0.4	<0.1	12.0	1.5	<0.1	<0.1
Diesel: Auto - Compact	197	50	0.2	<0.1	0.3	0.1	<0.1	<0.1
Diesel: Auto - Full-Size	188	96	0.2	<0.1	0.3	0.1	<0.1	<0.1
Diesel: SUV/Pickup	1,581	934	1.8	0.3	1.8	0.6	0.3	0.3
Diesel: Heavy Truck	28,777	50,479	359.1	14.0	275.2	35.3	14.2	13.1
	163,315	**132,703**	**562.5**	**26.8**	**2,552.3**	**270.3**	**18.9**	**17.5**
Onroad Vehicle Total:	**945,585**	**1,111,724**	**6,100**	**257**	**13,956**	**1,529**	**227**	**209**

DASH bus emissions are included in the above totals but are not accounted for separately in this report.

3.2.2 Offroad Engines

The offroad engines category covers a varied collection of equipment, including vehicles and equipment in the following categories:

- Recreational vehicles, such as all-terrain vehicles and personal watercraft;
- Construction equipment, such as graders and back hoes;
- Industrial equipment, such as fork lifts and sweepers;
- Residential and commercial lawn and garden equipment, such as leaf and snow blowers.

Emissions from offroad engines were calculated using USEPA's NMIM (USEPA 2005), version 2005a (February 8, 2006). NMIM is a consolidated emissions modeling system for EPA MOBILE6 and NONROAD models. The model includes more than 80 basic and 260 specific types of nonroad equipment, and further stratifies equipment types by horsepower rating (see Exhibit B-8 for a list of the nonroad equipment types). Fuel types include gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG). NMIM estimates emissions for all CAPs and CO_2. The NONROAD2005 model estimates emissions for each specific type of nonroad equipment by multiplying the following input data estimates:

- Equipment population for base year (or base year population grown to a future year), distributed by age, power, fuel type, and application;
- Average load factor expressed as average fraction of available power;
- Available power in horsepower;
- Activity in hours of use per year; and
- Emission factor with deterioration and/or new standards.

The emissions are then temporally and geographically allocated to the City of Alexandria using appropriate allocation factors.

There are several input files that provide necessary information to calculate and allocate emissions estimates. These input files correspond to the basic data needed to provide the calculations: emission factors, base year equipment population, activity, load factor, average lifetime, scrappage function, growth estimates, and geographic and temporal allocation. Default values are provided for all input files. For this analysis, we used the EPA national defaults for all input parameters. Exhibit 3-6 summarizes the results of NMIM for 2005.

3.2.3 Aircraft

There are no airports located in the City of Alexandria. Ronald Reagan Washington National Airport is located in Arlington County, just to the north of the Arlington/Alexandria border. This inventory does not account for GHG and CAP emissions from aircraft traveling from National Airport over the airspace of the city.

Exhibit 3-6

Base Year Community Offroad Engine GHG/CAP Emissions (tonnes)

Fuel Type/ Sector	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$
CNG							
Commercial	103.2	1.3	<0.1	9.7	<0.1	<0.1	<0.1
Industrial	80.1	1.6	<0.1	7.8	<0.1	<0.1	<0.1
	183.3	**2.9**	**<0.1**	**17.5**	**<0.1**	**<0.1**	**<0.1**
Diesel							
Commercial	1,731.3	19.5	2.6	11.9	3.2	2.3	2.1
Industrial	2,595.1	24.7	3.9	11.4	2.5	2.4	2.2
Lawn and Garden	1,111.4	12.6	1.6	6.2	1.7	1.3	1.2
Railroad Equipment	107.4	1.4	0.2	1.1	0.3	0.2	0.2
	5,545.3	**58.2**	**8.3**	**30.6**	**7.7**	**6.2**	**5.6**
Gasoline							
Commercial	2,270.3	10.4	0.1	1,173.0	43.0	0.6	0.5
Industrial	113.3	1.1	<0.1	36.0	1.1	<0.1	<0.1
Lawn and Garden	9,947.5	39.7	0.5	5,125.6	343.2	9.9	9.1
Railroad Equipment	5.5	<0.1	<0.1	3.0	0.1	<0.1	<0.1
	12,336.7	**51.3**	**0.6**	**6,337.6**	**387.4**	**10.5**	**9.6**
LPG							
Commercial	239.7	3.8	<0.1	12.7	0.8	<0.1	<0.1
Industrial	1,410.3	21.8	<0.1	104.1	6.1	0.1	0.1
Lawn and Garden	50.7	0.7	<0.1	3.7	0.2	<0.1	<0.1
Railroad Equipment	0.2	<0.1	<0.1	0.0	<0.1	<0.1	<0.1
	1,700.9	**26.3**	**<0.0**	**120.5**	**7.1**	**0.1**	**0.1**
Totals for Offroad Engines	**19,766.2**	**138.7**	**9.0**	**6,506.2**	**402.2**	**16.8**	**15.3**

Note 1: USEPA's NMIM model reports zero emissions for recreational vehicles since there are very few, if any, all-terrain vehicles, offroad motorcycles, or snowmobiles in Alexandria.

Note 2: USEPA's NMIM model reports zero emissions for pleasure craft. The reason for this is that the City's boundary generally ends at the shoreline. Although pleasure craft may be docked within the City's boundary, nearly all of the activity is in the Potomac River, which is technically in the District of Columbia.

3.2.4 Marine Vessels

Commercial marine vessels include all boats and ships used either directly or indirectly for commerce or military activity. These include vessels ranging in size from 20-foot charter boats to the largest tankers and military vessels, which can exceed 1,000 feet in length. According to the PM2.5 SIP documentation (MWCOG, 2008d), no jurisdiction in the DC-MD-VA region reported emissions for this category.

The City of Alexandria Marina and other private marinas in the city service pleasure boats. Emissions from pleasure boats and personal watercraft are included in the NMIM model previously discussed in Section 3.2.2.

3.2.5 Rail Traffic

Rail traffic in the City of Alexandria includes both the transportation of freight and passenger rail systems. Since both the freight and passenger systems are part of a larger regional system, emissions are generally apportioned to a jurisdiction based on a distance traveled basis within the jurisdiction. Railroad locomotives can be powered by either electricity or diesel. Exhibit 3-7 shows the emissions from rail traffic in the City of Alexandria.

The Virginia Department of Environmental Quality (VADEQ) provided diesel fuel usage by railroad locomotives (VADEQ, 2008a). For calendar year 2005, VADEQ estimated that 15,056.3 gallons of diesel was consumed by railroad locomotives in the City of Alexandria.

The Washington Metropolitan Area Transit Authority (WMATA) provided electricity consumption for all WMATA facilities in 2005 (WMATA, 2008). For calendar year 2005, WMATA estimated consumption of 765,011,161 kwh by all WMATA facilities. Lacking any breakdown by type of facility, it was assumed that all electricity use by WMATA was for Metro trains. We allocated Metrorail electricity consumption to the City of Alexandria based track mileage (WMATA, 2007). Specifically, we used the ratio of Metrorail track mileage in Alexandria (6.11 miles) to total system track mileage (106.1 miles) to allocate 5.76% of Metrorail electricity consumption to the City of Alexandria.

Exhibit 3-7

Base Year Community Rail Traffic GHG/CAP Emissions (tonnes)

Energy Source	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	PM_{10}
Diesel	145	2.7	0.5	0.4	0.2	0.1	0.1
Electricity	29,310	49.0	162.0	4.0	0.5	3.3	3.0
Totals for Rail:	**29,455**	**51.7**	**162.5**	**4.5**	**0.7**	**3.4**	**3.1**

3.3 Electric Generating Units

A significant amount of fuel is consumed within the city to generate electricity for the grid. There are two electric generating units (EGUs) in Alexandria – the Mirant Potomac River Generating Station and the Covanta energy-from-waste facility. GHG and CAP emissions from fuel combustion at these two facilities were not accounted for in Section 3.1. While these plants generate emissions in the city, the electricity they generate is not necessarily consumed in the city. Significant amounts of electricity are exported outside of the city.

Mirant's Potomac River Generating Station consists of five coal-fired generating units capable of producing 482 megawatts (MW) of electricity. Units 1 and 2 have a capacity of 88 MW each, and Units 3-5 have a capacity of 102 MW each. All units began operation in the 1950s. Units 1 and 2 are cycling units that can be brought online quickly to respond to increases in demand. Units 3, 4 and 5 are considered baseload units and are called into service more often than Units 1 and 2. The baseload units typically run 24 hours a day.

Covanta operates for solid waste disposal the Alexandria/Arlington Resource Recovery Facility. The facility serves about 300,000 residents of the County of Arlington and the City of Alexandria, which jointly own the site. The facility has three, 325 ton-per-day furnaces that process up to 975 tons of solid waste, generating up to 23 megawatts of renewable energy that is sold to Dominion Virginia Power.

Exhibit 3-8 presents the GHG and CAP emissions for 2005 for Mirant and Covanta. In addition to CO_2, electric power plants also emit some CH_4, and N_2O, which are also GHG gases. The electricity generated, heat input, CO_2, CH_4, and N_2O emissions for 2005 for Mirant and Covanta were available from USEPA's Emissions & Generation Resource Integrated Database (eGrid) database (USEPA, 2008). The CACPS software was used to calculate the CO_2e emissions. CAP emissions for Mirant and Covanta were obtained from the VADEQ 2005 point source inventory (VADEQ, 2005).

The Covanta facility combusts solid waste, which typically consists of a mixture of renewable materials (biomass such as wood, paper, and food waste) and nonrenewable materials (fossil fuels and fossil-based materials such as plastics). eGRID assumes that the renewable materials are subject to the natural carbon cycle and, therefore, do not contribute to global warming. (e.g., eGRID assigns zero CO_2 emissions to generation from the combustion of all biomass). In 2007, the USEPA updated the methodology regarding the renewable-nonrenewable composition (biomass and fossil) of municipal solid waste. Beginning with eGRID's year 2005 data, EPA modified the biomass/fossil splits and provides different splits for the consumption data, based on the type of combustor.

Exhibit 3-8

Base Year 2005 Electric Generating Unit GHG/CAP Emissions (tonnes)

Unit	Gross Load (MWh)	Heat Input mmBtu	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$
Mirant Potomac River Generating Station									
1	298,442	4,024,530	376,657	687	1,867	33	4	48	31
2	232,554	2,746,203	257,018	422	1,413	25	3	37	23
3	316,072	3,049,041	285,361	379	1,496	27	3	40	26
4	292,198	2,802,634	262,299	396	1,352	25	3	37	24
5	313,367	3,173,040	296,966	400	1,565	27	3	40	26
	1,452,633	**15,795,448**	**1,478,301**	**2,284**	**7,694**	**136**	**16**	**202**	**129**
Covanta Arlington/Alexandria Waste to Energy Facility									
B100	59,810	1,178,466	105,153	178	2	25	1	1	1
B200	60,380	1,189,695	106,155	177	2	24	1	1	1
B300	60,737	1,196,735	106,783	180	5	19	1	1	1
	180,926	**3,564,895**	**318,092**	**535**	**9**	**69**	**3**	**3**	**3**
EGU Total	**1,633,559**	**19,360,343**	**1,796,393**	**2,819**	**7,703**	**205**	**19**	**205**	**131**

* Mirant's emissions were abnormally low in 2005 because it was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year.

3.4 Wastewater Treatment

Wastewater treatment processes can produce GHG emissions, primarily in the form of methane. Wastewater from domestic sewage is treated to remove soluble organic matter, suspended solids, pathogenic organisms, and chemical contaminants. The Alexandria Sanitation Authority (ASA) provides wastewater treatment for approximately 325,000 people in a service area that includes the City of Alexandria and portions of Fairfax County. ASA's plant is an Advanced Waste Treatment facility with a design capacity of 54 million gallons per day. It is located on a 31-acre site on the north bank of Hunting Creek near its junction with the Potomac River.

ASA completed a $275 million upgrade in June 2005, including an anaerobic digestion facility that processes the plant's solids. The solids remain in the digesters for 30 days, during which a portion of the organic material is decomposed and converted to methane gas. The plant upgrades incorporated a system that burns digester gas in low-pressure steam boilers, thereby reducing the amount of fossil fuel needed.

During the first 6 months of digester operation, all digester gas was flared (ASA, 2008). The amount of digester gas flared in 2005 was 2,771,100 ft^3. Since the gas was flared at 1600

degrees Fahrenheit, there was no methane measured that went directly to the atmosphere. Since then, the digester gas is used along with natural gas in the dual-fuel low-pressure steam boilers. A small amount of CAP emissions are generated at ASA from natural gas combustion and other treatment processes at the plant. The VADEQ 2005 point source inventory (VADEQ, 2005) shows that CAP emissions from ASA are less than 5 tons per year for each CAP. These emissions are accounted for in Section 3.1.1 – natural gas consumption.

3.5 Solid Waste Disposal

GHG emissions from the disposal of solid waste depend on the type of waste and on the disposal method. Municipal solid waste (MSW) is the single largest type of solid waste, and is comprised of those wastes generated daily by residential, institutional, and commercial sources. Examples of MSW include household refuse, food waste, container packaging, and yard wastes. Solid waste can be recycled or disposed by placing in a landfill, composting, or incineration.

Alexandria's Solid Waste Management Plan (T&ES, 2004) identifies the types and quantities of solid waste generated. Exhibit B-9 summarizes the types of wastes generated and disposal methods - MSW is the largest type of solid waste material.

The Alexandria Division of Solid Waste provides municipal solid waste collection services for single family homes (defined to include residential buildings with four or less units), various city facilities, and street cans. All municipal waste collected by the Division of Solid Waste is transported to the Covanta Alexandria/Arlington energy-from-waste facility. In 2005, it is estimated that transported 27,131 tons of MSW to the Covanta facility (T&ES, 2008a).

Private haulers collect solid wastes generated by businesses and multi-family residences with five or more units. Most of this waste is collected by one of the three large haulers – Browning-Ferris Industries, Inc. (Allied), Waste Management, Inc., or AAA Rainbow (Republic Inc.); the remaining is collected by several smaller haulers. Some of this waste is transported to the Covanta facility and some is sent to landfills. The quantity of waste collected/disposed by private haulers and not transported to Covanta is estimated to be 2,445 tons.

ASA's plant also generates sludge that is disposed of by land application, incineration, or landfilling. In 2005, 32,906 tons of solids were processed. Of this total, 3,500 tons were considered biosolids and were distributed to permitted sites in rural Virginia where it was recycled into farmland soil. Another 22,366 tons of sludge were incinerated in Hopewell, VA. And 7,040 tons were landfilled in King George, VA.

GHG and CAP emissions from solid waste sent to the Covanta incinerator are included in the emissions for the Covanta facility discussed in Section 3.3. Due to a lack of information of the CAPs emitted from waste disposal, the CACP software only reports on the GHG being released by waste disposal. GHG emissions depend on the combination of waste type and disposal type.

In landfills, some of the carbon in the solid waste decomposes into methane. In well managed landfills, the methane gas is captured and either flared or used as a biofuel. Also, not all of the waste decomposes. A fraction of the carbon found in solid waste is never released but remains sequestered in the landfill, acting as a carbon sink. Certain waste disposal practices, such as land application of biosolids, both sequester carbon in the soil and reduce the need for the production of chemical fertilizer, but also may release methane into the atmosphere during decomposition. ICLEI's Local Government Operations Protocol indicates that there is not a national or international consensus on how best to measure those emissions. ICLEI's short-term recommendation is to zero out the emissions from land application of biosolids until more information is available.

Exhibit 3-9 summarizes the GHG emissions from MSW and wastewater sludge disposal.

Exhibit 3-9

Base Year Solid Waste Disposal GHG Emissions

Material Type	Disposal Method	Estimated Amount Generated by City Residents (tons)	Equiv CO_2 (tonnes)
MSW residential (Division of Solid Waste collected)	Covanta Energy to Waste Plant	27,131	Included with Covanta GHG emissions
MSW multi-family and commercial (Privately collected)	Covanta Energy to Waste Plant	108,968	Included with Covanta GHG emissions
MSW multi-family and commercial (Privately collected)	Landfill outside of Alexandria	2,445	1,388
ASA Sludge**	Land Application at permitted sites in rural Virginia	1,376	0*
ASA Sludge**	Landfill in King George, VA	2,768	2,837
ASA Sludge**	Incinerated in Hopewell, VA	8,793	644
	Total:	**151,481**	**4,869**

* Land application of biosolids both sequesters carbon in the soil and releases methane to the atmosphere during decomposition. ICLEI's Local Government Operations Protocol indicates that there is not a national or international consensus on how best to measure those emissions. ICLEI's short-term recommendation is to zero out the emissions from land application of biosolids until more information is available.

** The ASA treatment plant provides sewage treatment for 350,000 people in a service area of 51 square miles, which includes the City of Alexandria and portions of Fairfax County. The amount of sludge generated by residents of the City of Alexandria was estimated by the ratio of the City's population to the total number of customers served by ASA (e.g., 137,600/350,000, or approximately 39%)

3.6 VOC Area Sources

Area sources include residential and commercial sources that in and of themselves generate a small amount of emisisons, but in aggregate may comprise significant emissions. In particular, the following area sources generate a significant amount of VOC emissions in the city:

- Gasoline service stations generate VOC emissions during tank truck unloading and vehicle refueling when gasoline vapors are expelled from fuel tanks as liquid gasoline fills the tank.
- Cold cleaning using solvents containing VOC is found primarily at auto repair stations or small manufacturing or repair facilities, where solvents at room temperature (or slightly warmed) are used to clean parts via immersion or rinsing.
- Surface coating includes paints, enamels, varnishes, lacquers and other product finishes. Same of those coatings contain a solvent-based liquid carrier; others use a waterbased liquid carrier but still contain a small portion of solvents. Solvents are also used to clean up painting equipment. The primary types of surface coating applications are architectural coatings, automobile refinishing and traffic paints.
- Graphic arts include operations that are involved in the printing of newspapers, magazines, books and other printed materials. Some of the inks used in the printing operations contain VOC which is emitted as the inks dry.
- Certain commercial/consumer products contain VOC, including the following subcategories: household products, toiletries, aerosol products, rubbing compounds, windshield washing fluids, polishes and waxes, non-industrial adhesives, space deodorants, moth control, laundry detergents and treatments, and pesticides.

These sources generate VOC emissions. Methane emissions are negligible. Exhibit 3-10 provides the 2005 VOC emissions for these area source categories

Exhibit 3-10

Base Year Evaporative VOC Area Source Emissions

Area Source Category	VOC Emissions (tonnes)
Gasoline Service Stations	192
Cold Cleaning Solvents	104
Surface Coating	394
Graphic Arts	50
Commercial/consumer Products	578
Total	**1,318**

4.0 Base Year City Government Operations Inventory

The City Government Operations inventory provides an estimate of all of the GHG and CAP emissions produced by City government activities during fiscal year 2006. The emissions inventory contains both direct emissions (all City government activities that directly emit to the atmosphere within the city's boundary; for example, emissions from fossil fuel combustion at City government buildings) and indirect emissions (all City government activities that generate emissions elsewhere; for example, emissions generated by City government employees commuting to Alexandria to work). The Alexandria City government inventory consists of the following sectors:

Sector	Description
Scope 1 Emissions – All direct emissions sources located within the city's geopolitical boundary	
City-owned or leased Buildings, Libraries, and Schools	Natural gas and fuel oil consumption in City-owned or leased buildings
City Vehicle Fleet, Police and Fire Department Vehicles, and School Buses	Gasoline and diesel fuel used by vehicles traveling on roads within the City's boundaries
Offroad Equipment	Gasoline and diesel fuel used by off-road equipment (landscaping, construction, etc.)
Solid Waste Disposal	Solid waste generated by City operations and processed at the Covanta energy-from-waste facility
Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city's boundary	
City-owned or leased Buildings, Libraries, and Schools	Electricity consumption in City government-owned or -leased buildings
Street and Traffic Lighting	Electricity consumption resulting from outdoor lighting such as streetlights, traffic signals, illuminated pedestrian signs, and parks and recreation lights
Scope 3 Emissions – Indirect emissions that result as a consequence of activity within the city, but the associated emissions occur outside of the city's boundary	
Employee Commute	Gasoline used by City government employees who commute to work by automobile

ICLEI believes that the most accurate description of emissions requires separate accounting of emissions by scope. This differentiation into scopes helps to avoid the possibility of double counting emissions and misrepresenting emissions when reporting. Exhibit 4-1 shows the GHG and CAP emissions resulting from City government operations. GHG emissions resulting from government operations totaled 79,820 tonnes of CO_2e in 2005. These emissions are a subset of the community total GHG emissions, representing approximately 3 percent of the community-wide total of 2.6 million tonnes. The largest source of GHG emissions from government operations is energy use at City government-owned and leased buildings, followed by energy use

at school buildings. Emissions from streetlight/traffic signals, City government vehicles, and City government employee commutes are approximately of equal importance.

