Greenhouse Gas and Criteria Air Pollutant Emissions Inventory

April 2009
(Revised October 2010)

Office of Environmental Quality
Department of Transportation and Environmental Services
Greenhouse Gas and Criteria Air Pollutant Emissions Inventory

April 2009 (Revised October 2010)

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Errata Statement, October 2010. After publication of this document in April 2009, it was discovered that an incorrect vehicle mix distribution was used to allocate City-wide vehicle miles travelled (VMT) to vehicle type, i.e., passenger cars, light duty trucks, heavy duty trucks. The corrected vehicle mix distribution was provided by MWCOG and assigns much more of the VMT to passenger cars/trucks and less VMT to heavy duty diesel trucks. As a result of this correction, the greenhouse gas emissions calculated for onroad vehicles in Section 3.2.1 are significantly lower than previously estimated. Section 3.2.1 has been updated to use the corrected vehicle mix distribution. All relevant summary tables/charts have also been corrected. No other substantive changes to this report have been made.
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<th>Definition</th>
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<tbody>
<tr>
<td>AEO</td>
<td>Annual Energy Outlook</td>
</tr>
<tr>
<td>ASA</td>
<td>Alexandria Sanitation Authority</td>
</tr>
<tr>
<td>BAU</td>
<td>Business-as-Usual</td>
</tr>
<tr>
<td>BTU</td>
<td>British Thermal Unit</td>
</tr>
<tr>
<td>CACPS</td>
<td>Clean Air and Climate Protection Software</td>
</tr>
<tr>
<td>CAP</td>
<td>Criteria Air Pollutant</td>
</tr>
<tr>
<td>CNG</td>
<td>Compressed Natural Gas</td>
</tr>
<tr>
<td>CH₄</td>
<td>Methane</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon Monoxide</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CO₂ₑ</td>
<td>Carbon Dioxide Equivalents</td>
</tr>
<tr>
<td>EGU</td>
<td>Electric Generating Unit</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
</tr>
<tr>
<td>GWP</td>
<td>Global Warming Potential</td>
</tr>
<tr>
<td>ICLEI</td>
<td>International Council on Local Environmental Initiatives</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Particulate Matter less than 10 microns in diameter</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>Particulate Matter less than 2.5 microns in diameter</td>
</tr>
<tr>
<td>MMBtu</td>
<td>Million British Thermal Units</td>
</tr>
<tr>
<td>MOBILE 6</td>
<td>MOBILE emissions estimation model version 6</td>
</tr>
<tr>
<td>MSW</td>
<td>Municipal solid waste</td>
</tr>
<tr>
<td>MWCOG</td>
<td>Metropolitan Washington Council of Governments</td>
</tr>
<tr>
<td>Mwh</td>
<td>Megawatt hours</td>
</tr>
<tr>
<td>NAS</td>
<td>National Academy of Science</td>
</tr>
<tr>
<td>NCRTPB</td>
<td>National Capitol Region Transportation Planning Board</td>
</tr>
<tr>
<td>NERC</td>
<td>North American Electric Reliability Council</td>
</tr>
<tr>
<td>NMIM</td>
<td>National Mobile Inventory Model</td>
</tr>
<tr>
<td>NONROAD</td>
<td>no acronym (model name)</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Oxides of Nitrogen</td>
</tr>
<tr>
<td>N₂O</td>
<td>Nitrous Oxide</td>
</tr>
<tr>
<td>SIP</td>
<td>State Implementation Plan</td>
</tr>
<tr>
<td>SO₂</td>
<td>Sulfur Dioxide</td>
</tr>
<tr>
<td>T&amp;ES</td>
<td>Transportation and Environmental Services</td>
</tr>
<tr>
<td>Tonnes</td>
<td>Metric Tons (equivalent to 1,000 kilograms or 2,204.6 pounds)</td>
</tr>
<tr>
<td>USDOE</td>
<td>U.S. Department of Energy</td>
</tr>
<tr>
<td>USEPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>VADEQ</td>
<td>Virginia Department of Environmental Quality</td>
</tr>
<tr>
<td>VMT</td>
<td>Vehicle Miles Traveled</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
</tr>
<tr>
<td>WMATA</td>
<td>Washington Metropolitan Area Transit Authority</td>
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</table>
**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.