Exhibit 4-1

Base Year City Government Operations GHG/CAP Emissions (tonnes)

	GHG	CAP					
Source Category	**Equiv CO_2**	**NO_x**	**SO_2**	**CO**	**VOC**	**PM_{10}**	**$PM_{2.5}$**
Scope 1 Emissions – All direct emissions sources located within the City's boundary							
City Buildings - Fossil Fuel	4,486	6.1	0.2	1.6	0.3	0.2	0.2
Schools – Fossil Fuel	3,240	4.4	0.2	1.1	0.2	0.1	0.1
City Fleet	5,146	18.3	0.9	123.3	12.9	0.5	0.5
Fire Dept. Vehicles	675	2.6	0.1	11.1	1.2	0.1	0.1
School Buses	1,435	10.2	0.4	7.8	1.0	0.4	0.4
Solid Waste Disposal	1,671	12.3	0.1	1.7	0.1	0.0	0.0
	16,653	**53.8**	**2.0**	**146.6**	**15.7**	**1.4**	**1.3**
Scope 2 Emissions – Indirect emissions limited to electricity consumption within the City, but the associated emissions occur outside of the City's boundary							
City Buildings - Electricity	29,243	49.2	161.5	3.7	0.4	3.2	1.4
Schools – Electricity	16,413	27.6	90.6	2.1	0.2	1.8	0.8
Lighting - Electricity	7,406	12.4	40.9	1.0	0.2	0.8	0.4
	53,062	**89.2**	**293.0**	**6.8**	**0.8**	**5.9**	**2.6**
Scope 3 Emissions – Indirect emissions that result as a consequence of activity within the City, but the associated emissions occur outside of the City's boundary							
Employee Commute	10,105	24.4	1.5	281.7	29.1	0.5	0.5
	10,105	**24.4**	**1.5**	**281.7**	**29.1**	**0.5**	**0.5**
Totals for City Government Operations	**79,820**	**167.5**	**296.6**	**435.1**	**45.7**	**7.8**	**4.4**

Note: the CACP software does not calculate emissions for particulate matter less than 2.5 microns in diameter ($PM_{2.5}$); see Exhibit B-10 for the methodology to estimate $PM_{2.5}$ emissions.

As shown in Exhibit 4-2, the consumption of electricity and the combustion of natural gas in buildings owned and leased by the City government resulted in the majority of emissions in 2005. These buildings were responsible for the emission of approximately 33,729 tonnes of CO_2e. Emissions of CO_2e from school buildings were the second largest source and made up 25 percent of the total government CO_2e emissions. Gasoline fuel used by City employee vehicles during their commute to work accounted for the third largest contribution of emissions at 13 percent, producing 10,105 tonnes of CO_2e.

Exhibit 4-3 shows clearly the dominance of electricity when 2005 government CO_2e emissions are categorized by energy source. Electricity consumption for use in City buildings, schools, and outdoor lighting accounted for the two-thirds of the emissions, producing 53,062 tonnes of CO_2e. Emissions of CO_2e from gasoline used in City government vehicles and employee vehicles while commuting represent the second largest source and made up 18 percent of the total government CO_2e emissions. The third largest energy source was natural gas used in City government buildings and schools.

Exhibit 4-2

FY06 Government CO_2e Emissions by Sector (79,820 tonnes)

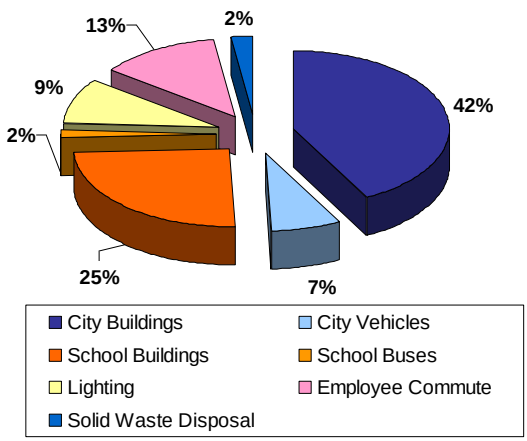
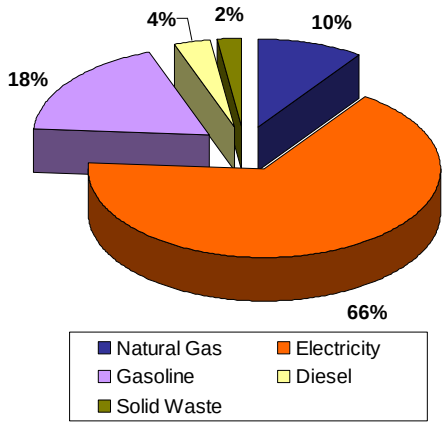


Exhibit 4-3

FY06 Government CO_2e Emissions by Fuel Type (79,820 tonnes)



4.1 City Government Buildings

The City of Alexandria occupies or manages a variety of buildings. City government staff provided information about the size and energy consumption in these buildings (T&ES, 2008b). For this inventory, buildings were assigned to the following categories:

- City government-owned buildings –includes 155 buildings such as City Hall, the Courthouse, fire departments, maintenance facilities and recreation facilities. Exhibit C-1 identifies these buildings by name and provides energy consumption for each building.
- City government-owned libraries –includes four libraries owned by the City. Exhibit C-2 identifies these libraries by name and provides energy consumption for each library.
- Leased facilities (City government as tenant) – includes 72 buildings used for office space, group homes, equipment storage, and recreation. Exhibit C-3 identifies these buildings by name and provides energy consumption estimates for each building.
- Leased facilities (City government as landlord) –includes 22 buildings used for office space and a variety of other purposes. Exhibit C-4 identifies these buildings by name and provides energy consumption estimates for each building.
- School facilities –includes 13 elementary schools, two middle schools, one ninth grade school, one high school, one rowing facility, one maintenance facility, and two leased spaces . Exhibit C-5 identifies these buildings by name and provides energy consumption for each school facility.

Exhibit 4-4 summarizes the energy consumption, GHG and CAP emissions from City government buildings.

Exhibit 4-4

Base Year Building Energy Use and GHG/CAP Emissions (tonnes)

Energy Source/ Sector	Energy (MMBtu)	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$
Electricity								
City Owned	89,553	17,450	29.4	96.4	2.2	0.2	1.9	0.8
Libraries	8,876	1,730	2.9	9.6	0.2	<0.1	0.2	0.1
Leased (Landlord)	21,498	4,189	7.0	23.1	0.5	0.1	0.5	0.2
Leased (Tenant)	30,145	5,874	9.9	32.4	0.7	0.1	0.6	0.3
Schools	84,233	16,413	27.6	90.6	2.1	0.2	1.8	0.8
	234,305	**45,656**	**76.8**	**252.1**	**5.8**	**0.6**	**5.0**	**2.2**
Natural Gas								
City Owned	60,053	3,366	4.6	0.2	1.2	0.3	0.1	0.1
Libraries	4,621	259	0.4	<0.1	0.1	<0.1	<0.1	<0.1
Leased (Landlord)	6,191	347	0.5	<0.1	0.1	<0.1	<0.1	<0.1
Leased (Tenant)	9,164	514	0.7	<0.1	0.2	<0.1	<0.1	<0.1
Schools	57,807	3,240	4.4	0.2	1.1	0.2	0.1	0.1
	137,836	**7,726**	**10.5**	**0.4**	**2.7**	**0.5**	**0.2**	**0.2**
Total	**372,141**	**53,382**	**87.3**	**252.5**	**8.5**	**1.1**	**5.2**	**2.4**

4.2 City Government Vehicle Fleet

The City government has several vehicle fleets. City government staff provided information about the size and energy consumption for these fleets. For this inventory, vehicles were assigned to the following categories:

- City Government Fleet – consists of 934 vehicles including the public works, police, solid waste, and other City government departments. Detailed data were provided on the type of vehicle, miles driven, and fuel consumed (T&ES, 2008c). Included in this fleet is offroad equipment such as backhoes, riding mowers, and tractors.
- Fire Department Fleet – consists of 115 vehicles including light duty vehicles, ambulances, pumper engines, aerial ladder trucks, and specialty units. Detailed data were provided on the type of vehicle, miles driven, and fuel type (AFD, 2008).
- School Buses – includes 98 school buses. Data on the number of buses and total miles driven were provided (ACPS, 2008)

Exhibit C-6 provides a detailed summary of the number and types of vehicles in each fleet, and how these vehicles were mapped to the CACPS fuel type and vehicle classifications. Exhibit 4-5 summarizes the energy consumption, GHG and CAP emissions from City government vehicles.

Exhibit 4-5

Base Year Vehicle Fleet Energy Use and GHG/CAP Emissions (tonnes)

Energy Source Sector	Number of Vehicles	Energy (MMBtu)	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$
City Government Fleet									
Gasoline	819	52,438	4,059	10.5	0.6	117.3	12.1	0.2	0.2
Diesel	115	13,817	1,087	7.7	0.3	5.9	0.8	0.3	0.3
	934	**66,255**	**5,146**	**18.3**	**0.9**	**123.3**	**12.9**	**0.5**	**0.5**
Fire Department									
Gasoline	80	4,978	385	0.8	0.1	9.7	1.0	0.0	0.0
Diesel	35	3,681	290	1.8	0.1	1.4	0.2	0.1	0.1
	115	**8,659**	**675**	**2.6**	**0.1**	**11.1**	**1.2**	**0.1**	**0.1**
School Buses									
Diesel	98	18,240	1,435	10.2	0.4	7.8	1.0	0.4	0.4
	98	**18,240**	**1,435**	**10.2**	**0.4**	**7.8**	**1.0**	**0.4**	**0.4**
Total	**1,147**	**93,154**	**7,256**	**31.1**	**1.5**	**142.2**	**15.1**	**1.0**	**1.0**

4.3 City Government Employee Commute

Emissions from the vehicles of City government employees who drive to work were analyzed to assess their relative contribution to the City government's carbon footprint. The City government employs about 3,000 people, many of whom drive to work. A four-step process was used to estimate the vehicle miles traveled by City employees commuting to work, as follows:

1. Calculate Daily VMT. The home address of each employee was provided by the Alexandria Human Resources Department (T&ES, 2008d). We counted the number of employees living in each zip code and calculated the distance from the zip code centroid to City Hall. We then calculated the daily miles traveled by multiplying the number of employees in the zip code by the roundtrip distance to City Hall. It should be noted that the 166 employees who live in the same zip code (22314) as City Hall were assumed to have a zero drive distance (i.e., they walk to work).

2. Calculate Raw Annual VMT. Using the daily VMT calculated above, we assumed an average work schedule of 5 days per week, 50 weeks per year. This schedule was used to calculate the annual VMT by multiplying the daily VMT by 250 days per year.

3. Adjust VMT for Employees Not Driving to Work. About 11% of City government employees are enrolled in the transportation benefits program. These employees receive subsidies for traveling by Metrorail, Metrobus, commuter buses/vans, DASH, or Virginia Rail Express. To account for these employees who do not drive to work, we reduced the annual VMT by 11%. It should also be noted that we had no data to indicate how many employees traveled by car pool (i.e., each employee was assumed to travel via single occupant vehicle).

4. Assign VMT to Vehicle Category. We allocated the total VMT to vehicle category by first allocating VMT to MOBILE6 vehicle type, and then matching MOBILE6 vehicle type to CACPS vehicle type.

Exhibits C-7 and C-8 summarizes data used, calculations made and results obtained from this procedure. Exhibit 4-6 summarizes the energy consumption, GHG and CAP emissions from City government employees driving to work.

Exhibit 4-6

Base Year Employees Commute Energy Use and GHG/CAP Emissions (tonnes)

Employee Commute	Energy (MMBtu)	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	PM_{10}
Total Gasoline	130,372	10,105	24.4	1.5	281.7	29.1	0.5	0.5

4.4 Streetlights, Traffic Signals, and Other Outdoor Lights

This sector includes road lighting, park lighting, accent lighting, traffic signals, and other lights operated by the City government that are not associated with any particular facility. Energy used by lighting connected to City government buildings is not included here, since those lights are generally connected to the meters of the nearby building and the electricity consumption is associated with the building. The city has a total of 286 traffic signals, flashers, and other traffic-related lighting that consumed approximately 3,005,304 kwh of electricity in 2007 (T&ES, 2008e). In addition, the city has approximately 10,000 street lights that consumed approximately 8,130,385 kwh of electricity in FY 2007 (T&ES, 2008f). Exhibit 4-7 summarizes the energy consumption and indirect GHG and CAP emissions from city traffic signal and street lighting electricity use.

Exhibit 4-7

Base Year Traffic Signal and Street Lighting Energy Use and GHG/CAP Emissions (tonnes)

Type of Lighting	Energy (MMBtu)	Equiv CO_2	NO_x	SO_2	CO	VOC	PM_{10}	PM_{10}
Traffic Signals	20,257	1,999	3.4	11.1	0.3	0.1	0.2	0.1
Street Lighting	27,749	5,407	9.1	29.8	0.7	0.1	0.6	0.3
Total	**48,006**	**7,406**	**12.4**	**40.9**	**1.0**	**0.2**	**0.8**	**0.4**

4.5 Wastewater Treatment

The Alexandria Sanitation Authority (ASA) provides wastewater treatment for approximately 325,000 people in a service area that includes the City of Alexandria and portions of Fairfax County. Emissions from ASA were previously discussed in Section 3.4.

4.6 Solid Waste Disposal

Solid waste generated by City government operations is collected by the Alexandria Division of Solid Waste, which provides municipal solid waste collection services for single family homes (defined to include residential buildings with four or less units), various City government facilities, and street cans. All municipal waste collected by the City Division of Solid Waste is transported to the Covanta Alexandria/Arlington energy-from-waste facility. In 2007, the City Division of Solid Waste transported 27,131 tons of MSW to the Covanta facility. Of this total, it is estimated that 30% (about 8,139 tons) was generated by City government operations (T&ES, 2008a). Covanta processed 348,127 tons in 2007. The proportion of Covanta's emissions that are attributable to solid waste from City government operations is about 2.3% (i.e., 8,139/348,127).

Exhibit 4-8

Proportion of Covanta GHG/CAP Emissions (tonnes)
Resulting from Solid Waste Generated by City Government Operations

Unit	Gross Load (MWh)	Heat Input mmBtu	CO2	NOx	SO2	CO	VOC	PM10	PM2.5
Covanta Arlington/Alexandria Waste to Energy Facility*									
B100	59,554	1,183,780	23,912	178.4	1.9	25.3	0.8	0.6	0.6
B200	60,277	1,198,164	24,281	178.4	1.9	25.3	0.8	0.6	0.6
B300	60,819	1,208,920	24,446	176.9	1.8	24.5	0.7	0.9	0.9
	180,650	3,590,864	72,639	533.8	5.6	75.2	2.4	2.1	2.1
Proportion Resulting from Solid Waste Generated by City Government Operations									
	4,155	82,590	1,671	12.3	0.1	1.7	0.1	<0.1	<0.1

5.0 Emissions Forecast and Reduction Targets

This section discusses future GHG emissions under a "business-as-usual (BAU)" scenario and sets targets for reducing GHG emissions. The BAU scenario accounts for the anticipated growth in energy consumption as a result of projected growth in population, employment, and vehicle traffic. Projections were made and emission reduction targets were set for the short-term (2010, 2012), medium term (2020, 2030), and long-term (2040, 2050).

5.1 Business-as-Usual Growth Projections

Alexandria is a growing city. Population will grow by nearly 26 percent between 2005 and 2030 (DPZ, 2007). Employment will increase by about 34 percent. MWCOG projects that emissions from transportation will grow by 38 percent from 2005 to 2030. These projections were used to develop the growth factors that were applied to project 2005 base year emissions to the out years. For the Mirant Potomac River Generating Station, City staff estimated that heat input would increase from 16 to 26 million mmBtu per year in the future. For the Covanta energy-from-waste plant, the throughput restriction in the facility's air pollution permit was used to project emissions (VADEQ, 2002). Note that all City government operations were projected to increase in proportion to the increase in city population.

Exhibit 5-1

Growth Factors Applied for Business-as-Usual Projection Inventory

Growth Factor	Source Category	Percent Change from 2005					
		2010	2012	2020	2030	2040	2050
Community Activities							
Population	Residential Fuel Residential Electricity Offroad Equipment Rail Traffic	5.0%	7.0%	15.0%	25.9%	37.9%	51.1%
Employment	Commercial Fuel Commercial Electricity Industrial Fuel Industrial Electricity	1.9%	4.5%	14.9%	33.8%	55.8%	81.4%
VMT	Onroad Vehicles	8.3%	11.7%	25.0%	38.0%	52.4%	68.2%
State Permit	Mirant	No throughput limit in Final Permit to Operate OEQ staff estimate heat input will increase from 16 to 26 trillion Btu annually in the future.					
Title V Permit	Covanta	Facility is permitted to burn 336,000 tons of MSW. In 2005, facility operated at about 85% capacity. Assume Facility operates at full capacity in future years.					
City Government Operations							
Population	All Government Sectors	5.0%	7.0%	15.0%	25.9%	37.9%	51.1%

5.2 Emission Reduction Targets

The MWCOG Climate Change Steering Committee is recommending goals to reduce regional GHG emissions that are consistent with the climate science and with the goals adopted by state and local governments in the Washington region. The goals are based on what some scientists say is needed to stabilize the projected rise in global surface temperatures to below 2.5-3°C (4.5-5.4°F) by 2050. The IPCC and NAS believe that GHG emissions must be reduced by 50–85 percent by 2050 to avoid the dire consequences of global warming (MWCOG, 2008d).

MWCOG has recommended targets for reducing regional GHG emissions for the years 2012, 2020, and 2050. MWCOG studied the IPCC recommendations and reviewed greenhouse gas reduction goals set by states, cities and regions in the U.S. As a compromise between IPCC recommended reduction levels and those adopted by MWCOG member local governments, MWCOG chose to set three goals. The goals include an early goal (2012) to force early action, a medium-range goal (2020) to encourage expansion of recommended policies and programs, and a long-range goal (2050) to stimulate support for research into technologies and clean fuels needed to stabilize greenhouse gas emissions. The MWCOG recommended targets are generally consistent with the target set in the Virginia Energy Plan, which was to reduce greenhouse gas emissions by 30 percent by 2025.

The City government is considering setting targets that are generally consistent with the MWCOG emission reduction percentage targets. The MWCOG targets are shown in Exhibit 5-2. Achieving these emission reduction targets will require a coordinated regional effort that will involve individual actions, state and local government actions, business actions, federal and state policy and regulations, academic research and development, and new technology.

Exhibit 5-2

MWCOG Greenhouse Gas Emission Reduction Targets

Year	Proposed Reduction Target	Rationale
2012	Reduce Business As Usual (BAU) Emissions by 10 Percent Below 2012 Levels	Early goal to force early action; the goal is to stop projected growth in regional greenhouse gas emissions by achieving a 10 percent reduction in regional emissions between 2008 and 2012.
2020	Reduce BAU Emissions by 20 Percent Below 2005 Levels	Medium-range goal to encourage expansion of recommended policies and programs on a national, state, and local level.
2050	Reduce BAU Emissions by 80 Percent Below 2005 Levels	Long-range goal to stimulate research into technologies and clean fuels needed to stabilize GHG emissions; this is an ambitious long-term goal and would place the region among national leaders calling for aggressive action to address climate change.

5.3 Community Forecast and Emission Reduction Targets

The business-as-usual (BAU) emissions scenario for the community inventory provides a projection of potential emissions in the future assuming that no new emission reduction measures are implemented. The BAU scenario forecast does not model for technological changes, since the BAU scenario is meant to act as a control group against which the impact of the City government and community actions can be measured.

Exhibit 5-3 compares the BAU scenario to the MWCOG emission reduction targets. As discussed previously in Section 3, we are framing emissions for target setting based on electricity consumption rather than electricity generation. We have subtracted grid-based generation in order to assign responsibility for electricity usage to the end-user, which will help in targeting policies to reduce emissions. The City government is considering setting targets for the community inventory that are generally consistent with the MWCOG emission reduction percentage targets. To meet the short-term goal in 2012, a 10 percent reduction in emissions from 2012 BAU levels is needed. Strategies to meet this short-term target, as well as the aggressive targets for 2020 and 2050, are currently under development.

As shown in Exhibit 5-4, the BAU scenario for the community inventory shows that GHG emissions would increase substantially corresponding with local economic, population and vehicle traffic growth. Consumption-based emissions are projected to increase from 2.6 million tonnes in 2005 to 2.8 million tonnes in 2012 and 4.5 million tonnes in 2050.

Exhibit 5-3

Comparison of Projected Community GHG Emissions under the Business-as-Usual Forecasts and MWCOG Emission Reduction Targets

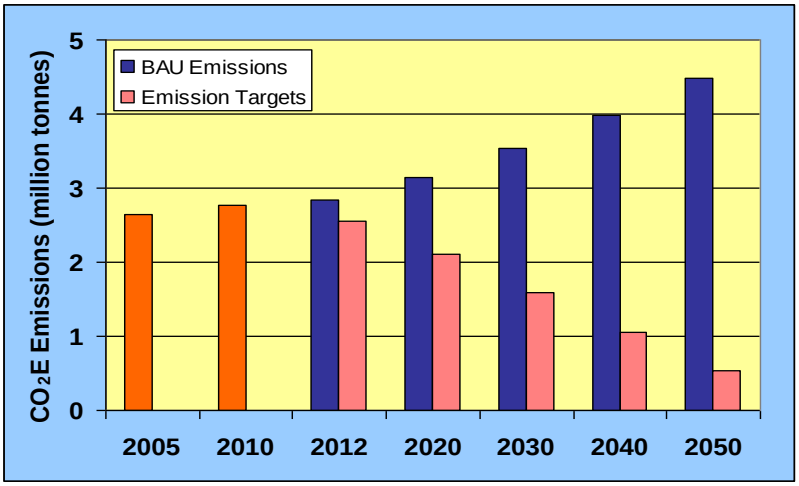


Exhibit 5-4

Business-as-Usual Emission Forecasts for the Community Inventory

	CO_2e Emissions (tonnes)			
Source Category	**2005**	**2012**	**2020**	**2050**
Scope 1 Emissions – All direct emissions sources located within the city's boundary				
Fossil Fuel - Residential	169,816	181,633	195,233	256,599
Fossil Fuel – Comm/Govt	67,520	70,588	77,599	122,485
Fossil Fuel - Industrial	74,020	77,383	85,070	134,276
Onroad Vehicles	1,111,724	1,241,425	1,389,655	1,869,920
Offroad Equipment	19,766	21,142	22,724	29,867
Locomotives – Diesel	145	155	167	219
Scope 1 Consumption Based Emissions:	**1,442,991**	**1,592,326**	**1,770,448**	**2,413,366**
Mirant Potomac River Generating Station	1,478,301	2,433,417	2,433,417	2,433,417
Covanta Energy from Waste Facility	318,092	371,107	371,107	371,107
Scope 1 Generation Based Emissions:	**1,796,393**	**2,804,525**	**2,804,525**	**2,804,525**
Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city's boundary				
Electricity - Residential	264,490	282,896	304,078	399,655
Electricity - Commercial	889,242	929,644	1,021,988	1,613,135
Electricity - Industrial	8,737	9,134	10,041	15,849
Electricity - Rail Traffic	29,310	31,350	33,697	44,289
Scope 2 Emissions:	**1,191,779**	**1,253,023**	**1,369,804**	**2,072,927**
Scope 3 Emissions – Indirect emissions that result as a consequence of activity within the city but the associated emissions occur outside of the city's boundary				
Municipal Solid Waste sent to landfills outside of Alexandria	1,388	1,457	1,485	1,596
Wastewater Sludge sent to landfill or incinerator, or used as fertilizer outside of Alexandria	3,481	3,654	3,723	4,002
Scope 3 Emissions:	**4,869**	**5,110**	**5,208**	**5,598**

5.4 City Government Operations Forecast and Emission Reduction Targets

Emissions from the City government operations were projected based entirely on projected increases in population. As for the community inventory, this assumes no new emission reduction measures are implemented and there are no technological changes, since the BAU scenario is meant to act as a control group against which the impact of the City's actions can be measured.

Exhibit 5-6 compares the BAU scenario to the MWCOG emission reduction targets. The City is considering setting targets for the City government inventory that are generally consistent with the MWCOG emission reduction percentage targets. To meet the short-term goal in 2012, a 10 percent reduction in emissions from 2012 BAU levels is needed. Strategies to meet this short-term target, as well as the aggressive targets for 2020 and 2050, are currently under development.

As shown in Exhibit 5-5, the BAU scenario for the City government inventory indicates that GHG emissions would increase substantially, corresponding with increased government activity to serve a growing population.

Exhibit 5-5
Comparison of Projected Government Operations GHG Emissions under the Business-as-Usual Forecasts and MWCOG Emission Reduction Targets

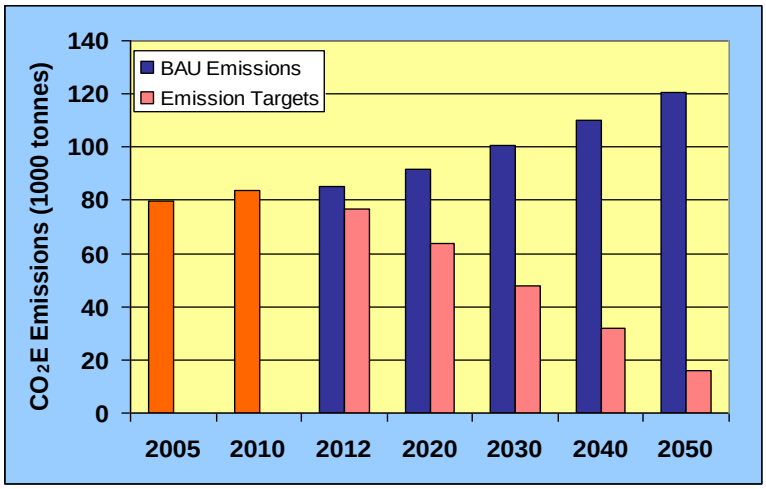


Exhibit 5-6
Business-as-Usual Emission Forecasts for the Government Operations Inventory

	CO_2e Emissions (tonnes)			
Source Category	**2005**	**2012**	**2020**	**2050**
Scope 1 Emissions – All direct emissions sources located within the city's boundary				
City Buildings - Fossil Fuel	4,486	4,798	5,157	6,779
Schools – Fossil Fuel	3,240	3,465	3,725	4,896
City Fleet	5,146	5,504	5,916	7,776
Fire Dept. Vehicles	675	722	776	1,020
School Buses	1,435	1,535	1,650	2,168
Solid Waste Disposal	1,671	1,787	1,921	2,525
Scope 1 Emissions	**16,653**	**17,812**	**19,146**	**25,163**
Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city's boundary				
City Buildings - Electricity	29,243	31,278	33,620	44,187
Schools – Electricity	16,413	17,555	18,870	24,801
Lighting - Electricity	7,406	7,921	8,514	11,191
Scope 2 Emissions	**53,062**	**56,755**	**61,004**	**80,179**
Scope 3 Emissions – Indirect emissions that result as a consequence of activity within the city, but the associated emissions occur outside of the city's boundary				
Employee Commute	10,105	10,808	11,617	15,269
Scope 3 Emissions	**10,105**	**10,808**	**11,617**	**15,269**
Total for All Government Operations	**79,820**	**85,375**	**91,767**	**120,611**

6.0 Emission Reduction Opportunities

Meeting the emission reduction targets identified in the previous section will require a coordinated effort that will involve individual actions, state and local government actions, business actions, federal and state policy and regulations, academic research and development, and new technology. This section summarizes efforts already undertaken as well as future opportunities for reducing GHG emissions and meeting the City's emission reduction targets.

6.1 Existing City of Alexandria Measures

The City government has already undertaken several initiatives to reduce GHG emissions. These measures are identified in Exhibit 6-1.

6.2 Alexandria's Environmental Action Plan

Alexandria's Environmental Action Plan (EAP) serves as the road map for city leaders, staff, and citizens to implement Alexandria's Eco-City Charter adopted by City Council on June 14, 2008. The City of Alexandria approved the Eco-City Action Plan on January 24, 2009. The Phase I Eco-City Action Plan consists of 41 goals and 133 action items, which focus on short-term environmental actions. Many of these goals and actions will help reduce GHG emissions in the City. Exhibit 6-2 identifies the goals listed in the draft Phase One Action Plan.

6.3 Opportunities for City Action to Reduce Emissions Identified by MWCOG

The MWCOG's Climate Change Steering Committee recommended a number of measures that local governments may consider in planning for regional GHG emission reductions. These measures are identified in Exhibit 6-3.

6.4 Opportunities for Community Emission Reductions Identified by MWCOG

MWCOG's Climate Change Steering Committee recommends a number of measures to reduce regional GHG emissions. The Committee recommends reducing emissions from the energy sector by improving energy efficiency, reducing demand for energy, and developing clean (alternative) energy sources. Secondly, it recommends reducing emissions from transportation by reducing Vehicle Miles Traveled (VMT), increasing fuel efficiency, and reducing the carbon content of fuel and via changes in land use planning (e.g. tree preservation, green building standards, etc.). A summary of the recommendations is provided in Exhibit 6-4. These recommendations would need to be implemented on a broader scale than the local measures identified earlier and will require the coordinated efforts of local governments, state and federal agencies, and business and other key stakeholders.

6.5 Virginia Climate Change Action Plan

In September 2007, Governor Timothy M. Kaine released the Virginia Energy Plan, an implementation document designed to demonstrate how the General Assembly-enacted state energy policy (SB-262; Code of Virginia § 67-100) could be executed. Included in the Virginia Energy Plan was the recommendation that the Governor create a commission to address climate change and its possible impacts on Virginia. The Governor's Commission on Climate Change released its final Climate Change Action Plan in December of 2008. More than 150 recommendations were debated by the Commission. The final list of recommendations, as adopted by the full Commission, is summarized in Exhibit 6-5. The list of recommendations is divided into two groups. The first group consists of those recommendations that affect GHG emissions. This first group of recommendations thus addresses the actions (beyond those identified in the Energy Plan) that need to be taken to achieve a 30% reduction goal by 2025. The second group of recommendations consists of strategies that will guide Virginia's response to climate change, including how the state should plan for and adapt to changes that are likely unavoidable.

Exhibit 6-1

Existing City of Alexandria Emission Reduction Measures

Investments in renewable energy resources:

- The City's municipal waste facility generates enough electricity to supply 20,000 homes. The operation of this facility contributes to a reduction in CO_2 emissions of approximately 160,000 metric tons per year.

Energy conservation projects for City government facilities:

- City Council approved a budget of $1.25 million for energy-conservation.
- The City is replacing incandescent lighting with energy-efficient fluorescent bulbs and distributed compact fluorescent bulbs at the City's 2007 Earth Day event.
- The City replaced 25 traffic signals with high efficiency light-emitting diode (LED) lights
- An Energy Manager was hired to implement energy conservation projects in City buildings.

Promote sustainable building practices:

- The City's goal is to achieve LEED-Silver rating for all new City-owned facilities over 5,000 square feet.
- The City was awarded a Green Innovation Award from Virginia Sustainable Building Network for the new T.C. Williams High School.
- The City installed green roofs at Alexandria Health Department, T.C. Williams High School, and Duncan Library with another planned for Cora Kelly Elementary School.

Promote tree planting to increase shading and to absorb CO2:

- The City plants approximately 350 trees annually, capturing about 13.5 metric tons of CO2.
- An Urban Forestry Master Plan is being completed by the Urban Forestry Steering Committee.

Retrofit school buses with emission control devices

- VDEQ awarded the City a grant to retrofit about 40 diesel-powered school buses with emission control devices.

Increase the average fuel efficiency of municipal fleet vehicles

- The City's sedans and SUVs are being replaced with low-emission/more energy-efficient vehicles and the fleet has 55 low-emission vehicles including 14 hybrids.

Land-use policies that reduce urban sprawl, create walkable communities and encourage mixed-use development

- The Open Space Master Plan, adopted in 2003 led to the acquisition of eight parcels consisting of 64 acres of key Waterfront and Four Mile Run properties.

Promote sustainable transportation options

- The City hired a Pedestrian/Bicycle Coordinator and is developing a Comprehensive Transportation Master Plan.
- Free bus rides are provided on air quality action days and financial incentives are provided to City employees to use the Metro and DASH transit system.

Increase recycling rates in City operations and community

- In 2006, a new Multi-family Residential and Business Recycling Program was initiated with initial compliance expected in 2007.
- The City expanded its leaf collection program for turning leaves into mulch.

Exhibit 6-2

Environmental Action Plan Phase I Goals

LAND USE AND OPEN SPACE

Goal 1: Continue to coordinate land use and site design decisions among City departments to ensure compatibility with existing City plans that promote walking, cycling, and taking public transportation.

Goal 2: Ensure that Small Area Plans, and new development and redevelopment projects are consistent with the vision and principles of the Eco City Charter.

Goal 3: Protect and enhance Alexandria's open space and green infrastructure including wildlife habitat, parks, trails, tree canopy, and watersheds.

Goal 4: Ensure that future land use and open space planning and project decisions will neither create or perpetuate social injustice, nor compromise the city's historic character.

Goal 5: Conduct outreach and education on sustainable land use practices, policies and programs.

WATER RESOURCES

Goal 1: Promote citizen involvement in and awareness of water quality and resource issues, particularly with regard to regulatory requirements of the Municipal Separate Storm Sewer System (MS4) permit.

Goal 2: Maintain and enhance stormwater and sanitary infrastructure and stream systems to minimize environmental degradation.

Goal 3: Promote, require, and invest in water conservation infrastructure.

AIR QUALITY

Goal 1: Improve ambient air quality.

Goal 2: Reduce off-road/mobile emissions by promoting more environmentally efficient lawn care and construction equipment.

TRANSPORTATION

Goal 1: Move aggressively to change the culture of City streets from "cars first" to "people first" by implementing development and transportation projects consistent with the following level of precedence: pedestrians, bicyclists, public transportation, shared motor vehicles, private motor vehicles.

Goal 2: Educate individuals and organizations on the availability will reduce dependency on single occupancy vehicles.

BUILDING GREEN

Goal 1: Building on the City's green building policy, promote the idea that all development, either new or renovation, should be constructed with the lowest environmental impact as is reasonably practical.

Goal 2: Expedite the Commonwealth's adoption of further green building standards.

Goal 3: Provide information and technical assistance regarding green building practices to businesses and residents.

Goal 4: The City Council will lead by example in green building practices.

Reference: Eco-City Alexandria, *Environmental Action Plan Phase I (FY2009 – FY2011)*; adopted January 24, 2009.

Exhibit 6-2 (continued)

Environmental Action Plan Phase I Goals

ENERGY

Goal 1: Explore incentives that encourage the adoption of renewable energy resources, such as wind and solar, that could yield significant reductions in the city's carbon footprint and other emissions.

Goal 2: Encourage the adoption of more energy efficient technologies by the City, its residents, and businesses.

Goal 3: Reduce energy consumption through conservation.

Goal 4: Support interdepartmental planning and prioritization of energy management and investment activities.

Goal 5: Evaluate the energy needs and impacts within the city in order objectives by initiating an energy planning process by 2010.

Goal 6: Purchase less polluting energy sources for City operations.

SOLID WASTE

Goal 1: Meet the City's goal of 35% diversion through increased waste reduction and reuse with new programs and incentives implemented by 2011.

Goal 2: Expand City recycling programs to exceed the Commonwealth recycling rate mandate of 25% and achieve a target diversion goal of 35% by 2011, as outlined in the City's Solid Waste Management Plan.

Goal 3: Develop an outreach strategy to educate the public on new and existing recycling mandates as well as opportunities for re-use through multiple communication and education strategies.

Goal 4: Increase the diversion of organic solid waste from disposal by improving and expanding the City's existing organic waste recycling program.

Goal 5: Maintain programs for ensuring that solid wastes are managed in accordance with Commonwealth and Federal laws and regulations in a manner that protects health, safety, and the environment.

ENVIRONMENT AND HEALTH

Goal 1: Promote respiratory health and improve indoor air quality in both new and existing residences by improving ventilation and reducing exposure to air contaminants including secondhand smoke, radon, lead, mold and other contaminants.

Goal 2: Improve indoor air quality health, in both new and existing work places by improving ventilation and reducing exposure to air contaminants including organic solvents, secondhand smoke, lead, and mold to promote respiratory health.

Goal 3: Encourage healthy lifestyles and improved air quality by providing safe, active transportation opportunities, in order to reduce obesity, chronic diseases such as diabetes, heart disease, and stroke, and respiratory diseases.

Goal 4: Improve access to fresh food, preferably locally grown and within a ½ mile walk for all residents.

Reference: Eco-City Alexandria, *Environmental Action Plan Phase I (FY2009 – FY2011)*; adopted January 24, 2009.

Exhibit 6-2 (continued)

Environmental Action Plan Phase I Goals

EMERGING THREATS

Goal 1: Adopt targets for reducing greenhouse gas emission reductions for 2012 and 2020.

Goal 2: Institutionalize the consideration of the effects of possible climate changes into long-term planning.

Goal 3: Prepare and educate City residents and business owners for a carbon-constrained economy.

Goal 4: Develop a strategic planning process for improving and maintaining environmental quality.

IMPLEMENTATION

Goal 1: Identify and promote action steps for increasing financial investment in sustainability.

Goal 2: Provide education and outreach to citizens to help achieve environmental goals and and promote the development of green jobs within the city.

Goal 3: Provide education and outreach to local businesses and related organizations to help achieve environmental goals.

Goal 4: Continue steps to improve the City government's own green culture.

Goal 5: Increase community participation in carrying out implementation activities.

Goal 6: Re-examine EPC's composition and membership

Reference: Eco-City Alexandria, *Environmental Action Plan Phase I (FY2009 – FY2011)*; adopted January 24, 2009.

Exhibit 6-3

MWCOG Recommendations for Emission Reduction Measures That Can Be Implemented by Local Governments

ENERGY

Energy Efficiency Measures

1. Regional Green Building Policy: Implement 2007 COG Regional Green Building Policy: All new government buildings meet "LEED Silver" standard, ENERGY STAR®, or equivalent.
2. Energy Use: Identify best practices to support reducing overall local government energy use by 15% by 2012.
3. Examine options and develop plans for replacing street lights with energy efficient street lighting (LED or other options) across the region.
4. Promote regional energy performance contracting to reduce energy use in public buildings.
5. Consider regional cooperative purchase approach to facilitate cost-effective implementation.
6. Develop a long-term goal for carbon neutrality for all government buildings.
7. Recycling Initiative: Enhance and expand existing recycling programs.
8. Encourage provision of energy audits and energy retrofits for individuals and businesses through regional cooperative effort.
9. In collaboration with local governments and area wastewater utilities, identify best practices and evaluate the potential for reducing greenhouse gas emissions through methane recapture and use of biosolids as a fuel as means for reducing energy requirements for operations at area wastewater treatment plants and landfills.

Reduce Energy Consumption/Demand Management

1. Partner with electric, gas and water utilities on regional energy conservation and energy efficiency program outreach.
2. Partner with business groups to assist businesses with taking action to reduce greenhouse gas emissions and implement best practices.

Clean Energy Sources

1. Establish regional goal of 20% renewable energy purchase by 2015 by local governments.
2. Evaluate regional cooperative purchase and/or reverse auctions to facilitate green power implementation among COG membership.
3. Work with jurisdictions exporting electricity into the metropolitan Washington region to encourage investments in clean low-emitting energy sources.

LAND USE PLANNING

1. Establish goal and develop program and plan to achieve a "no net loss" in the region's tree canopy. Consider associated issues related to density and height requirements for buildings.
2. Research and develop specific regional goals (up to 95%) to significantly increase percentage of new development located in regional activity centers.
3. Promote regional policies that support walkable communities and affordable housing near transit.
4. Comprehensive Planning: Identify best practices for local governments to include greenhouse gas reduction and energy as an element in their local comprehensive planning. Such efforts should include practices that address climate change risk reduction to guide local zoning, building codes, site planning and review.

Exhibit 6-3 (continued)

MWCOG Recommendations for Emission Reduction Measures That Can Be Implemented by Local Governments

TRANSPORTATION and LAND USE

Increase Fuel Efficiency

1. Establish a regional Green Fleet Policy: Establish Regional Green Fleet Policy with measurable goals and timetables.
2. Promote transit-supportive street designs
3. Idling: Increase enforcement of existing idling regulations to prevent extended vehicle idling.