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/Environment
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 4 percent of the city-wide total of 2.2 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$_2$e. School buildings were the second largest source and made up 25 percent of the total government CO$_2$e emissions. Gasoline fuel used by City government employees commuting to work was the third largest category of emissions.

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.

<table>
<thead>
<tr>
<th>Year</th>
<th>MWCOG Proposed Reduction Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Reduce Business As Usual (BAU) Emissions by 10 Percent Below 2012 Levels</td>
</tr>
<tr>
<td>2020</td>
<td>20 Percent Below 2005 Levels</td>
</tr>
<tr>
<td>2050</td>
<td>80 Percent Below 2005 Levels</td>
</tr>
</tbody>
</table>

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.

**FY06 (July 1, 2005 to June 30, 2006) City Government CO$_2$e Emissions by Sector (79,820 tonnes)**

**City Operations Emission Reduction Targets**
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\textsubscript{x} emissions** result from electricity consumption, employee commutes, and City vehicles.
- **SO\textsubscript{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\textsubscript{10} and PM\textsubscript{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.

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**FY06 City Government NO\textsubscript{x} Emissions** (tonnes)

**FY06 City Government SO\textsubscript{2} Emissions** (tonnes)

**FY06 City Government VOC Emissions** (tonnes)

**FY06 City Government CO Emissions** (tonnes)

**FY06 City Government PM\textsubscript{10} Emissions** (tonnes)

**FY06 City Government PM\textsubscript{2.5} Emissions** (tonnes)
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 2.2 million metric tons (tonnes) in 2005.

The operation of commercial and residential buildings account for 44 percent and 20 percent of the total, respectively. Onroad vehicle traffic in the city accounts for 30 percent of the 2.2 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 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).

- **NOx 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.
- **SO2 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.
- **PM10 and PM2.5 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.
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.

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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.

<table>
<thead>
<tr>
<th>Government Operations</th>
<th>Community Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong> – energy audits; lighting retrofits; policy to shut down computers at end of day; purchase green energy; purchase renewable energy.</td>
<td><strong>Energy</strong> – City Energy Master Plan; energy audits for home owners and businesses; energy conservation outreach.</td>
</tr>
<tr>
<td><strong>Building Green</strong> – LEED silver status for new construction/renovation; green roof for City Hall.</td>
<td><strong>Building Green</strong> – green building standards as part of Special Use Permit process.</td>
</tr>
<tr>
<td><strong>Land Use</strong> – Urban Forestry Master Plan; open space and green infrastructure; low impact landscaping practices; green roofs and parking lots.</td>
<td><strong>Land Use</strong> – City Bikeway and Trail network; increase density near Metro and transportation hubs; pedestrian friendly neighborhoods.</td>
</tr>
<tr>
<td><strong>Solid Waste</strong> – recycling bins in City-run facilities; optimize trash truck routing to reduce fuel use.</td>
<td><strong>Solid Waste</strong> – expanded multi-family/condominium recycling and household hazardous waste program</td>
</tr>
<tr>
<td><strong>Transportation</strong> – encourage carpooling, transit, and telecommuting for employees; fuel efficient or hybrid government vehicles; bio-diesel for vehicles.</td>
<td><strong>Transportation</strong> – Green taxi fleet; improved facilities for cyclists; improve access to mass transit; “no idling” near Metro stations.</td>
</tr>
</tbody>
</table>

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.
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.

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 (CO₂) 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

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.
as CO₂, 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 CO₂ from the atmosphere in the process of photosynthesis are no longer present.