Low Carbon "Clean" Fuels

1. Promote adoption of CAL LEV II standards for all jurisdictions in the region.
2. Promote/accelerate adoption of efficient clean fuel vehicles, including hybrids (cars, trucks, buses). Target public and private fleets, transit, taxicabs, rental cars, refuse haulers.
3. Evaluate benefits of specific "green fleet" conversion percentages. Provide incentives for purchase of clean fuel vehicles.
4. Assess benefits from a "Cash-for-Clunkers" Program and rebates or tax incentives for purchase of hybrid vehicles.

Reduce Vehicle Miles Traveled (VMT)

1. Expand existing and fund new programs to enhance access to transit and alternative modes, commuter connections, guaranteed ride home, telework programs, bike/ped access, park/ride lots. Evaluate greenhouse gas reduction benefits of expand existing and establishment of new exclusive bus transit routes, lanes, on-ramps, corridors.
3. Promote equalization of transit and parking benefits.
4. Promote car-sharing.
5. Examine parking policies and relation to VMT. Implement new parking policies to reduce VMT.
6. Bicycle/Pedestrian: Fully fund construction of bicycle/pedestrian paths in the region as outlined in the regional bicycle/pedestrian plan. Provide incentives to developments that speed improvements to bicycle/pedestrian access. This includes improvements to sidewalks, curb ramps, crosswalks, lighting, etc. Promote regional Smart Bike program.
7. Design regional program to promote bike sharing.

Reference: Metropolitan Washington Council of Governments, *National Capital Region – Climate Change Report – Appendix D Recommendations for Local Governments: Governments Leading by Example*; prepared by the Climate Change Steering Committee for the Metropolitan Washington Council of Governments Board of Directors; November 12, 2008 final draft.

Exhibit 6-4

MWCOG Recommendations for Regional Emission Reduction Measures

Regional GHG Reduction Goals

1. 2012: Reduce 10% by 2012
2. 2020: Reduce 20% below 2005
3. 2050: Reduce 80% below 2005

Energy

1. Regional green building policy
2. Energy performance goals for public buildings
3. Incentives/outreach to improve private building efficiency
4. Identify best practices for private buildings, improve efficiency
5. Green affordable housing policies/programs
6. Energy conservation and efficiency goals
7. Home weatherization program, energy audits, retrofits
8. Best practices to reduce methane, use biosolids
9. Identify best practices for local govt, reduce 15%
10. Energy Use: Energy Star goals for new buildings
11. Green Power: utilization goals
12. Green Power: regional cooperative purchase
13. Regional street lighting analysis
14. Regional energy performance contracting
15. Long term goal: carbon neutrality for public buildings
17. Partnership programs
18. Promote 20% Renewable Portfolio Standards, including imports
19. Regional Greenhouse Gas Initiative (RGGI) - Expand to DC & VA 20.
20. RGGI funds for efficiency and renewables

Economic Development

1. Promote green business & green jobs
2. Promote eco-business or green business zones
3. Promote cooperative green purchasing
4. Promote local food production options
5. Promote local vendors and suppliers
6. Regional green jobs analysis

Exhibit 6-4 (continued)

MWCOG Recommendations for Regional Emission Reduction Measures

Transportation and Land Use

1. Promote adoption of clean vehicles, including CAL LEV II
2. Provide incentives for early vehicle retirement
3. Green fleet policy
4. Traffic engineering and roadway improvements
5. Anti-idling initiatives: rules and enforcement
6. VMT Reduction: goals
7. VMT Reduction: shift short trips
8. VMT Reduction: financial incentives
9. VMT Reduction: car sharing
10. VMT Reduction: parking policies
11. VMT Reduction: financial and other incentives
12. Develop conformity process for GHGs
13. Stated goal of GHG reduction in transportation planning
14. Direct development to activity centers
15. Expand transit infrastructure and use
16. Alternative Modes: exclusive transit routes
17. Alternative Modes: promote increase transit use
18. Targets for shifting modes
19. Alternative Modes: enhance access
20. Travel management plan for new developments
21. Equalize transit and parking benefits
22. Bicycle/pedestrian programs
23. Land Use Planning: Tree canopy preservation
24. Land Use Planning: Promote location & design of new development around regional activity centers
25. Land Use Planning: Promote walkable communities and affordable housing near transit
26. Evaluate LEED-ND Standards
27. Comprehensive Planning: best practices
28. Comprehensive Planning: environmental review

V. Adaptation

1. Partner w/ university to develop 2050 Impacts Report
2. Develop adaptation policies based on report
3. Conduct regional adaptation workshops

Exhibit 6-4 (continued)

MWCOG Recommendations for Regional Emission Reduction Measures

VI. Financing

1. Evaluate financing mechanisms for GHG reduction & Energy Efficiency Projects
2. Regional offset fund for tree canopy enhancement
3. Identify funding for transit
4. Identify funding for building retrofits

VII. Outreach & Education

1. Citizen Outreach Campaign
2. Develop partnerships w/private sector & others
3. COG member outreach (assistance)
4. Recognition program
5. COG Climate Change website

Reference: Adapted from Metropolitan Washington Council of Governments, *National Capital Region – Climate Change Report – Table ES-1: Recommendations Summary and Preliminary Assessment*; prepared by the Climate Change Steering Committee for the Metropolitan Washington Council of Governments Board of Directors; November 12, final draft.

Exhibit 6-5

Recommendations from Virginia's Climate Change Action Plan

Group 1: Recommendations that affect GHG emissions.

1. Virginia will reduce GHG emissions by increasing energy efficiency and conservation.
2. Virginia will advocate for federal actions that will reduce net GHG emissions.
3. Virginia will reduce GHG emissions related to vehicle miles traveled through expanded commuter choice, improved transportation system efficiency, and improved community designs.
4. Virginia will reduce GHG emissions from automobiles and trucks by increasing efficiency of the transportation fleet and use of alternative fuels.
5. Virginia will reduce GHG emissions through accelerated research and development.
6. Virginia will reduce GHG emissions by increasing the proportion of energy demands that are met by renewable sources.
7. Virginia will reduce GHG emissions by increasing the proportion of electricity generation provided by emissions-free sources of energy.
8. Virginia will reduce net GHG emissions by protecting/enhancing natural carbon sequestration capacity and researching/promoting carbon capture and storage technology.
9. The Commonwealth and local governments will lead by example by implementing practices that will reduce GHG emissions.

Group 2: Recommendations that Address Steps Virginia Should Take to Plan For and Adapt to Climate Change Impacts that are Likely Unavoidable

10. Virginia should consider a more aggressive GHG reduction goal.
11. Virginia will focus and expand state capacity to ensure implementation of the Climate Change Action Plan.
12. Virginia will educate the public about climate change and the actions necessary to address it.
13. Virginia will continually monitor, track, and report on GHG emissions and the impacts of climate change.
14. Virginia state agencies and local governments will prepare for and adapt to the impacts of climate change that cannot be prevented.
15. Virginia will undertake a thorough review of state agency and local government authority to account for climate change in their actions.

Reference: Governor's Commission on Climate Change, *Final Report: A Climate Change Action Plan*; December 15, 2008

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8.0 Glossary

Alternative Fuel: A popular term for "non-conventional" transportation fuels made from natural gas (propane, compressed natural gas, methanol, etc.) or biomass materials (ethanol, methanol).

British thermal unit (Btu): The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit; equal to 252 calories. British thermal unit is abbreviated as Btu.

Carbon Dioxide (CO_2): Carbon dioxide is a greenhouse gas that enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.

Carbon Dioxide Equivalent (CO_2e): This is a common unit for combining emissions of greenhouse gases with different levels of impact on climate change. It is a measure of the impact that each gas has on climate change and is expressed in terms of the potency of carbon dioxide. For carbon dioxide itself, emissions in metric tons of CO_2 and metric tons of CO_2e are the same, whereas for nitrous oxide and methane, stronger greenhouse gases, one tonne of emissions is equal to 310 tonnes and 21 tonnes of CO_2e respectively.

Carbon monoxide (CO): This gas is created when the carbon in fossil fuels is not entirely burned during combustion and can have serious impacts on human health. The majority of carbon monoxide emissions come from the use of fossil fuels in transportation. Lesser quantities come from electricity production and natural events like forest fires. Improperly-adjusted gas stoves can also release high levels of indoor carbon monoxide. When released into the air, carbon monoxide can exacerbate heart disease and damage the human nervous system.

Clean Air Act (CAA): A federal law passed in 1970 and amended in 1974, 1977 and 1990 which forms the basis for the national air pollution control effort. Basic elements of the act include national ambient air quality standards, mobile and stationary control measures, air toxics standards, acid rain control measures, and enforcement provisions.

Climate Change: A term that refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). The term climate change is often used interchangeably with the term global warming, but according to the National Academy of Sciences, "the phrase 'climate change' is growing in preferred use to 'global warming' because it helps convey that there are changes in addition to rising temperatures."

Criteria Air Pollutants: A group of common air pollutants regulated by the EPA. These pollutants are carbon monoxide, lead, nitrogen oxide, ozone, particulates and sulfer dioxide.

Department of Transportation and Environmental Services (T&ES) – The City Department responsible for multimodal transportation services and facilities and protection and enhancement of natural environment to improve the quality of life for those who live in, work in, and visit the City of Alexandria." T&ES is responsible for the engineering, design, construction, inspection, surveying and maintenance of streets, bridges, sewers, fire hydrants and traffic control mechanisms. The department also oversees environmental regulation and management, including air and water quality, transit and refuse and recycling collection

Direct Emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions. All direct emissions are Scope 1 emissions.

Electricity Generation: The process of producing electric energy or the amount of electric energy produced by transforming other forms of energy, commonly expressed in kilowatthours (kWh) or megawatthours (MWh).

Energy Efficiency: Refers to activities that are aimed at reducing the energy used by substituting technically more advanced equipment, typically without affecting the services provided. Examples include high-efficiency appliances, efficient lighting programs, high-efficiency heating, ventilating and air conditioning (HVAC) systems or control modifications, efficient building design, advanced electric motor drives, and heat recovery systems.

Fluorinated Gases: Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases.

Fossil Fuels: Fuels (coal, oil, natural gas, etc.) that result from the compression of ancient plant and animal life formed over millions of years.

Global Warming: A term describing the average increase in the temperature of the atmosphere near the Earth's surface which can contribute to changes in global climate patterns.

Global Warming Potential (GWP): The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one mass-based unit of a given GHG compared to one equivalent unit of carbon dioxide (CO_2) over a given period of time.

Greenhouse Effect - The effect of the Earth's atmosphere, due to certain gases, in trapping heat from the sun; the atmosphere acts like a greenhouse.

Greenhouse Gases: Any of the atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface. They include carbon dioxide (CO2), methane (CH4), nitrous oxide (NO2), fluorinated gases, and water vapor. Although greenhouse gases occur naturally in the atmosphere, the elevated levels especially of carbon dioxide and methane that have been observed in recent decades are directly related, at least in part, to human activities such as the burning of fossil fuels and the deforestation of tropical forests.

Indirect Emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity. For example, emissions of electricity used by a manufacturing entity that occur at a power plant represent the manufacturer's indirect emissions.

Intergovernmental Panel on Climate Change (IPCC): The international body of climate change scientists. The role of the IPCC is to assess the scientific, technical and socio-economic information relevant to the understanding of the risk of human-induced climate change.

Methane (CH4): Methane is a greenhouse gas emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

Metropolitan Washington Council of Governments (MWCOG): The regional planning organization for 21 Washington area governments, including Alexandria. MWCOG works to resolve regional problems such as growth, transportation, air pollution, water supply, water quality, economic development, and other environmental issues.

National Ambient Air Quality Standards (NAAQS): Standards established by the U.S. EPA that apply for outdoor air throughout the country. There are two types of NAAQS. Primary standards set limits to protect public health and secondary standards set limits to protect public welfare.

Nitrogen Oxides (Oxides of Nitrogen, NOx): A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO2) and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition.

Nitrous Oxide (N2O): Nitrous oxide is a greenhouse gas emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

Office of Environmental Quality – An office within T&ES responsible for monitoring and maintaining environmental quality thus preserving and protecting public health and welfare and the environment.

Ozone: A principle component of smog. Ozone can be either good or bad for living things, depending upon where it is located. Ground level ozone is harmful and can cause adverse health effects. However, an ozone layer that exists naturally in the stratosphere keeps out most of the dangerous ultraviolet rays from the sun that can cause health and environmental problems.

Particulate matter (PM, PM10, PM2.5): Air pollution consisting of very small liquid and solid particles floating in the air. Of greatest concern to public health are the particles small enough to be inhaled into the deepest parts of the lung. These particles are less than 10 microns in diameter - about 1/7th the thickness of the a human hair and are known as PM10. This includes fine particulate matter known as PM2.5, the fraction of particulate matter that penetrates most deeply into the lungs.

State Implementation Plan (SIP): a detailed description of the programs a state will use to carry out its responsibilities under the Clean Air Act. State implementation plans are collections of the regulations used by a state to reduce air pollution. The Clean Air Act requires that EPA approve each state implementation plan. Members of the public are given opportunities to participate in review and approval of state implementation plans. SIPs include the technical foundation for understanding the air quality (e.g., emission inventories and air quality monitoring), control measures and strategies, and enforcement mechanisms.

Virginia Department of Environmental Quality (VA DEQ): VA DEQ, though it's Division of Air Quality, is responsible for carrying out the mandates of the Virginia Air Pollution Control Law, as well as meeting Virginia's federal obligations under the federal Clean Air Act.

Volatile Organic Compounds (VOCs): Carbon-containing compounds that evaporate into the air (with a few exceptions). VOCs contribute to the formation of smog and/or may themselves be toxic. VOCs often have an odor, and some examples include gasoline, alcohol, and the solvents used in paints.

APPENDIX A:

PROJECT PARTICIPANTS

Exhibit A-1

Technical Team Members

Name	Affiliation
William Skrabak	City of Alexandria Department of Transportation and Environmental Services
Lalit K. Sharma, PE	City of Alexandria Department Transportation and Environmental Services Office of Environmental Quality
Khoa D. Tran	City of Alexandria Department Transportation and Environmental Services Office of Environmental Quality
Erica Bannerman	City of Alexandria Department of Transportation and Environmental Services Office of Environmental Quality
Alem Y. Zewoldai	City of Alexandria Department of General Services
Edward Sabo	MACTEC Engineering and Consulting, Inc. (Consultant to the City)

Exhibit A-2

Sources of Data for Community Inventory

Sector	Contact/Organization	Data Provided
Stationary Energy	Jeff King MWCOG	Natural gas therm sales for 2005 from Washington Gas
Stationary Energy	Jeff King MWCOG	Electricity consumption for 2005 from Dominion Virginia Power
Mobile Source	Eulalie Gower-Lucas MWCOG	VMT by vehicle type and road type for 2002
Mobile Sources	Thomas Foster VA DEQ	Diesel fuel consumption by railroad locomotives in 2005
Mobile Sources	Jeff King MWCOG	Electricity consumption by WMATA for Metro trains
Wastewater Treatment	Paul Carbary ASA	Fuel (including methane) consumption at the ASA treatment plant; quantity of sludge disposed of by land application, landfilling, and incineration.
Solid Waste Disposal	Alton Weaver T&ES	Data on solid waste collection and disposal

Exhibit A-3

Sources of Data for City Government Operations Inventory

Sector	Contact/Organization	Data Provided
Buildings	Alem Zewoldai T&ES	Data on city owned and leased building square footage, electricity use, and natural gas consumption
Buildings	David Contact ACPS	Data on school building square footage, electricity use, and natural gas consumption
Vehicle Fleet	Erica Bannerman T&ES	Annual VMT and fuel use (Maintenance & Fuel Cost Billing Report)
Vehicle Fleet	Joe Saputa AFD	Annual VMT for Fire Department vehicles
Vehicle Fleet	David Rose ACPS	Annual VMT for Alexandria City school buses
Wastewater Treatment	Paul Carbary ASA	Fuel (including methane) consumption at the ASA treatment plant; quantity of sludge disposed of by land application, landfilling, and incineration
Employee Commute	Donna Norfleet T&ES	List of City employee residences; Data on number of employees enrolled in transportation benefits program.
Lighting	Bonnie Wine T&ES	Number of streetlights and electricity consumption
Lighting	Bob Garbacz T&ES	Number of traffic signals and electricity consumption
Solid Waste Disposal	Alton Weaver T&ES	Data on solid waste collection and disposal

APPENDIX B:

DATA FOR THE COMMUNITY INVENTORY

Exhibit B-1

Washington Gas – Natural Gas Therm Sales from Jan. 2005 – Dec. 2005

	Rate Schedule.				
County	**Commercial & Industrial**	**Group Metered Apts.**	**Interruptible**	**Residential**	**Grand Total**
District of Columbia	71,601,119	30,095,090	108,036,237	108,639,986	318,372,431
DC Total	**71,601,119**	**30,095,090**	**108,036,237**	**108,639,986**	**318,372,431**
Calvert	1,676,739	0	324,332	424,686	2,425,756
Charles	3,169,773	3,997	3,152	8,463,044	11,639,965
Montgomery	77,319,683	20,361,366	54,590,366	182,499,247	334,770,662
Prince Georges	73,899,868	31,497,089	37,042,364	132,061,682	274,501,004
Frederick	17,642,856	536,105	11,454,548	17,634,983	47,268,492
St. Mary's	5,147,078		312,087	1,175,857	6,635,022
MD Total	**178,855,997**	**52,398,557**	**103,726,849**	**342,259,499**	**677,240,901**
Arlington	20,108,690	8,042,857	18,724,137	31,945,234	78,820,918
Alexandria	13,760,044	7,180,855	6,273,868	18,743,462	45,958,229
City of Fairfax	4,551,650	754,292	3,325,261	4,191,220	12,822,423
Falls Church	1,836,527	645,615	83,875	2,524,957	5,090,975
Manassas	245,579	0	0	10,985	256,564
Manassas Park	111,154	0	0	1,178,429	1,289,583
Fairfax County	57,777,283	16,570,763	27,339,297	176,416,621	278,103,963
Loudoun	11,067,866	406,127	1,696,476	38,189,648	51,360,115
Prince William	12,702,616	2,276,491	1,782,678	45,598,834	62,360,619
Town of Leesburg	3,056,594	449,303	226,660	9,472,440	13,204,996
Town of Middleburg	78,574	0	0	15,557	94,132
Town of Occoquan	97,712	6,413	0	104,539	208,663
Town of Vienna	1,531,126	320,805	0	3,836,942	5,688,872
VA Total	**126,925,414**	**36,653,519**	**59,452,251**	**332,228,867**	**555,260,051**
Grand Total	**377,382,530**	**119,147,165**	**271,215,337**	**783,128,351**	**1,550,873,383**

Data provided by Jeff King, MWCOG, April 16, 2008

City of Alexandria

Therms	13,760,044	7,180,855	6,273,868	18,743,462	45,958,229
million cubic feet	1,349	704	615	1,837	4,505
million BTU	1,376,004	718,086	627,387	1,874,346	4,595,823

Apportionment of Alexandria Natural Gas Use to CACPS Categories

	50% Commercial 50% Industrial	All Residential	50% Commercial 50% Industrial	All Residential	
Residential (mmBtu)	-	718,086	-	1,874,346	2,592,432
Commercial (mmBtu)	688,002	-	313,693	-	1,001,696
Industrial (mmBtu)	688,002	-	313,693	-	1,001,696

Exhibit B-2

Electricity Consumption Calculations

Utility	Location	Residential	Commercial	Industrial/ Large Commercial	Government	Total
Pepco	Montgomery	3,824,038,626	4,337,300,574	127,359,789	1,443,210,386	9,731,909,375
Pepco	Prince Georges	2,481,379,778	2,408,531,112	26,098,877	1,179,009,677	4,919,415,629
Allegheny	Frederick	1,104,777,633	463,650,842	3,492,135,921		5,061,024,589
Allegheny	City of Frederick	297,663,138	387,185,162	97,085,972		786,503,442
Allegheny	Montgomery	378,953,049	170,635,073	62,919,720		612,507,842
						21,111,360,877
Dominion	Alexandria	397,699,466	1,050,770,919	26,276,156	273,199,209	1,747,945,750
Dominion	Arlington	621,495,580	1,762,946,199	790,200	712,127,350	3,097,359,329
Dominion	Fairfax City	91,202,212	209,616,936		27,065,620	327,884,768
Dominion	Fairfax	4,259,913,371	5,289,046,511	168,048,949	1,843,056,100	11,560,064,931
Dominion	Falls Church	43,139,115	78,210,788		4,368,785	125,718,688
Dominion	Loudoun	863,131,849	1,098,582,220	36,196,406	122,116,836	2,120,027,311
Dominion	Prince William	712,766,647	323,117,358	1,370,688	145,241,113	1,182,495,806
NOVEC	Prince William	1,000,400,575	645,173,020	118,664,108		1,764,237,703
NOVEC	Fairfax	388,128,298	158,664,633	41,634,677		588,427,608
NOVEC	Loudoun	232,420,614	77,875,656	12,154,569		322,450,839
NOVEC	Mannassas Park	45,644,137	25,102,181			70,746,318
						22,907,359,051
Pepco	DC	1,932,578,574	6,411,719,754		3,391,392,729	**11,735,691,057**
						55,754,410,985

Data provided by Jeff King, MWCOG, April 16, 2008

Apportionment of Alexandria Electricity Use to CACPS Categories

		All Residential	All Commercial	50% Comm. 50% Ind.	All Commercial	
Residential (kwh)		397,699,466	0	0	0	397,699,466
Commercial (kwh)		0	1,050,770,919	13,138,078	273,199,209	1,337,108,206
Industrial (kwh)		0	0	13,138,078	0	13,138,078

Exhibit B-3

"Top-Down" Residential Fuel Consumption Calculations

A	B	C	D	E	F	G
EIA Fuel Category	**CACPS Fuel Type**	**Virginia Residential Energy Use for 2005 (Million BTU)**	**Virginia Number of Households Using Fuel for Heating**	**Alexandria Number of Households Using Fuel for Heating**	**Scaling Factor**	**Alexandria Residential Energy Use for 2005 (Million BTU)**
Distillate Fuel	Light Fuel Oil	31,395,376	362,618	2,469	0.0068	213,765
Kerosene	Light Fuel Oil	8,083,621	362,618	2,469	0.0068	55,040
LPG	Propane	13,710,233	138,595	668	0.0048	66,081
Wood	Fuelwood	8,859,882	78,994	21	0.0003	2,355

1. Energy use for residential end-uses is presented in the State Energy Consumption, Price, and Expenditure Estimates (SEDS) for 2005 prepared by the U.S. DOE Energy Information Agency (EIA). Column A shows the EIA Fuel Category, while Column B shows the corresponding fuel category in CACPS.
2. Column C shows 2005 state totals for residential energy use in Virginia by fuel type.
3. State level consumption is allocated to Alexandria using the U.S. Census Bureau's 2000 Census Detailed Housing Information that provides the number of housing units using a specific type of fuel for residential heating. Column D has the statewide totals; Column E has the totals for the City of Alexandria.
4. Column F has the ratio of Number of households in Alexandria to the number of households in Virginia.
5. Alexandria Energy use for 2005 (Column G) is calculated by applying the scaling factor (Column F) to the statewide energy use (Column C)

Exhibit B-4

"Top-Down" Commercial Fuel Consumption Calculations

A	B	C	D	E	F	G
EIA Fuel Category	**CACPS Fuel Type**	**Virginia Commercial Energy Use for 2005 (Million BTU)**	**Virginia Commercial Employment (CBP Data)**	**Alexandria Commercial Employment (CBP Data)**	**Scaling Factor**	**Alexandria Commercial Energy Use for 2005 (Million BTU)**
Distillate Fuel	Light Fuel Oil	17,358,468	2,511,174	76,906	0.0306	531,612
Kerosene	Light Fuel Oil	1,150,266	2,511,174	76,906	0.0306	35,227
LPG	Propane	2,419,453	2,511,174	76,906	0.0306	74,097
Wood	Fuelwood	0	2,511,174	76,906	0.0306	0

1. Energy use for commercial end-uses is presented in the State Energy Consumption, Price, and Expenditure Estimates (SEDS) for 2005 prepared by the U.S. DOE Energy Information Agency (EIA). Column A shows the EIA Fuel Category, while Column B shows the corresponding fuel category in CACPS.

2. Column C shows 2005 state totals for commercial energy use in Virginia by fuel type.

3. State level consumption is allocated to Alexandria using the U.S. Census Bureau's 2005 County Business Patterns that provides employment for the commercial sector (NAICS codes 42, 44, 51, 52, 53, 54, 55, 56, 61, 62, 71, 72, and 81). Column D has the statewide total commercial/institutional employment and Column E has the total for the City of Alexandria.

4. Column F has the ratio of commercial employment in Alexandria to commercial employment in Virginia.

5. Alexandria Energy use for 2005 (Column G) is calculated by applying the scaling factor (Column F) to the statewide energy use (Column C)

Exhibit B-5

"Top-Down" Industrial Fuel Consumption Calculations

A	B	C	D	E	F	G
EIA Fuel Category	**CACPS Fuel Type**	**Virginia Industrial Energy Use for 2005 (Million BTU)**	**Virginia Industrial Employment (CBP Data)**	**Alexandria Industrial Employment (CBP Data)**	**Scaling Factor**	**Alexandria Industrial Energy Use for 2005 (Million BTU)**
Distillate Fuel	Light Fuel Oil	41,387,900	290,052	1,516	0.0052	216,320
Kerosene	Light Fuel Oil	379,176	290,052	1,516	0.0052	1,982
LPG	Propane	4,502,885	290,052	1,516	0.0052	23,535
Wood	Fuel wood	0	290,052	1,516	0.0052	0

1. Energy use for industrial end-uses is presented in the State Energy Consumption, Price, and Expenditure Estimates (SEDS) for 2005 prepared by the U.S. DOE Energy Information Agency (EIA). Column A shows the EIA Fuel Category, while Column B shows the corresponding fuel category in CACPS.

2. Column C shows 2005 state totals for industrial energy use in Virginia by fuel type.

3. State level consumption is allocated to Alexandria using the U.S. Census Bureau's 2005 County Business Patterns that provides employment for the industrial sector (NAICS code 33). Column D has the statewide total industrial employment and Column E has the total for the City of Alexandria.

4. Column F has the ratio of industrial employment in Alexandria to industrial employment in Virginia.

5. Alexandria Energy use for 2005 (Column G) is calculated by applying the scaling factor (Column F) to the statewide energy use (Column C).

Exhibit B-6

Federal Highway Administration Functional Road Classification System

Road Type	Description
Interstate	The interstate system consists of all presently designated routes of the Interstate System. In Alexandria, interstates include I-95, I-395, and I-495.
Principal Arterial	The urban principal arterial system serves the major centers of activity of a metropolitan area, the highest traffic volume corridors, and the longest trip desires; and should carry a high proportion of the total urban area travel on a minimum of mileage. In Alexandria, principal arterials include US Route 1 (Jefferson Davis Highway), VA Route 7 (King Street), and VA Route 236 (Duke Street).
Minor Arterial	The minor arterial street system includes all arterials not classified as a principal and contains facilities that place more emphasis on land access than the higher system, and offer a lower level of traffic mobility. Such facilities may carry local bus routes and provide intra-community continuity, but ideally should not penetrate identifiable neighborhoods.
Collector	The collector street system provides traffic circulation within residential neighborhoods, commercial and industrial areas. It differs from the arterial system in that facilities on the collector system may penetrate residential neighborhoods, distributing trips from the arterials through the area to the ultimate destination. The collector street also collects traffic from local streets in residential neighborhoods and channels it into the arterial system.
Local	The local street system comprises all facilities not on one of the higher systems. It serves primarily to provide direct access to abutting land and access to the higher order systems. It offers the lowest level of mobility and usually contains no bus routes. Service to through, traffic movement usually is deliberately discouraged.

Source: FHWA website: http://www.fhwa.dot.gov/planning/fcsec2_1.htm

Exhibit B-7

Crosswalk for Matching MOBILE6 Vehicle Types to CACPS Vehicle Types

MOBILE6 Vehicle Class		CACPS Vehicle Type	
LDGV	Light-Duty Vehicles (Passenger Cars) Gasoline	Subcompact/ Compact	51% of LDGV assigned to autos with 85 to 109 cubic feet of combined passenger and luggage volume.
		Mid-Size	27% of LDGV assigned to autos with 110 to 119 cubic feet of combined passenger and luggage volume.
		Full-Size	22% of LDGV VMT assign to autos with 120 or more cubic feet of passenger and cargo volume.
LDDV	Light-Duty Vehicles (Passenger Cars) Diesel	Subcompact/ Compact	51% of LDGV assigned to autos with 85 to 109 cubic feet of combined passenger and luggage volume.
		Full-Size	49% of LDGV VMT assign to autos with 120 or more cubic feet of passenger and cargo volume.
LDT1	Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)	Light Truck/ SUV/ Pickup	Sport Utility Vehicles (SUVs), pickup trucks and commercial delivery vans and trucks with a GVW up to 8,500 lbs.
LDT2	Light-Duty Trucks 2 (0-6,000 lbs. GVWR, 3,751-5,750 lbs. LVW)		
LDT3	Light-Duty Trucks 3 (6,001-8,500 lbs. GVWR, 0-5,750 lbs. ALVW*)		
LDT4	Light-Duty Trucks 4 (6,001-8,500 lbs. GVWR, 5,751 lbs. and greater ALVW)		
HDV2B	Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs. GVWR)	Heavy Truck	Trucks with a gross vehicle weight (GVW) over 8,500 lbs.
HDV3	Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs. GVWR)		
HDV4	Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs. GVWR)		
HDV5	Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs. GVWR)		
HDV6	Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs. GVWR)		
HDV7	Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs. GVWR)		
HDV8A	Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs. GVWR)		
HDV8B	Class 8b Heavy-Duty Vehicles (>60,000 lbs. GVWR)		

MOBILE6 Vehicle Class		CACPS Vehicle Type	
HDBS	School Buses	Transit Bus	40-foot or longer single body unit or articulated bus with a GVW of these vehicles is 40,000 lbs. and greater.
HDBT	Transit and Urban Buses		
MC	Motorcycles	Motorcycles	

GVWR – Gross vehicle weight rating
LVW – Loaded vehicle weight
ALVW – Alternate loaded vehicle weight

Functional classification is the process by which streets and highways are grouped in classes (systems) according the character of service provided.

- Arterials provide direct, relatively high speed service for longer trips and large traffic volumes. Mobility is emphasized, and access is limited.
- Collectors provide a bridge between arterials and local roads. Collectors link small towns to arterials as well as collect traffic from local roads.
- Local roads provide direct access to individual homes and farms.

Exhibit B-8

NONROAD Model Equipment Types

Sector	Equipment Type
Agricultural Equipment	2-Wheel Tractors Agricultural Mowers Balers Combines Irrigation Sets Other Agricultural Equipment Sprayers Swathers Tillers > 6 HP
Airport Ground Support Equipment	Airport Ground Support Equipment
Commercial Equipment	Air Compressors Gas Compressors Generator Sets Pressure Washers Pumps Welders
Construction and Mining Equipment	Bore/Drill Rigs Cement and Mortar Mixers Concrete/Industrial Saws Cranes Crawler Tractor/Dozers Crushing/Processing Equipment Dumpers/Tenders Excavators Graders Off-highway Tractors Off-highway Trucks Other Construction Equipment Pavers Paving Equipment Plate Compactors Rollers Rough Terrain Forklifts Rubber Tire Loaders Scrapers Signal Boards/Light Plants Skid Steer Loaders Surfacing Equipment Tampers/Rammers Tractors/Loaders/Backhoes Trenchers

Exhibit B-8 (continued)

Sector	Equipment Type
Pleasure Craft	Inboard/Sterndrive Outboard Personal Water Craft
Industrial Equipment	AC\Refrigeration Aerial Lifts Forklifts Other General Industrial Equipment Other Material Handling Equipment Other Oil Field Equipment Sweepers/Scrubbers Terminal Tractors
Lawn and Garden Equipment	Chain Saws < 6 HP (Commercial) Chain Saws < 6 HP (Residential) Chippers/Stump Grinders (Commercial) Front Mowers (Commercial) Lawn and Garden Tractors (Commercial) Lawn and Garden Tractors (Residential) Lawn Mowers (Commercial) Lawn Mowers (Residential) Leafblowers/Vacuums (Commercial) Leafblowers/Vacuums (Residential) Other Lawn and Garden Equipment (Commercial) Other Lawn and Garden Equipment (Residential) Rear Engine Riding Mowers (Commercial) Rear Engine Riding Mowers (Residential) Rotary Tillers < 6 HP (Commercial) Rotary Tillers < 6 HP (Residential) Shredders < 6 HP (Commercial) Snowblowers (Commercial) Snowblowers (Residential) Trimmers/Edgers/Brush Cutters (Commercial) Trimmers/Edgers/Brush Cutters (Residential) Turf Equipment (Commercial)
Logging Equipment	Chain Saws > 6 HP Forest Eqp - Feller/Bunch/Skidder Shredders > 6 HP
Railway Maintenance	Railway Maintenance
Recreational Equipment	All Terrain Vehicles Golf Carts Motorcycles: Offroad Snowmobiles Specialty Vehicles/Carts

Exhibit B-9

Types of Solid Waste Generated and Disposal Methods

Material Type	Disposal Method	Estimated Amount (Tons)	Reference
MSW residential (City collected)	Covanta Incinerator Recycled	27,131 35,540	T&ES, 2008a T&ES, 2008a
MSW multi-family and commercial (Privately collected)	Covanta Incinerator Landfill	108,968 26,763	T&ES, 2008a T&ES, 2008a
Construction and Demolition	Landfill	3,727	T&ES, 2004
Industrial Waste	Landfill	Small	T&ES, 2004
Regulated Medical Waste	Out-of-region processing	No data	T&ES, 2004
Vegetative and Yard Waste	Composted/Mulched	5,391	T&ES, 2008a
Covanta Incinerator Ash	Landfill	50,110	T&ES, 2004
Mirant Incinerator Ash	Brandywine MD Storage Facility	Unknown	http://potomac.mirant.com
ASA Sludge**	Land Application Landfill Incineration	3,500 (1,376) 7,040 (2,768 22,366 (8,793)	ASA, 2008
Tires	Recycled	1	T&ES, 2008a
White Goods (appliances such as stoves, washers, water heaters)	Recycled or Landfill	467	T&ES, 2004
Other (Used oil, oil filters, antifreeze, batteries, electronics)	Recycled	1,632	T&ES, 2008a

* 2005 data not available; 2003 data used instead.

** The ASA treatment plant provides sewage treatment for 350,000 people in a service area of 51 square miles, which includes the City of Alexandria and portions of Fairfax County. The amount of sludge generated by residents of the City of Alexandria was estimated by the ratio of the City's population to the total number of customers served by ASA (e.g., 137,600/350,000, or approximately 39%). The amount shown in parenthesis is the amount generated by the citizens of Alexandria.

Exhibit B-10

Factors Used to Estimate $PM_{2.5}$ Emissions

Fuel	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Ratio to Convert PM_{10} Emissions to $PM_{2.5}$ Emissions	Reference
Coal – Utility controlled with ESP	0.054 lbs/ton	0.024 lbs/ton	0.44	AP-42 Table 1.1-6
Fuel Oil - Industrial	1.00 lbs/10^3 gal	0.25 lbs/10^3 gal	0.25	AP-42 Table 1.3-6
Fuel Oil – Commercial	1.08 lbs/10^3 gal	0.83 lbs/10^3 gal	0.77	AP-42 Table 1.3-7
Fuel Oil - Residential	1.08 lbs/10^3 gal	0.83 lbs/10^3 gal	0.77	AP-42 Table 1.3-7
Natural Gas	7.6 lbs 10^6 scf	7.6 lbs 10^6 scf	1.00	AP-42 Table 1.4-2
Propane	0.2 lbs/10^3 gal	0.2 lbs/10^3 gal	1.00	Ap-42 Table 1.5-1
Wood	n/a	n/a	1.00	All PM assumed to be < 2.5 microns
Solid Waste	n/a	n/a	1.00	All PM assumed to be < 2.5 microns
Gasoline – Onroad Vehicles	0.0065 g/mile	0.0061 g/mile	0.94	MOBILE6 emission factor model
Gasoline - Offroad Engines	n/a	n/a	n/a	PM_{10} and $PM_{2.5}$ calculated directly by NMIM
Diesel – Onroad Vehicles	0.3177 g/mile	0.2924 g/mile	0.92	MOBILE6 emission factor model
Diesel – Offroad Engines	n/a	n/a	n/a	PM_{10} and $PM_{2.5}$ calculated directly by NMIM

References:

AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources; http://www.epa.gov/ttn/chief/ap42/index.html

EPA's National Inventory Model (NMIM), A Consolidated Emissions Modeling System for MOBILE6 and NONROAD, EPA-420-R-05-024, December 2005.

APPENDIX C:

DATA FOR GOVERNMENT OPERATIONS INVENTORY

Exhibit C-1

Energy Use by Buildings Owned by the City of Alexandria

	Facility Name	Facility Address	Square Footage	Annual Electricity Usage (kwh)	Electricity Cost	Annual Natural Gas Usage (therms)	Gas Cost
1	ALX 2300 Commonwealth Motor	400 COMMONWEALTH AVE		108	$64		
2	ALX 2300 Commonwealth Motor	2300 COMMONWEALTH AVE		105	$35		
3	ALX Ben Brenman Park	4800 Duke St	672	333,920	$22,758		
4	ALX Ben Brenman Park	4725 Duke St		3,198	$249		
5	AMPHITHEATER	4301 W BRADDOCK RD	2,400	53,581	$4,072		
6	ALX Animal Shelter new	4101 EISENHOWER AVE	13,362	394,320	$26,043		
7	ALX Apothecary Museum	105 S. FAIRFAX DR	1,100	44,362	$3,734		
8	ALX Armory Tot Lot	208 S ROYAL AVE		1,130	$92		
9	ALX Auburn Village	3505 COMMONWEALTH AVE	600	13,920	$1,066		
10	ALX Ball Field	4300 EISENHOWER AVE		67,920	$5,319		
11	ALX Ben Brenman Park	5000 CAMERON STATION		75,560	$5,892		
12	ALX Black History Museum	902 WYTHE ST/638 N Alfred st	3,690	65,566	$4,824		
13	ALX Charles Houston Rec Ctr	901 WYTHE ST	24,302	596,320	$39,962		
14	ALX Chart House/Doc matr& mari	1 CAMERON ST	164	12,965	$987		
15	ALX Chetworth Park	800 CHESTWORTH RD		254	$72		
16	ALX Chinquapin Recreation Cntr	3200 KING ST	37,000	1,305,908	$73,458	97,365	$136,594
17	ALX City Court House	520 KING ST	115,215	2,665,800	$151,953	26,405	$38,459
18	ALX City Hall	125 N ROYAL ST	87,100	2,068,500	$116,635	19,874	$29,050
19	ALX City Hall Annex	405 CAMERON	8,000	51,781	$3,948	2,612	$4,119
20	ALX City Maintenance Facility	3550 WHEELER AVE(133 quk)	36,500	637,404	$37,990	29,307	$42,164
21	ALX City Maintenance Facility/motor	3550 WHEELER AVE	2,284	20,465	$1,501		
22	ALX City Park King Street	2000 KING ST		306	$74	373	$779
23	ALX Colvin Apartments	3105 COLVIN ST	3,935	59,052	$4,557	3,048	$4,758
24	ALX Colvin Apartments	3105 COLVIN ST	3,935	32,199	$2,398		