CO₂ 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 CO₂ during the last 140 years (FAS, 2008). The top shows CO₂ 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 CO₂ 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 CO₂ 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 CO₂ to the atmosphere. About half of this excess CO₂ 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, 2008c):

- **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 CO₂ 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 (MWCOC, 2008c) voluntarily adopted stringent goals for reducing the region’s greenhouse gas emissions. MWCOC’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\textsubscript{2}e 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 (CO2e). CO2 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 CO2e accords them much more weight than their abundance may suggest. Non-CO2 gases are converted to CO2e 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 CO2.

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 (NO2), ozone (O3), particulate matter less than 10 microns in diameter (PM10), particulate matter less than 2.5 microns in diameter (PM2.5) and sulfur dioxide (SO2). Ozone is not directly emitted to the atmosphere, but is caused by the chemical reaction of oxides of nitrogen (NOx) 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:

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

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 53% of the total GHG emissions directly emitted in the city, while onroad vehicle travel accounts for about 23% of the total. Emissions from fossil fuel combustion in residential, commercial, and industrial buildings account for about 11% of the total direct emissions.
### City of Alexandria GHG/CAP Emissions Inventory

#### Exhibit 3-1

**Base Year Community GHG/CAP Emissions (tonnes)**

<table>
<thead>
<tr>
<th>Source Category</th>
<th>GHG</th>
<th>CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equivalent CO₂</td>
<td>NOₓ</td>
</tr>
<tr>
<td><strong>Scope 1 Emissions – All direct emissions sources located within the city’s boundary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil Fuel – Residential</td>
<td>169,816</td>
<td>243</td>
</tr>
<tr>
<td>Fossil Fuel - Comm/Govt</td>
<td>67,520</td>
<td>91</td>
</tr>
<tr>
<td>Fossil Fuel – Industrial</td>
<td>74,020</td>
<td>151</td>
</tr>
<tr>
<td>Onroad Vehicles</td>
<td>644,896</td>
<td>2,053</td>
</tr>
<tr>
<td>Offroad Equipment</td>
<td>19,766</td>
<td>139</td>
</tr>
<tr>
<td>Locomotives – Diesel</td>
<td>145</td>
<td>3</td>
</tr>
<tr>
<td>VOC Area Sources</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Scope 1 Consumption Based Emissions:</strong></td>
<td>976,163</td>
<td>2,679</td>
</tr>
<tr>
<td>Mirant Potomac River Generating Station</td>
<td>1,478,301</td>
<td>2,284</td>
</tr>
<tr>
<td>Covanta Energy-from-Waste Facility</td>
<td>318,092</td>
<td>535</td>
</tr>
<tr>
<td><strong>Scope 1 Generation Based Emissions:</strong></td>
<td>1,796,393</td>
<td>2,819</td>
</tr>
<tr>
<td><strong>Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city’s boundary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity – Residential</td>
<td>264,490</td>
<td>445</td>
</tr>
<tr>
<td>Electricity – Commercial</td>
<td>889,242</td>
<td>1,496</td>
</tr>
<tr>
<td>Electricity – Industrial</td>
<td>8,737</td>
<td>15</td>
</tr>
<tr>
<td>Electricity - Rail Traffic</td>
<td>29,310</td>
<td>52</td>
</tr>
<tr>
<td><strong>Scope 2 Emissions:</strong></td>
<td>1,191,779</td>
<td>2,008</td>
</tr>
<tr>
<td><strong>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</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Municipal Solid Waste sent to landfills outside of Alexandria</td>
<td>1,388</td>
<td>Not calculated; presumed to be small.</td>
</tr>
<tr>
<td>Wastewater Sludge sent to landfill or incinerator, or used as fertilizer outside of Alexandria</td>
<td>3,481</td>
<td>Not calculated; presumed to be small.</td>
</tr>
<tr>
<td><strong>Scope 3 Emissions:</strong></td>
<td>4,869</td>
<td></td>
</tr>
</tbody>
</table>

Note: the CACP software does not calculate emissions for particulate matter less than 2.5 microns in diameter (PM₂.₅); see Exhibit B-10 for the methodology to estimate PM₂.₅ 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:

\[
\text{Total Emissions} = \text{All Scope 1 (except Mirant/Covanta)} + \text{All Scope 2} + \text{All Scope 3}
\]

\[
\text{Total Emissions} = 976,163 + 1,191,779 + 4,869
\]

\[
\text{Total Emissions} = 2,172,811 \text{ metric tons (tonnes)}
\]

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 2.2 million tonnes.