	Facility Name	Facility Address	Square Footage	Annual Electricity Usage (kwh)	Electricity Cost	Annual Natural Gas Usage (therms)	Gas Cost
25	ALX Cora Kelly playground	3600 COMMONWEALTH AVE		30,252	$2,356		
26	ALX Cora Kelly Recreation center	25 W REED AVE	25,840	381,560	$27,056	7,451	$11,315
27	ALX Cora Kelly Recreation	3600 COMMONWEALTH AVE		8,463	$656		
28	ALX Del Ray Center	2708 MT VERNON AVE	18,900	22,383	$1,698	1,009	$1,739
29	ALX Durant Center	1605 CAMERON ST	16,575	27,680	$19,261	7,743	$11,616
30	ALX Ewald Pool	4500 DUKE ST	900	22,500	$1,639		
31	ALX Fire Dept HQ #204	900 2nd st	12,407	450,080	$30,783	8,932	$13,360
32	ALX Fire Station 201	317 PRINCE ST	3,300	55,545	$4,085	4,300	$6,629
33	ALX Fire Station 202	213 E WINDSOR AVE	4,920	103,940	$7,252	7,341	$11,155
34	ALX Fire Station 203	2801 CAMERON MILLS RD	3,588	91,710	$6,464	4,835	$7,376
35	ALX Fire Station 205	1210 CAMERON ST	7,854	121,359	$8,420	3,346	$5,226
36	ALX Fire Station 206	4609 SEMINARY RD	5,248	126,920	$8,878	5,294	$8,044
37	ALX Fire Station 207	3301 DUKE ST	8,103	120,120	$8,500	4,472	$6,868
38	ALX Fire Station 208	175 N PAXTON ST	11,800	292,000	$19,109	1,554	$2,454
39	ALX Former Animal Shelter	910 S PAYNE ST	4,594	22,624	$1,718	269	$600
40	ALX Former Health Dept	517 N St Asaph St	32,000	364,040	$22,716	13,407	$19,809
41	ALX Former MH Clubhouse	115 N PATRICK ST	5,545	16,938	$1,281	4,296	$6,638
42	ALX Founders Park	312 N UNION ST		20,219	$1,541		
43	ALX Four Mile Park	3901 MT VERNON ST		0	$66		
44	ALX Four Mile Park	3690 COMMONWEALTH AVE		15,014	$1,163		
45	ALX Friendship Firehouse	107 S ALFRED ST	2,288	26,970	$2,065	1,605	$2,634
46	ALX Ft Ward	4301 W BRADDOCK RD	4,753	12,573	$965		
47	ALX Gadsbys Tavern	134 N ROYAL AVE	25,315	755,225	$46,255	13,420	$19,771
48	Alex Gas Street light	100 Prince St				1,001	$1,676
49	ALX Grp Home 1105 Taylor	1105 E TAYLOR RUN PKWY	3,726	42,387	$3,222	1,818	$2,930
50	ALX Grp Home 1114 Howard	1114 N HOWARD ST	2,464	61,170	$4,644	448	$814
51	ALX Grp Home 1521 Dogwood	1521 DOGWOOD DR	1,792	22,127	$1,686	1,426	$2,355

	Facility Name	Facility Address	Square Footage	Annual Electricity Usage (kwh)	Electricity Cost	Annual Natural Gas Usage (therms)	Gas Cost
52	ALX Grp Home 1639 Kenwood	1639 KENWOOD AVE	1,246	14,142	$1,044		
53	ALX Grp Home 1758 Dogwood	1758 DOGWOOD DR	1,246	23,831	$1,783		
54	ALX Grp Home 211 Aspen	211 ASPEN ST	1,369	11,857	$908	744	$1,290
55	ALX Grp Home 213 Randolph	213 Randolph	4,280	32,423	$2,475	2,435	$3,946
56	ALX Grp Home 2802 Dartmouth	2802 Dartmouth	1,160	12,995	$988		
57	ALX Grp Home 3 Linden	3 W LINDEN ST	2,304	38,232	$2,917	2,372	$3,821
58	ALX Grp Home 4525 Peacock	4525 PEACOCK AVE	2,926	38,417	$2,855	1,488	$2,389
49	ALX Grp Home 4547 Seminary	4547 SEMINARY RD	2,295	31,315	$2,385	1,673	$2,752
60	ALX Grp Home 51 Skyhill	51 SKYHILL	1,190	10,035	$747		
61	ALX Grp Home 522 Windsor	522 WINDSOR AVE	1,471	27,902	$2,131	1,680	$2,794
62	ALX Grp Home 5911 Edsall	5911 EDSALL RD	1,169	6,307	$482		
63	ALX Grp Home 5911 Edsall	5911 EDSALL RD	1,018	4,996	$394		
64	ALX Grp Home 5911 Edsall	6230 EDSALL RD	1,006	16,684	$1,261		
65	ALX Grp Home 5911 Edsall	6240 Edsall Rd	1,002	18,316	$1,367		
66	ALX Grp Home 610 Notabene	610 NOTABENE AVE	650	16,287	$1,233	1,543	$2,476
67	ALX Grp Home 610 Notabene	610 NOTABENE AVE #101	650	3,761	$292		
68	ALX Grp Home 610 Notabene	610 NOTABENE AVE #102	650	3,417	$245		
69	ALX Grp Home 610 Notabene	610 NOTABENE AVE #201	650	4,696	$363		
70	ALX Grp Home 610 Notabene	610 NOTABENE AVE #202	650	4,471	$348		
71	ALX Grp Home 610 Notabene	610 NOTABENE AVE #204	650	3,104	$244		
72	ALX Grp Home 610 Notabene	610 NOTABENE AVE #302	650	5,874	$456		
73	ALX Grp Home 610 Notabene	610 NOTABENE AVE #303	650	3,578	$277		
74	ALX Grp Home 610 Notabene	610 NOTABENE AVE	650	5,988	$466		
75	ALX Grp Home 610 Notabene	610 NOTABENE AVE	650	3,924	$304		
76	ALX Grp Home 610 Notabene	610 NOTABENE AVE	650	3,212	$248		
77	ALX Grp Home 6230 Edsall	6230 EDSALL RD	1,036	16,379	$1,251		
78	ALX Grp Home 6240 Edsall	6240 EDSALL RD	1,036	18,078	$1,380		

	Facility Name	Facility Address	Square Footage	Annual Electricity Usage (kwh)	Electricity Cost	Annual Natural Gas Usage (therms)	Gas Cost
79	ALX Grp Home 716 Four Mile	716 FOR MILE RUN	1,056	6,613	$505	851	$1,458
80	ALX Grp Home 718 Four Mile	718 FOUR MILE RUN	1,056	6,389	$483	705	$1,226
81	ALX Grp Home 726 Fayette	726 FAYETTE	600	9,094	$703		
82	ALX Grp Home 726 Fayette	726 FAYETTE	600	12,133	$878		
83	ALX Grp Home 803 Howard	803 Howard St	1,028	17,075	$1,306		
84	ALX Grp Home 805 Howard	805 Howard St	1,028	18,599	$1,386		
85	ALX Health Dept Clubhouse NEW	4480 King St	67,416	1,853,250	$126,739	20,468	$30,195
86	ALX Hensley Park	4200 EISENHOWER AVE		8,336	$625		
87	ALX Herbert Street Facility	2 HERBERT ST	3,150	45,931	$3,388		
89	ALX Impound Lot	5249 EISENHOWER AVE	2,400	51,498	$3,932		
90	ALX Jefferson Davis Hwy Park	2401 JEFF DAVIS HWY		1,550	$141		
91	ALX Jones Point Lighthouse	50 JONES PT		0	$66		
92	ALX King St Garden and Fountain	1806 KING ST		727	$100		
93	ALX Landover Pathway	202 GLEBE RD W.		2,064	$159		
94	ALX Lee Center	1108 JEFFERSON ST	63,800	137,798	$93,933	23,998	$34,953
95	ALX Lee Center	1108 JEFFERSON ST		912	$98	1,024	$1,779
96	ALX Little League Field	1700 JEFF DAVIS HWY		6,696	$503		
97	ALX Lloyd House	220 N WASHINGTON ST	6,240	64,720	$4,541		
98	ALX Luckett Field	3300 DUKE ST		15,696	$1,196		
99	ALEX Lyceum	201 S WASHINGTON ST	9,460	254,200	$17,302		
100	ALX Market Square Garage	108 N FAIRFAX ST	89,700	484,704	$30,174		
101	ALX Marshall Lane Park	823 MARSHAL LN		8,144	$619		
102	ALX MH Community Shelter DTX	2355 MILL RD	24,650	398,640	$28,200	10,140	$15,021
103	ALX Minnie Howard Field	3801 W BRADDOCK RD		28,880	$2,092		
104	ALX Montgomery Tennis Courts	301 MONTGOMERY ST		10,016	$780		
105	ALX Mt Vernon Recreation Ctr					1,146	$1,938
106	ALX Mt Vernon Ave Field	1005 MT VERNON AVE		13,232	$1,003		

	Facility Name	Facility Address	Square Footage	Annual Electricity Usage (kwh)	Electricity Cost	Annual Natural Gas Usage (therms)	Gas Cost
107	ALX Multi Use Bldg 116 Quaker	116 S QUAKER LN (DASH)	33,150	847,477	$47,644	8,729	$13,055
108	ALX Multi Use Bldg 133 Quaker	133 Quaker Ln	30,690	302,752	$29,938	19,049	$28,132
109	ALX Office on Aging	718 N COLUMBUS ST	2,940	28,851	$2,138	1,762	$2,799
110	ALX Office on Women	311 E CUSTIS AVE	2,980	44,202	$3,283	2,178	$3,463
110	ALX Old Town Pool	1609 CAMERON ST	5,336	65,545	$4,486	275	$531
112	ALX Oronoco N Pitt Pkng Lot	500 ORONOC ST		1,661	$128		
113	ALX Oronoco Park Sprinkler Systm	100 MADISON ST		30	$66		
114	ALX Oronoco Park Lights	100 MADISON ST		12,716	$967		
115	ALX Oronoco Park Lights	1 ORONOCO ST		4,046	$308		
116	ALX Patrick Henry Rec Center	4643 TANEY AVE	8,850	124,656	$8,662	4,596	$6,913
117	ALX Patrick Henry Rec Center	4623 TANEY AVE		31,686	$2,399		
118	ALX Patrick St Parking Lot	111 S PATRICK ST		1,616	$137		
119	ALX Point Lumley	202 THE STRAND		2,267	$173		
120	ALX Police K9 Facility	1108 JEFFERSON ST		36,080	$2,549		
121	ALX Police Pistol Range	5261 EISENHOWER AVE	864	37,301	$2,823	602	$1,127
122	ALX Print Shop and Archives	801 PAYNE ST	34,759	389,680	$24,426	17,716	$25,117
123	ALX PTO Pedestrian Tunnel	300 TELEGRAPH RD		13,497	$1,019		
124	ALX Public Safety Center (POLICE)	2355 MILL RD	258,278	5,365,080	$274,994	168,244	$237,494
125	ALX Ramsay House Visitor Ctr	221 KING ST	1,946	26,171	$1,992	778	$1,368
126	ALX Ramsay Recreation Ctr	5650 SANGER AVE	18,000	557,080	$36,578	7,193	$10,832
127	ALX Ramsay Tennis Courts	SANGER/BEAULEGARD ST		2,154	$179		
128	ALX Recovery Home/mr/mh/sa	116 N GRAYSON ST	3,088	25,814	$1,965	1,825	$3,025
129	ALX Rivergate Pl Park Lights	815 RIVERGATE PL		12,114	$923		
130	ALX Roth Street Building	2908 BUSINESS CENTER DR	31,145	58,208	$4,286	2,190	$3,568
131	ALX Roth Street Building	2914 BUSINESS CENTER DR	9,584	17,737	$1,331	674	$1,098
132	ALX Roth Street Building	2914 BUSINESS CENTER DR	19,167	36,338	$2,693	1,348	$2,126
133	ALX RP and CA Maint Facility	3618 WHEELER AVE		5,351	$406		

	Facility Name	Facility Address	Square Footage	Annual Electricity Usage (kwh)	Electricity Cost	Annual Natural Gas Usage (therms)	Gas Cost
134	ALX Simpson Stadium	430 E MONROE AVE		39,000	$2,971		
135	ALX Soccer Field and Flower Bed	4000 MT VERNON AVE		8,646	$697		
136	ALX Soccer Field Eisenhower	4200 EISENHOWER AVE		14,256	$1,027		
137	ALX Tennis Courts Fayette St	200 Fayette st n		15,997	$1,209		
138	ALX The Lyceum	201 S WASHINGTON ST	9,460	254,500	$17,374		
139	ALX Torpedo Factory	105 N Union St	76,000	1,797,132	$116,302	19,930	$29,586
140	ALX Torpedo Factory Parking Grg	105 N Union St		166,680	$11,083		
141	ALX Torpedo Factory	10 THOMPSON ALY unit b		39,040	$2,963		
142	ALX Torpedo Factory garage	220 N UNION ST		119,418	$7,936		
143	ALX Transit Store	1775 DUKE ST		16,752	$1,227		
144	ALX Trash Compactor	102 N UNION ST		1,009	$90		
145	ALX Van Dorn Tunnel	400 N VAN DORN ST		1,610	$151		
146	ALX Virginia Ave City Shop	222 VIRGINIA AVE		2	$66		
147	ALX Warwick Pool	3301 LANDOVER ST	4,736	62,524	$4,306	51	$266
148	ALX Waterfront Park	100 S UNION ST		4,493	$351		
149	ALX Watson Reading Room	906 WYTHE ST	950	11,747	$885	174	$467
150	ALX Wheeler Ave Facility Salt Yrd	3608 WHEELER AVE		57,979	$4,197		
151	ALX Wheeler Ave Facility Fuel Isld	3550 WHEELER AVE	96	8,007	$583		
152	ALX Wilkes St Tunnel	300 WILKES st		4,320	$316		
153	ALX Wolfe St Park	2 WOLFE ST		7,963	$608		
154	ALX Wythe St Park	601 N FAIRFAX ST		2,342	$184		
155	Irrigation S Washington	1201 S. Washington St		0	$66		
		TOTAL	**1,399,278**	**26,239,088**	**$1,721,943**	**600,532**	**$875,937**

Exhibit C-2

Energy Use by Libraries Owned by the City of Alexandria

	Facility Name	Facility Address	Square Footage	Annual Electricity Usage (kwh)	Electricity Cost	Annual Natural Gas Usage (therms)	Gas Cost
1	BEATLEY	5005 DUKE ST	62,400	1,510,650	$104,860	30,665	$41,621
2	BARRETT	1115 MARTHA-CUSTIS AVE	9,800	532,512	$36,031	10,603	$15,210
3	BURKE	4701 SEMINARY RD	18,100	352,720	$25,020		
4	DUNCAN	2506 COMMONWEALTH AVE	9,060	204,760	$13,652	4,944	$7,090
		TOTAL	**99,360**	**2,600,642**	**$179,563**	**46,212**	**$63,921**

Exhibit C-3

Energy Use by Leased Facilities with the City as Tenant

	Facility Address	Use	Square Footage	Annual Electricity Usage (kwh)	Annual Natural Gas Usage (therms)
1	100 N. PITT ST. #301&307	OFFICE	8,803	205,990	2,025
2	2525 MT. VERNON AVE.	OFFICE	41,175	963,495	9,470
3	2 HERBERT ST.	OFFICE	3,150	73,710	725
4	421 KING ST., FL 2,3,4&5	OFFICE	18,424	431,122	4,238
5	110 N. ROYAL FL3/123 N. PITT FL2	OFFICE	32,504	760,594	7,476
6	132 N. ROYAL ST., FL 1&2	OFFICE	14,143	330,946	3,253
7	132 N. ROYAL ST., FL 2	STORAGE	195	4,563	45
8	720 N. ST. ASAPH ST.	OFFICE	24,552	574,517	5,647
9	3105 COLVIN ST.	OFFICE/TRAINING	7,871	184,181	1,810
10	220 N. WASHINGTON ST.	OFFICE	6,240	146,016	1,435
11	2900 EISENHOWER AVE.	OFFICE	15,000	351,000	3,450
12	POLICE/SPECIAL OPERATIONS	OFFICE	17,030	398,502	3,917
13	2034 EISENHOWER AVE.	OFFICE	29,888	699,379	6,874
14	1900 N. BEAUREGARD ST. #200	OFFICE	10,012	234,281	2,303
15	1900 N. BEAUREGARD ST. #300	OFFICE	13,281	310,775	3,055
16	309 HOOFFS RUN DRIVE	STORAGE	8,000	187,200	1,840
17	422 N. ARMISTEAD ST. #301	GROUP HOME	925	11,563	342
18	424 N. ARMISTEAD ST. #T-1	GROUP HOME	925	11,563	342
19	479 N. ARMISTEAD ST. #102	GROUP HOME	1,254	15,675	464
20	525 N. ARMISTEAD ST. #102	GROUP HOME	1,254	15,675	464
21	301 N. BEAUREGARD ST. #205	GROUP HOME	1,225	15,313	453
22	8 CANTURBURY SQ. #102	GROUP HOME	1,300	16,250	481
23	22 CANTURBURY SQ. #201	GROUP HOME	1,300	16,250	481
24	633 N. COLUMBUS ST.	GROUP HOME	2,500	31,250	925

	Facility Address	Use	Square Footage	Annual Electricity Usage (kwh)	Annual Natural Gas Usage (therms)
25	3305B COMMONWEALTH AVE.	GROUP HOME	800	10,000	296
26	1521 DOGWOOD DR.	GROUP HOME	1,792	0	
27	1758 DOGWOOD DR. #B	GROUP HOME	1,246	0	
28	5911 EDSALL RD. #111	GROUP HOME	1,169	0	
29	5911 EDSALL RD. #413	GROUP HOME	1,018	0	
30	6230 EDSALL RD. #101C	GROUP HOME	1,006	0	
31	6240 EDSALL RD. #402	GROUP HOME	1,004	0	
32	726 S. FAYETTE ST. #G1 & G2	GROUP HOME	1,322	0	
33	716 FOUR MILE RD.	GROUP HOME	1,056	0	
34	718 FOUR MILE RD.	GROUP HOME	1,056	0	
35	116 N. GRAYSON ST.	GROUP HOME	2,719	33,988	1,006
36	5300 HOLMES RUN PKWY. #516	GROUP HOME	1,362	17,025	504
37	803 N. HOWARD ST. #360	GROUP HOME	1,028	0	
38	805 N. HOWARD ST. #140	GROUP HOME	1,028	0	
39	1114 N. HOWARD ST.	GROUP HOME	2,464	0	
40	1639 KENWOOD AVE. UNIT B	GROUP HOME	1,246	0	
41	3 W. LINDEN ST.	GROUP HOME	2,304	0	
42	4525 PEACOCK AVE.	GROUP HOME	2,926	0	
43	213 E. RANDOLPH AVE.	GROUP HOME	4,280	0	
44	4547 SEMINARY RD.	GROUP HOME	2,295	0	
45	1105 E. TAYLOR RUN PKWY.	GROUP HOME	3,726	0	
46	5250 VALLEY FORGE DR. #607	GROUP HOME	1,323	16,538	490
47	2500 N. VAN DORN ST. #127	GROUP HOME	1,310	16,375	485
48	2500 N. VAN DORN ST. #328	GROUP HOME	1,310	16,375	485
49	4900 SEMINARY RD.	ANTENNA/EQUIPMENT	300	7,020	69
50	101 CALLAHAN DR.	ANTENNA/EQUIPMENT	300	7,020	69
51	3201 LANDOVER ST.	ANTENNA/EQUIPMENT	96	2,246	22

	Facility Address	Use	Square Footage	Annual Electricity Usage (kwh)	Annual Natural Gas Usage (therms)
52	211 YOAKUM PKWY	ANTENNA/EQUIPMENT	192	4,493	44
53	836 N. ALFRED ST.	RESIDENT OFFICER	n/a		
54	441 N. ARMISTEAD ST. #13	RESIDENT OFFICER	n/a		
55	5801 DUKE ST. #F-161	SATELLITE FACILITY	800	18,720	184
56	3620 EDISON ST. #201	SATELLITE FACILITY	n/a		
57	800 FRANKLIN ST.	SATELLITE FACILITY	n/a		
58	1025 W. GLEBE ROAD	SATELLITE FACILITY	n/a		
59	3671 JEFFERSON DAVIS HWY.	SATELLITE FACILITY	102	2,387	23
60	3410 KING ST.	SATELLITE FACILITY	n/a		
61	3113 MT. VERNON AVE.	SATELLITE FACILITY	n/a		
62	3823-A MT. VERNON AVE.	SATELLITE FACILITY	100	2,340	23
63	4949 SEMINARY RD.	SATELLITE FACILITY	n/a		
64	5442 BRADFORD CT. #A	SATELLITE FACILITY	800	18,720	184
65	551 JOHN CARLYLE ST.	SATELLITE FACILITY	800	18,720	184
66	2960 EISENHOWER AVE.	PARKING	parking		
67	3612 MT. VERNON AVE.	PARKING	7,500	175,500	1,725
68	717 QUEEN ST.	LIBRARY	25,000	585,000	5,750
69	1775-C DUKE ST.	RETAIL STORE	680	15,912	156
70	3301 LANDOVER ST.	RECREATION	34,927	817,292	8,033
71	3301 LANDOVER ST.	RECREATION	45,176	1,057,118	10,390
72	5920 STEVENSON AVE. (GROUND)	DETENTION CENTER	ground		
				8,832,597	**91,637**
	Highlighted in yellow are included Table C-1 since the City pays the utility costs for these leased spaces				
	Electricity and natural gas usage calculated based on average kwh/sq.ft. and therms/sq. ft. for City-owned office space, except for group homes which were based on average kwh/sq.ft. and therms/sq. ft. for group homes for which the City pays the utility bill.				