Exhibit 3-2 shows that 30 percent of the 2.2 million tonnes result from onroad vehicle traffic in the city. The operation of commercial and residential buildings accounts for 44 and 20 percent of the total, respectively.

Exhibit 3-3 shows that 55 percent of the 2.2 million tonnes result from electricity consumption in buildings within the city. Transportation fuels – gasoline and diesel – account for 31 percent of the total. The remainder of the emissions is from fossil fuel combustion in buildings.
3.1  Stationary Source 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)**

<table>
<thead>
<tr>
<th>Energy Source/ Sector</th>
<th>Energy (MMBtu)</th>
<th>Equiv CO₂</th>
<th>NO₂</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>1,357,336</td>
<td>264,490</td>
<td>445</td>
<td>1,460</td>
<td>34</td>
<td>4</td>
<td>29</td>
<td>13</td>
</tr>
<tr>
<td>Commercial</td>
<td>4,563,509</td>
<td>889,242</td>
<td>1,496</td>
<td>4,910</td>
<td>113</td>
<td>13</td>
<td>98</td>
<td>44</td>
</tr>
<tr>
<td>Industrial</td>
<td>44,840</td>
<td>8,737</td>
<td>15</td>
<td>48</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,965,685</td>
<td>1,162,469</td>
<td>1,956</td>
<td>6,418</td>
<td>148</td>
<td>17</td>
<td>128</td>
<td>57</td>
</tr>
<tr>
<td><strong>Fuel Oil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>268,805</td>
<td>20,158</td>
<td>32</td>
<td>18</td>
<td>7</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Commercial</td>
<td>86,839</td>
<td>6,512</td>
<td>10</td>
<td>33</td>
<td>2</td>
<td>&lt;1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Industrial</td>
<td>218,302</td>
<td>16,332</td>
<td>15</td>
<td>32</td>
<td>51</td>
<td>10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>573,946</td>
<td>43,002</td>
<td>57</td>
<td>83</td>
<td>60</td>
<td>11</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td><strong>Natural Gas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>2,592,432</td>
<td>145,300</td>
<td>206</td>
<td>8</td>
<td>51</td>
<td>11</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Commercial</td>
<td>1,001,696</td>
<td>56,143</td>
<td>76</td>
<td>3</td>
<td>20</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Industrial</td>
<td>1,001,696</td>
<td>56,143</td>
<td>134</td>
<td>64</td>
<td>38</td>
<td>7</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4,595,824</td>
<td>257,586</td>
<td>416</td>
<td>75</td>
<td>109</td>
<td>22</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td><strong>Propane</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>66,081</td>
<td>4,339</td>
<td>5</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Commercial</td>
<td>74,097</td>
<td>4,865</td>
<td>5</td>
<td>&lt;1</td>
<td>1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Industrial</td>
<td>23,535</td>
<td>1,545</td>
<td>2</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>163,713</td>
<td>10,749</td>
<td>12</td>
<td>&lt;1</td>
<td>2</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td><strong>Wood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Residential</td>
<td>2,355</td>
<td>19</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Commercial</td>
<td>0</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Industrial</td>
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<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,355</td>
<td>19</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total by Sector</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>4,287,009</td>
<td>434,306</td>
<td>688</td>
<td>1,486</td>
<td>102</td>
<td>18</td>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>Commercial</td>
<td>5,726,141</td>
<td>956,762</td>
<td>1,587</td>
<td>4,946</td>
<td>136</td>
<td>17</td>
<td>101</td>
<td>46</td>
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<tr>
<td>Industrial</td>
<td>1,288,373</td>
<td>82,757</td>
<td>166</td>
<td>144</td>
<td>90</td>
<td>17</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11,301,523</td>
<td>1,473,825</td>
<td>2,441</td>
<td>6,576</td>
<td>328</td>
<td>52</td>
<td>148</td>
<td>76</td>
</tr>
</tbody>
</table>