Exhibit C-4

Energy Use by Leased Facilities with the City as Landlord

	Facility Address	Use	Square Footage	Annual Electricity Usage (kwh)	Annual Natural Gas Usage (therms)
1	1200 N. HOWARD ST.	OFFICE	18,310	428,454	4,211
2	520 KING ST.	OFFICE	270	6,318	62
3	110 N. ROYAL ST. #300	OFFICE	2,200	51,480	506
4	116 S. QUAKER LANE	OFFICE/GARAGE	33,150	775,710	7,625
5	405 CAMERON ST.	RETAIL STORE	1,100	25,740	253
6	138 N. ROYAL ST.	RESTAURANT	4,896	114,566	1,126
7	520 KING ST.	ANTENNA/EQUIPMENT	378	8,845	87
8	N. UNION ST. (Air Rights)	AIR RIGHTS	45,000	1,053,000	10,350
9	5920 STEVENSON AVE.	DETENTION HOME	7,500	175,500	1,725
10	5301 EISENHOWER AVE.	FACILITY SITE	n/a		
11	EISENHOWER AVE. (LOTS 500&701)	ADDITIONAL SITE	36,876	862,898	8,481
12	100 CALLAHAN DR.	PARKING	1,200	28,080	276
13	105 N. UNION ST.	ART CENTER	47,450	1,110,330	10,914
14	4480 KING ST.	OFFICE	36,000	842,400	8,280
15	200 STRAND ST.	PARKING	11,562	270,551	2,659
16	0 PRINCE ST.	PIER & BUILDING	n/a		
17	4401 W. BRADDOCK RD.	ATHLETIC FIELD	5 acres		
18	1108 JEFFERSON ST.	PARKING	n/a		
19	401 SWANN AVE.	PARKING	20,967	490,628	4,822
20	25 W. REED ST.	CHILD CARE	n/a		
21	4001 EISENHOWER AVE.	PARK	26 acres		
22	2704 MT VERNON AVE.	ART ACTIVITIES	2,326	54,428	535
				6,298,929	**61,913**
	Electricity and natural gas usage calculated based on average kwh/sq.ft. and therms/sq. ft. for City-owned office space, except for group homes which were based on average kwh/sq.ft. and therms/sq. ft. for group homes for which the City pays the utility bill.				

Exhibit C-5

Energy Use by City School Buildings

Bldg #	School Building Name	Square Footage	Electricity Use (kWh)	Electricity Cost ($)	Nat. Gas Use (therms)	Nat. Gas Cost	Total Energy Use (KBTUs)	Total Energy Cost	Energy Use per Square Foot	Energy Cost Per Square Foot
1	George Washington	237,332	2,433,882	$179,880	63,855	$85,820	14,689,905	$265,700	61,896	$1.12
2	Mount Vernon	112,730	1,117,440	$79,809	24,939	$36,505	6,306,605	$116,314	55,944	$1.03
3	Patrick Henry	62,400	725,700	$60,187	28,188	$41,254	5,294,888	$101,441	84,854	$1.63
4	Maury	51,800	560,900	$40,245	19,303	$31,867	3,844,091	$72,112	74,210	$1.39
5	Lyles Crouch	65,645	582,160	$42,100	20,466	$33,234	4,032,930	$75,334	61,435	$1.15
6	Jefferson Houston	83,385	813,600	$58,876	15,177	$22,930	4,293,703	$81,806	51,493	$0.98
7	George Mason	50,935	642,300	$44,649	16,876	$27,915	3,879,128	$72,564	76,158	$1.42
8	Douglas MacArthur	63,120	836,544	$59,896	23,757	$34,889	5,229,988	$94,785	82,858	$1.50
9	Charles Barrett	62,760	833,440	$57,443	13,792	$20,549	4,222,897	$77,992	67,286	$1.24
10	Cora Kelly	69,000	724,500	$52,244	25,981	$38,090	5,070,094	$90,334	73,480	$1.31
11	Hammond	236,125	2,638,380	$189,794	98,121	$141,884	18,814,253	$331,678	79,679	$1.40
12	Ramsey	87,650	705,000	$51,234	16,486	$24,473	4,054,060	$75,707	46,253	$0.86
13	Rowing Facility	16,300	147,440	$10,528	Na.	Na.	503,065	$10,528	30,863	$0.65
14	TC Williams .	440,000	5,835,307	$402,566	66,338	$96,774	26,543,867	$499,340	60,327	$1.13
15	Polk	76,265	638,400	$45,990	16,120	$23,895	3,790,221	$69,885	49,698	$0.92
16	John Adams	137,350	940,608	$67,618	31,856	$46,522	6,394,954	$114,140	46,560	$0.83
17	Maintenance Facility	18,300	308,530	$22,021	11,061	$16,782	2,158,804	$38,803	117,967	$2.12
18	Tucker	80,180	1,144,500	$83,362	17,052	$23,632	5,610,234	$106,994	69,970	$1.33
19	Minnie Howard	130,435	1,462,700	$105,239	34,350	$50,240	8,425,732	$155,479	64,597	$1.19
20	Central Office (leased)	45,000	1,462,700	$105,239	34,350	$50,240	8,425,732	$155,479	187,238	$3.46
21	Stonewall Jackson (leased)	17,000	126,092	$9,221			430,226	$9,221	25,307	$0.54
	TOTAL	**2,143,712**	**24,680,123**	**$1,768,141**	**578,068**	**$847,495**	**142,015,380**	**$2,615,636**	**1,468,075**	**$27.22**

Exhibit C-6

City Vehicle Information – Fleet, School Bus, and Fire Department Vehicles

Group	Description	Quantity	Miles or Hours Driven	Fuel Quantity	Fuel Type	CACPS Category
12	Refuse Packer, Rear Load	13	73,180	46,538	Diesel	Heavy Truck
13	Refuse Packer, Side Load	1	96	3,221	Diesel	Heavy Truck
2	Trucks, Street/Sewer Cleaning	12	33,868	8,227	Diesel	Heavy Truck
4	Trucks, Dumps/Excavating	13	29,493	6,121	Diesel	Heavy Truck
5	Trucks, Special Purpose	2	1,891	314	Diesel	Heavy Truck
6	Trucks, General Purpose	22	63,002	19,833	Diesel	Heavy Truck
G	Loaders, Backhoes	14	2,277	5,312	Diesel	Heavy Truck
J	Tractors, Farm/Industrial	11	1,220	1,025	Diesel	Heavy Truck
P	Self-Propelled Sweepers	15	20,205	10,114	Diesel	Heavy Truck
	Heavy Truck Total	**103**	**225,232**	**100,705**		
8	Buses, 14,000+ LB	10	41,832	12,474	Diesel	Transit Bus
	Transit Bus Total	**10**	**41,832**	**12,474**		
C4	Vans Diesel	2	586	66	Diesel	Van
	Van Total	**2**	**586**	**66**		
A2	Sedan Small (4 Cyl)	48	263,353	13,398	Gasoline	Auto - Compact
AH	Sedan Small/Hybrid	13	55,262	1,299	Gasoline	Auto - Compact
K	Turf Equip, Riding Mowers	31	2,549	1,723	Gasoline	Auto - Compact
	Auto - Compact Total	**92**	**321,164**	**16,420**		
A4	Sedan Large (8 Cyl)	55	389,137	31,605	Gasoline	Auto - Full Size
A5	Sedan LG, Marked Cruisers (8 Cyl)	215	1,780,903	183,493	Gasoline	Auto - Full Size
A6	Sedan Mid-Size, Marked Cruiser	1	766	319	Gasoline	Auto - Full Size
A7	Sedan LG, Unmarked Cruisers	1	14,173	911	Gasoline	Auto - Full Size
CV	Ford Crown Vic	1	16,945	989	Gasoline	Auto - Full Size
	Auto - Full Size Total	**273**	**2,201,924**	**217,317**		
A3	Sedan Mid-Size (6 Cyl)	85	277,575	32,524	Gasoline	Auto - Mid Size
	Auto - Mid Size Total	**85**	**277,575**	**32,524**		
F	Trailers, All	49	382	1,078	Gasoline	Heavy Truck
	Heavy Truck Total	**49**	**382**	**1,078**		

Group	Description	Quantity	Miles or Hours Driven	Fuel Quantity	Fuel Type	CACPS Category
B1	Pickup/SUV 6 Cyl	84	410,251	36,819	Gasoline	Light Truck/SUV/Pickup
B2	Pickup/SUV 8 Cyl 1/2 ton	1	8,747	959	Gasoline	Light Truck/SUV/Pickup
B3	Pickup/SUV 8 Cyl 3/4 ton	31	225,358	27,769	Gasoline	Light Truck/SUV/Pickup
B4	Pickup/SUV 8 Cyl 1 & 1.5 ton	46	194,973	37,297	Gasoline	Light Truck/SUV/Pickup
BH	Sm Pickup/SUV Hybrid	5	29,143	2,309	Gasoline	Light Truck/SUV/Pickup
	Light Truck/SUV/Pickup Total	**167**	**868,472**	**105,153**		
E1	Motorcycles	14	45,006	62	Gasoline	Motorcycle
E2	3-Wheel PE Vehicles	4	15,254	1,165	Gasoline	Motorcycle
E4	Scooters, ATV's	10	2,219	544	Gasoline	Motorcycle
	Motorcycle Total	**28**	**62,479**	**1,772**		
C1	Vans 6 Cyl	7	28,611	4,922	Gasoline	Van
C2	Vans 8 Cyl	70	787,236	25,369	Gasoline	Van
C3	Vans 8 Cyl 3/4 ton	31	70,521	12,938	Gasoline	Van
	Van Total	**108**	**886,368**	**43,229**		
R	Compressors	6	150	39	n/a	n/a
L	Chippers/Shredders	4	39	0	n/a	n/a
N	Non-Self Propelled Equip	5	0	0	n/a	n/a
U	Welders/Generators	2	1	0	n/a	n/a
	n/a Total	**17**	**190**	**39**		
	Fleet Total	**934**	**4,886,204**	**530,777**		
School	School Buses	98	818,182	Unknown	Diesel	Transit Bus
	School Bus Total	**98**	**818,182**			
Fire Dept.	Service Body Truck	2	14,963	Unknown	Diesel	Heavy Truck
Fire Dept.	Pumper Engines	11	78,046	Unknown	Diesel	Heavy Truck
Fire Dept.	Specialty Units	8	13,704	Unknown	Diesel	Heavy Truck
Fire Dept.	Aerial Ladder Trucks	5	24,660	Unknown	Diesel	Heavy Truck
	Heavy Truck Total	**26**	**131,373**			
Fire Dept.	Ambulance	7	93,896	Unknown	Diesel	Light Truck/SUV/Pickup
	Light Truck/SUV/Pickup Total	**7**	**93,896**			
Fire Dept.	Cargo Van	1	4,880	Unknown	Diesel	Vanpool Van
Fire Dept.	Canteen Unit/Cargo Van	1	2,200	Unknown	Diesel	Vanpool Van
	Van Total	**2**	**7,080**	Unknown		

Group	Description	Quantity	Miles or Hours Driven	Fuel Quantity	Fuel Type	CACPS Category
Fire Dept.	Large Sedan	7	72,092	Unknown	Gasoline	Auto - Full Size
	Auto - Full Size Total	**7**	**72,092**			
Fire Dept.	Mid-Size Sedan	2	4,837	Unknown	Gasoline	Auto - Mid Size
	Auto - Mid Size Total	**2**	**4,837**			
Fire Dept.	Compact Sedan	4	15,346	Unknown	Gasoline	Auto - Compact
	Auto - Compact Total	**4**	**15,346**			
Fire Dept.	Flat Bed	1	2,897	Unknown	Gasoline	Heavy Truck
	Heavy Truck Total	**1**	**2,897**			
Fire Dept.	Compact SUV	27	162,483	Unknown	Gasoline	Light Truck/SUV/Pickup
Fire Dept.	Large Pickup	3	11,536	Unknown	Gasoline	Light Truck/SUV/Pickup
Fire Dept.	Large SUV	4	31,576	Unknown	Gasoline	Light Truck/SUV/Pickup
Fire Dept.	Mid-Size SUV	4	70,458	Unknown	Gasoline	Light Truck/SUV/Pickup
Fire Dept.	Small Pickup	2	5,969	Unknown	Gasoline	Light Truck/SUV/Pickup
Fire Dept.	Small SUV	25	186,624	Unknown	Gasoline	Light Truck/SUV/Pickup
	Light Truck/SUV/Pickup Total	**65**	**468,646**			
Fire Dept.	Passenger Van	1	2,076	Unknown	Gasoline	Vanpool Van
	Van Total	**1**	**2,076**			
	Fire Department Total	**115**	**798,243**			

Exhibit C-7

Daily Miles Traveled During Employee Commute by Zip Code

ZIP5	Post Office Name	State	Count	UTM EAST (meters)	UTM NORTH (meters)	UTM ZONE	Distance (miles)	Daily Miles Travelled
20001	WASHINGTON	DC	5	325145	4308731	0018	7.38	73.8
20002	WASHINGTON	DC	8	328123	4308264	0018	8.00	128.0
20003	WASHINGTON	DC	2	327429	4302944	0018	5.26	21.0
20004	WASHINGTON	DC	1	324856	4306547	0018	6.06	12.1
20005	WASHINGTON	DC	2	323824	4307865	0018	6.61	26.4
20007	WASHINGTON	DC	3	320045	4309123	0018	7.14	42.8
20008	WASHINGTON	DC	2	321422	4311405	0018	8.55	34.2
20009	WASHINGTON	DC	8	323164	4309577	0018	7.55	120.7
20010	WASHINGTON	DC	4	324016	4311069	0018	8.56	68.5
20011	WASHINGTON	DC	16	325148	4313234	0018	10.04	321.4
20012	WASHINGTON	DC	1	324471	4316333	0018	11.82	23.6
20015	WASHINGTON	DC	4	320592	4315187	0018	10.89	87.1
20016	WASHINGTON	DC	2	318757	4311805	0018	8.88	35.5
20017	WASHINGTON	DC	5	327256	4311614	0018	9.55	95.5
20018	WASHINGTON	DC	4	328538	4310723	0018	9.43	75.4
20019	WASHINGTON	DC	12	331793	4306335	0018	8.69	208.6
20020	WASHINGTON	DC	15	328916	4302603	0018	5.89	176.8
20024	WASHINGTON	DC	2	324503	4304797	0018	4.99	20.0
20032	WASHINGTON	DC	6	326600	4300340	0018	3.96	47.5
20036	WASHINGTON	DC	1	323093	4307512	0018	6.28	12.6
20037	WASHINGTON	DC	2	321260	4309589	0018	7.42	29.7
19734	TOWNSEND	DE	1	444367	4364548	0018	87.30	174.6
19968	MILTON	DE	1	471977	4282527	0018	94.39	188.8
20601	WALDORF	MD	12	337333	4274269	0018	17.79	427.0
20602	WALDORF	MD	11	333290	4264885	0018	21.79	479.4
20603	WALDORF	MD	14	320242	4265444	0018	20.02	560.6
20607	ACCOKEEK	MD	11	326138	4281413	0018	10.62	233.7
20613	BRANDYWINE	MD	9	341277	4280296	0018	16.67	300.1
20616	BRYANS ROAD	MD	5	318546	4278251	0018	12.14	121.4
20622	CHARLOTTE HALL	MD	3	346925	4260820	0018	28.06	168.3
20623	CHELTENHAM	MD	2	340044	4289942	0018	12.87	51.5
20625	COBB ISLAND	MD	1	338119	4236292	0018	39.62	79.2
20637	HUGHESVILLE	MD	1	344701	4264871	0018	25.21	50.4
20639	HUNTINGTOWN	MD	1	365187	4264377	0018	34.46	68.9
20640	INDIAN HEAD	MD	6	320875	4257966	0018	24.67	296.0
20646	LA PLATA	MD	8	324729	4264543	0018	20.72	331.5
20650	LEONARDTOWN	MD	2	355166	4237849	0018	42.86	171.4
20653	LEXINGTON PARK	MD	1	374769	4232404	0018	52.61	105.2
20657	LUSBY	MD	2	372697	4261356	0018	39.34	157.4
20658	MARBURY	MD	1	311827	4270325	0018	17.88	35.8
20659	MECHANICSVILLE	MD	4	359322	4237807	0018	44.22	353.8
20662	NANJEMOY	MD	1	308620	4255658	0018	27.18	54.4

ZIP5	Post Office Name	State	Count	UTM EAST (meters)	UTM NORTH (meters)	UTM ZONE	Distance (miles)	Daily Miles Travelled
20676	PORT REPUBLIC	MD	2	366546	4268887	0018	33.57	134.3
20677	PORT TOBACCO	MD	1	322309	4263578	0018	21.20	42.4
20678	PRINCE FREDERICK	MD	1	366722	4263457	0018	35.57	71.1
20695	WHITE PLAINS	MD	5	326674	4273784	0018	15.28	152.8
20705	BELTSVILLE	MD	2	336723	4323225	0018	18.71	74.8
20706	LANHAM	MD	2	339177	4313861	0018	15.21	60.8
20707	LAUREL	MD	1	337243	4328581	0018	21.75	43.5
20708	LAUREL	MD	3	341254	4323688	0018	20.56	123.4
20710	BLADENSBURG	MD	1	332996	4307358	0018	9.67	19.3
20711	LOTHIAN	MD	3	357081	4295908	0018	22.56	135.3
20712	MOUNT RAINIER	MD	5	329530	4312058	0018	10.45	104.5
20715	BOWIE	MD	5	348948	4316073	0018	20.89	208.9
20716	BOWIE	MD	3	351790	4309790	0018	20.67	124.0
20720	BOWIE	MD	6	344870	4316831	0018	19.11	229.3
20721	BOWIE	MD	11	345057	4309148	0018	16.66	366.6
20723	LAUREL	MD	2	338495	4333366	0018	24.75	99.0
20725	LAUREL	MD	1	337009	4299780	0018	10.14	20.3
20732	CHESAPEAKE BEACH	MD	2	367041	4269495	0018	33.63	134.5
20735	CLINTON	MD	27	333801	4289422	0018	9.55	515.9
20737	RIVERDALE	MD	3	333840	4314249	0018	13.10	78.6
20743	CAPITOL HEIGHTS	MD	21	335860	4306034	0018	10.69	449.2
20744	FORT WASHINGTON	MD	54	328169	4291485	0018	5.96	644.1
20745	OXON HILL	MD	23	330019	4297799	0018	5.72	262.9
20746	SUITLAND	MD	12	333974	4299997	0018	8.30	199.2
20747	DISTRICT HEIGHTS	MD	26	336351	4301767	0018	9.98	519.0
20748	TEMPLE HILLS	MD	40	331931	4298066	0018	6.91	552.6
20749	FORT WASHINGTON	MD	1	337009	4299780	0018	10.14	20.3
20750	OXON HILL	MD	1	337009	4299780	0018	10.14	20.3
20754	DUNKIRK	MD	2	360290	4273866	0018	28.64	114.5
20764	SHADY SIDE	MD	1	362318	4313978	0018	27.71	55.4
20770	GREENBELT	MD	5	337115	4317789	0018	16.09	160.9
20772	UPPER MARLBORO	MD	25	344929	4297678	0018	14.98	749.0
20774	UPPER MARLBORO	MD	23	342487	4303524	0018	13.95	641.5
20781	HYATTSVILLE	MD	1	332080	4311880	0018	11.27	22.5
20782	HYATTSVILLE	MD	4	329433	4308668	0018	8.68	69.5
20783	HYATTSVILLE	MD	2	329212	4318481	0018	13.95	55.8
20784	HYATTSVILLE	MD	3	335714	4312883	0018	13.23	79.4
20785	HYATTSVILLE	MD	8	337404	4309610	0018	12.70	203.2
20794	JESSUP	MD	1	343315	4335366	0018	27.28	54.6
20814	BETHESDA	MD	3	317747	4319169	0018	13.50	81.0
20815	CHEVY CHASE	MD	1	319883	4316838	0018	11.93	23.9
20817	BETHESDA	MD	1	313450	4317635	0018	13.23	26.5
20841	BOYDS	MD	1	298846	4339651	0018	29.45	58.9
20850	ROCKVILLE	MD	3	311093	4328765	0018	20.25	121.5
20851	ROCKVILLE	MD	2	316109	4327351	0018	18.68	74.7

ZIP5	Post Office Name	State	Count	UTM EAST (meters)	UTM NORTH (meters)	UTM ZONE	Distance (miles)	Daily Miles Travelled
20852	ROCKVILLE	MD	1	316451	4324505	0018	16.90	33.8
20860	SANDY SPRING	MD	1	323287	4334373	0018	22.86	45.7
20866	BURTONSVILLE	MD	1	332611	4330066	0018	21.43	42.9
20872	DAMASCUS	MD	1	308934	4350597	0018	33.71	67.4
20874	GERMANTOWN	MD	1	302740	4334092	0018	25.27	50.5
20878	GAITHERSBURG	MD	4	309875	4329072	0018	20.67	165.3
20879	GAITHERSBURG	MD	2	311197	4338048	0018	25.80	103.2
20901	SILVER SPRING	MD	4	325956	4322531	0018	15.78	126.2
20902	SILVER SPRING	MD	2	323055	4322996	0018	15.80	63.2
20903	SILVER SPRING	MD	3	328526	4320130	0018	14.76	88.6
20904	SILVER SPRING	MD	2	327232	4325895	0018	17.99	72.0
20905	SILVER SPRING	MD	1	326580	4331215	0018	21.15	42.3
20910	SILVER SPRING	MD	2	324238	4318867	0018	13.35	53.4
20912	TAKOMA PARK	MD	5	326256	4316509	0018	12.19	121.9
20914	SILVER SPRING	MD	1	309222	4334857	0018	24.21	48.4
21015	BEL AIR	MD	1	388425	4378595	0018	65.53	131.1
21044	COLUMBIA	MD	1	336999	4341139	0018	28.82	57.6
21046	COLUMBIA	MD	1	341487	4337623	0018	27.95	55.9
21054	GAMBRILLS	MD	1	358848	4323198	0018	28.46	56.9
21061	GLEN BURNIE	MD	1	360036	4314265	0018	26.46	52.9
21075	ELKRIDGE	MD	1	348632	4340874	0018	31.93	63.9
21113	ODENTON	MD	5	362529	4315023	0018	28.07	280.7
21114	CROFTON	MD	1	359625	4324973	0018	29.48	59.0
21144	SEVERN	MD	1	359417	4316034	0018	26.56	53.1
21146	SEVERNA PARK	MD	1	361038	4312366	0018	26.61	53.2
21203	BALTIMORE	MD	1	360230	4349416	0018	40.42	80.8
21206	BALTIMORE	MD	1	366128	4355111	0018	45.46	90.9
21223	BALTIMORE	MD	1	357656	4348877	0018	39.20	78.4
21228	CATONSVILLE	MD	1	359298	4348261	0018	39.50	79.0
21229	BALTIMORE	MD	3	357455	4349683	0018	39.53	237.2
21401	ANNAPOLIS	MD	2	360491	4314164	0018	26.70	106.8
21701	FREDERICK	MD	1	296322	4376154	0018	51.09	102.2
21702	FREDERICK	MD	6	288355	4374115	0018	51.61	619.3
21703	FREDERICK	MD	2	287753	4359938	0018	43.81	175.3
21740	HAGERSTOWN	MD	2	268106	4385404	0018	63.60	254.4
21755	JEFFERSON	MD	3	278790	4358953	0018	46.18	277.1
21769	MIDDLETOWN	MD	1	286431	4378889	0018	54.81	109.6
21771	MOUNT AIRY	MD	1	309361	4364098	0018	41.89	83.8
21783	SMITHSBURG	MD	2	275463	4385464	0018	61.41	245.6
21784	SYKESVILLE	MD	1	330529	4369098	0018	44.80	89.6
21793	WALKERSVILLE	MD	1	298457	4373691	0018	49.24	98.5
17055	MECHANICSBURG	PA	1	314632	4449891	0018	94.67	189.3
17201	CHAMBERSBURG	PA	3	272072	4420746	0018	82.26	493.6
17244	ORRSTOWN	PA	1	271528	4439806	0018	93.48	187.0
17252	SAINT THOMAS	PA	1	259656	4422023	0018	86.12	172.2

ZIP5	Post Office Name	State	Count	UTM EAST (meters)	UTM NORTH (meters)	UTM ZONE	Distance (miles)	Daily Miles Travelled
17257	SHIPPENSBURG	PA	3	290239	4438308	0018	89.44	536.6
17268	WAYNESBORO	PA	1	278044	4407856	0018	73.45	146.9
17340	LITTLESTOWN	PA	1	320692	4410749	0018	70.27	140.5
17602	LANCASTER	PA	2	393326	4428758	0018	93.09	372.3
20105	ALDIE	VA	2	274369	4315108	0018	30.83	123.3
20106	AMISSVILLE	VA	1	237567	4285843	0018	52.25	104.5
20109	MANASSAS	VA	9	283384	4293258	0018	23.42	421.6
20110	MANASSAS	VA	8	283800	4291673	0018	23.30	372.9
20111	MANASSAS	VA	12	287196	4293988	0018	21.02	504.4
20112	MANASSAS	VA	19	287196	4293988	0018	21.02	798.7
20115	MARSHALL	VA	2	249063	4302848	0018	44.71	178.8
20120	CENTREVILLE	VA	17	285897	4302230	0018	21.89	744.1
20121	CENTREVILLE	VA	13	286786	4299398	0018	21.18	550.6
20124	CLIFTON	VA	3	293093	4295066	0018	17.31	103.8
20136	BRISTOW	VA	7	278563	4290151	0018	26.67	373.4
20144	DELAPLANE	VA	1	242688	4310923	0018	49.24	98.5
20147	ASHBURN	VA	11	285297	4323627	0018	27.34	601.5
20148	ASHBURN	VA	1	281090	4321182	0018	28.69	57.4
20151	CHANTILLY	VA	3	287878	4306835	0018	21.25	127.5
20152	CHANTILLY	VA	9	282393	4308187	0018	24.76	445.6
20155	GAINESVILLE	VA	5	272375	4299398	0018	30.12	301.2
20164	STERLING	VA	6	292277	4321867	0018	23.26	279.1
20165	STERLING	VA	1	293454	4324520	0018	23.83	47.7
20166	STERLING	VA	4	285850	4317411	0018	24.96	199.6
20169	HAYMARKET	VA	4	270563	4305189	0018	31.58	252.6
20170	HERNDON	VA	1	294930	4317447	0018	20.25	40.5
20171	HERNDON	VA	7	292569	4310999	0018	19.41	271.8
20175	LEESBURG	VA	2	274516	4324454	0018	33.24	133.0
20176	LEESBURG	VA	6	274931	4333082	0018	36.02	432.3
20186	WARRENTON	VA	1	253319	4285957	0018	42.57	85.1
20187	WARRENTON	VA	1	261620	4288543	0018	37.22	74.4
20190	RESTON	VA	3	297104	4314892	0018	18.22	109.3
20191	RESTON	VA	1	296056	4311649	0018	17.67	35.3
20194	RESTON	VA	3	297135	4317051	0018	19.02	114.1
20195	RESTON	VA	1	301317	4300409	0018	12.24	24.5
22003	ANNANDALE	VA	44	307935	4300678	0018	8.22	723.7
22015	BURKE	VA	33	301430	4295285	0018	12.14	801.2
22026	DUMFRIES	VA	47	295307	4273106	0018	22.00	2068.4
22027	DUNN LORING	VA	1	307347	4307263	0018	10.28	20.6
22030	FAIRFAX	VA	12	299978	4302818	0018	13.34	320.2
22031	FAIRFAX	VA	13	301787	4302834	0018	12.26	318.7
22032	FAIRFAX	VA	15	301427	4299049	0018	12.08	362.5
22033	FAIRFAX	VA	4	293641	4305881	0018	17.64	141.2
22039	FAIRFAX STATION	VA	6	299136	4292413	0018	13.86	166.4
22041	FALLS CHURCH	VA	16	313880	4302140	0018	5.13	164.3

ZIP5	Post Office Name	State	Count	UTM EAST (meters)	UTM NORTH (meters)	UTM ZONE	Distance (miles)	Daily Miles Travelled
22042	FALLS CHURCH	VA	17	309648	4303690	0018	7.89	268.2
22043	FALLS CHURCH	VA	3	310129	4307689	0018	9.11	54.7
22044	FALLS CHURCH	VA	3	313035	4303116	0018	5.91	35.4
22046	FALLS CHURCH	VA	6	311416	4306054	0018	7.83	94.0
22060	FORT BELVOIR	VA	4	311521	4287112	0018	8.74	69.9
22066	GREAT FALLS	VA	2	300274	4319284	0018	18.53	74.1
22079	LORTON	VA	51	308299	4284783	0018	11.16	1138.5
22101	MC LEAN	VA	5	310466	4311660	0018	10.82	108.2
22102	MC LEAN	VA	2	306806	4313723	0018	13.25	53.0
22124	OAKTON	VA	5	297920	4307251	0018	15.43	154.3
22125	OCCOQUAN	VA	1	303364	4283670	0018	13.90	27.8
22150	SPRINGFIELD	VA	26	310057	4292576	0018	7.40	384.7
22151	SPRINGFIELD	VA	12	307942	4297007	0018	8.01	192.3
22152	SPRINGFIELD	VA	32	305938	4294033	0018	9.52	609.2
22153	SPRINGFIELD	VA	35	310426	4291858	0018	7.40	517.9
22172	TRIANGLE	VA	3	293797	4272775	0018	22.83	137.0
22180	VIENNA	VA	9	304534	4307578	0018	11.85	213.3
22181	VIENNA	VA	5	300967	4308562	0018	14.07	140.7
22182	VIENNA	VA	5	303410	4311832	0018	13.95	139.5
22191	WOODBRIDGE	VA	75	302243	4277466	0018	17.05	2557.7
22192	WOODBRIDGE	VA	60	298491	4283143	0018	16.55	1986.1
22193	WOODBRIDGE	VA	92	295911	4279662	0018	19.10	3513.8
22194	WOODBRIDGE	VA	1	285529	4288603	0018	22.64	45.3
22195	WOODBRIDGE	VA	2	285529	4288603	0018	22.64	90.6
22199	LORTON	VA	1	301317	4300409	0018	12.24	24.5
22201	ARLINGTON	VA	12	317924	4305963	0018	5.46	131.1
22202	ARLINGTON	VA	15	321267	4302433	0018	2.98	89.3
22203	ARLINGTON	VA	14	316137	4304802	0018	5.31	148.6
22204	ARLINGTON	VA	39	317714	4303161	0018	3.92	306.1
22205	ARLINGTON	VA	13	314356	4304967	0018	6.06	157.6
22206	ARLINGTON	VA	31	318700	4300918	0018	2.41	149.7
22207	ARLINGTON	VA	12	315980	4308445	0018	7.34	176.3
22209	ARLINGTON	VA	3	316980	4306880	0018	6.21	37.2
22213	ARLINGTON	VA	2	312430	4307140	0018	7.87	31.5
22219	ARLINGTON	VA	1	316707	4305467	0018	5.48	11.0
22301	ALEXANDRIA	VA	108	319452	4298988	0018	1.18	255.9
22302	ALEXANDRIA	VA	75	318620	4299501	0018	1.78	267.4
22303	ALEXANDRIA	VA	43	319227	4295446	0018	1.70	145.9
22304	ALEXANDRIA	VA	253	316804	4298185	0018	2.52	1274.0
22305	ALEXANDRIA	VA	88	320858	4300314	0018	1.65	290.1
22306	ALEXANDRIA	VA	79	318639	4291882	0018	3.84	606.6
22307	ALEXANDRIA	VA	29	320529	4293227	0018	2.76	160.2
22308	ALEXANDRIA	VA	28	320912	4288808	0018	5.50	308.1
22309	ALEXANDRIA	VA	97	311180	4287984	0018	8.49	1646.8
22310	ALEXANDRIA	VA	61	315891	4294228	0018	3.73	455.5

ZIP5	Post Office Name	State	Count	UTM EAST (meters)	UTM NORTH (meters)	UTM ZONE	Distance (miles)	Daily Miles Travelled
22311	ALEXANDRIA	VA	52	316005	4300147	0018	3.37	350.3
22312	ALEXANDRIA	VA	74	313266	4296571	0018	4.74	702.1
22313	ALEXANDRIA	VA	3	318542	4298207	0018	1.46	8.7
22314	ALEXANDRIA	VA	166	320822	4297662	0018	0.00	0.0
22315	ALEXANDRIA	VA	66	313305	4292067	0018	5.82	768.6
22401	FREDERICKSBURG	VA	2	282801	4241259	0018	42.27	169.1
22405	FREDERICKSBURG	VA	17	287028	4245743	0018	38.49	1308.8
22406	FREDERICKSBURG	VA	12	278694	4254636	0018	37.42	898.0
22407	FREDERICKSBURG	VA	15	271965	4238996	0018	47.44	1423.2
22408	FREDERICKSBURG	VA	7	275688	4234666	0018	48.15	674.1
22443	COLONIAL BEACH	VA	2	340284	4227707	0018	45.12	180.5
22460	FARNHAM	VA	1	359385	4193470	0018	69.03	138.1
22463	GARRISONVILLE	VA	1	285282	4260443	0018	31.98	64.0
22473	HEATHSVILLE	VA	1	374478	4192886	0018	73.14	146.3
22485	KING GEORGE	VA	6	309989	4238600	0018	37.31	447.7
22501	LADYSMITH	VA	1	275336	4210457	0018	61.11	122.2
22508	LOCUST GROVE	VA	2	255511	4243519	0018	52.71	210.9
22520	MONTROSS	VA	1	340052	4219602	0018	49.95	99.9
22542	RHOADESVILLE	VA	1	246588	4242005	0018	57.65	115.3
22546	RUTHER GLEN	VA	1	285799	4202711	0018	62.89	125.8
22553	SPOTSYLVANIA	VA	11	263559	4229333	0018	55.40	1218.7
22554	STAFFORD	VA	73	287450	4257115	0018	32.63	4764.1
22565	THORNBURG	VA	1	279238	4223832	0018	52.65	105.3
22567	UNIONVILLE	VA	1	244641	4236573	0018	60.68	121.4
22572	WARSAW	VA	1	344842	4203691	0018	60.27	120.5
22580	WOODFORD	VA	3	288129	4222793	0018	50.76	304.6
22601	WINCHESTER	VA	1	744615	4339222	0017	82.54	165.1
22602	WINCHESTER	VA	2	736016	4336767	0017	94.37	377.5
22630	FRONT ROYAL	VA	4	744944	4312413	0017	72.89	583.1
22642	LINDEN	VA	3	234311	4313546	0018	54.65	327.9
22643	MARKHAM	VA	1	239426	4309271	0018	51.09	102.2
22645	MIDDLETOWN	VA	1	734935	4325502	0017	83.46	166.9
22655	STEPHENS CITY	VA	3	737940	4338307	0017	88.32	529.9
22664	WOODSTOCK	VA	1	715663	4310510	0017	94.61	189.2
22701	CULPEPER	VA	1	239045	4266627	0018	54.35	108.7
22720	GOLDVEIN	VA	1	269492	4261343	0018	39.07	78.1
22728	MIDLAND	VA	2	266520	4275870	0018	36.36	145.4
22734	REMINGTON	VA	1	255607	4268234	0018	44.46	88.9
22738	ROCHELLE	VA	1	735677	4244708	0017	99.37	198.7
22801	HARRISONBURG	VA	1	685314	4254652	0017	135.44	270.9
22922	ARRINGTON	VA	1	680925	4173228	0017	156.6	313.2
22939	FISHERSVILLE	VA	1	675987	4218206	0017	162.82	325.6
22960	ORANGE	VA	2	233321	4234314	0018	67.12	268.5
22974	TROY	VA	2	739273	4204208	0017	108.49	434.0
23113	MIDLOTHIAN	VA	1	264569	4152914	0018	96.50	193.0

ZIP5	Post Office Name	State	Count	UTM EAST (meters)	UTM NORTH (meters)	UTM ZONE	Distance (miles)	Daily Miles Travelled
23225	RICHMOND	VA	1	278985	4155233	0018	92.24	184.5
23234	RICHMOND	VA	1	280684	4146057	0018	97.45	194.9
23323	CHESAPEAKE	VA	1	380316	4063429	0018	150.17	300.3
23803	PETERSBURG	VA	1	288006	4121440	0018	111.38	222.8
25414	CHARLES TOWN	WV	5	253394	4355272	0018	55.11	551.1
25425	HARPERS FERRY	WV	1	259506	4355205	0018	52.25	104.5
25438	RANSON	WV	1	255723	4349242	0018	51.61	103.2
26505	MORGANTOWN	WV	1	588637	4384742	0017	219.34	438.7
26714	DELRAY	WV	1	701790	4354044	0017	128.5	257.0
26836	MOOREFIELD	WV	1	688687	4320894	0017	131.96	263.9
26847	PETERSBURG	WV	1	662030	4317216	0017	144.36	288.7
			3,020					**75,765**

Methodology:

1. Get home addresses of City Employees from Human Resources
2. Sort by Zip Code
3. Get location of zip code centroid from US Census Bureau
   http://www.census.gov/geo/www/tiger/zip1999.html
4. Calculate distance from zip code to city hall
   City Hall UTMs 320822 East, 4297662 North
   ZIP 22314
5. Estimate distance for zip codes not in UTM zone 18 (Google Maps)
6. Calculate Daily Miles Travelled = # of employees x distance x 2 trip/day

Exhibit C-8

Methodology to Calculate Annual Vehicle Miles Traveled During Employee Commutes

1 Calculate Raw Annual VMT

3,020	Number of City Employees
75,765	Average Daily Travel (miles/day) from Exhibit C-7
5	Days per week worked
50	Weeks per year worked
250	Days per year worked
18,941,270	Vehicle Miles Travelled (miles/year)

2 Adjust for Employees not Driving to Work

# of Employees	Transportation Benefit Program
145	Smart Benefit (Metrorail or commuter buses)
63	DASH
70	Metrobus
55	Metrochek (VRE Riders)
333	**Subtotal**
11.0	% of employees in Benefit Program; assumed not to drive to work
16,852,712	Reduce VMT by % of employees in Benefits Program

3 Get VMT Fractions for COG Ozone SIP Appendix E1

App E1 - Mob6.2.03 Inventories and Documentation 5.23.07.pdf
Attachment C Mobile6 Input Paramaters
Table D-15 Summer VMT Mix Fractions for Auto Access (Alexandria)

Fraction	VMT	Mobile6 Vehicle Ty	
0.4025	6,783,217	LDV	1 LDV Light-Duty Vehicles (Passenger Cars)
0.0877	1,477,983	LDT1	2 LDT1 Light-Duty Trucks 1
0.3352	5,649,029	LDT2	3 LDT2 Light-Duty Trucks 2
0.1152	1,941,432	LDT3	4 LDT3 Light-Duty Trucks 3
0.0543	915,102	LDT4	5 LDT4 Light-Duty Trucks 4
0	0	HDV	6 – 15 Heavy-Duty Trucks and Buses
0.005	84,264	MC	16 MC Motorcycles (All)
1.000	**16,851,027**		

4 Match CACPS Vehicle Categories to Mobile6 vehicle categories

VMT	CACPS	Mobile6 Categories
1,492,308	Auto Full Size	22% of LDV per Section 2.2.1
1,831,469	Auto Mid Size	27% of LDV per Section 2.2.1
3,459,441	Auto Subcompact/Compact	51% of LDV per Section 2.2.1
0	Heavy Truck	All heavy duty
9,983,547	Light Truck/SUV	LDT1, LDT2, LDT3, LDT4
84,264	Motorcycle	MC
0	Passenger Vehicle	
0	Vanpool Van	
16,851,027		

ECO-CITY ALEXANDRIA

10 THINGS YOU CAN DO TO CLEAN THE AIR

1) When buying your next vehicle, consider choosing efficient, low-polluting models

2) Drive less, especially during peak traffic periods or hot days

3) Use public transportation, walk, ride a bike, or consider carpooling to work one day a week or more

4) Combine shopping errands into one trip

5) Recycle paper, plastic, glass bottles, cardboard, and aluminum cans

6) Conserve energy - and save money – by using compact fluorescent light bulbs and buying energy-efficient appliances when you replace old ones

7) Purchase an electric mower when you replace your gasoline-powered model, or use a rake instead of a gasoline-powered blower

8) Purchase "Green Power" for your home's electricity

9) When painting or cleaning homes, choose products that contain little or no smog-forming pollutants identified as volatile organic compounds or VOCs

10) Plant deciduous trees around your home to provide shade in the summer and allow sunlight in the winter

LEARN MORE ABOUT WHAT YOU CAN DO AT:

http://alexandriava.gov/Environment
Office of Environmental Quality
Department of Transportation and Environmental Services