**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:

\[
\text{Emissions (lbs/yr)} = \text{VMT (1000 miles/yr)} \times \text{EF (lbs/1000 mile)}
\]

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, 2010). VMT data were provided for the City of Alexandria for six road types (interstate, other freeway/expressway, 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 957.6 million 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)**

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Million VMT</th>
<th>Equivalent CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interstate Roads</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas: Auto - Compact</td>
<td>77.6</td>
<td>29,739</td>
<td>114.4</td>
<td>6.1</td>
<td>1,227.0</td>
<td>125.8</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Gas: Auto - Mid-Size</td>
<td>41.1</td>
<td>20,021</td>
<td>60.5</td>
<td>3.2</td>
<td>649.4</td>
<td>66.6</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Gas: Auto - Full-Size</td>
<td>32.9</td>
<td>17,158</td>
<td>48.5</td>
<td>2.6</td>
<td>520.0</td>
<td>53.3</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Gasoline: SUV/Pickup</td>
<td>153.4</td>
<td>108,729</td>
<td>220.9</td>
<td>16.0</td>
<td>2649.8</td>
<td>274.9</td>
<td>4.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Gasoline: Heavy Truck</td>
<td>7.4</td>
<td>14,631</td>
<td>30.8</td>
<td>1.4</td>
<td>299.5</td>
<td>29.0</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Gasoline: Motorcycle</td>
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<td>638</td>
<td>1.4</td>
<td>&lt;0.1</td>
<td>39.6</td>
<td>5.0</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Compact</td>
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<td>56</td>
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<td>0.3</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Full-Size</td>
<td>0.2</td>
<td>108</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>0.3</td>
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<td>Diesel: SUV/Pickup</td>
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<td>0.4</td>
</tr>
<tr>
<td>Diesel: Heavy Truck</td>
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<td>33,871</td>
<td>241.0</td>
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<td>184.7</td>
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<td><strong>Total</strong></td>
<td>336.2</td>
<td>226,397</td>
<td>720.7</td>
<td>39.2</td>
<td>5,573.3</td>
<td>579.4</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Other Freeways and Expressways</strong></th>
<th>Million VMT</th>
<th>Equivalent CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas: Auto - Compact</td>
<td>4.8</td>
<td>1,831</td>
<td>7.0</td>
<td>0.4</td>
<td>75.6</td>
<td>7.7</td>
<td>0.2</td>
<td>0.2</td>
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<tr>
<td>Gas: Auto - Mid-Size</td>
<td>2.5</td>
<td>1,233</td>
<td>3.7</td>
<td>0.2</td>
<td>40.0</td>
<td>4.1</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td>Gas: Auto - Full-Size</td>
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<td>1,057</td>
<td>3.0</td>
<td>0.2</td>
<td>32.0</td>
<td>3.3</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Gasoline: SUV/Pickup</td>
<td>9.4</td>
<td>6,695</td>
<td>13.6</td>
<td>1.0</td>
<td>163.2</td>
<td>16.9</td>
<td>0.3</td>
<td>0.3</td>
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<tr>
<td>Gasoline: Heavy Truck</td>
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<td>902</td>
<td>1.9</td>
<td>0.1</td>
<td>18.5</td>
<td>1.8</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Gasoline: Motorcycle</td>
<td>0.1</td>
<td>39</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>2.4</td>
<td>0.3</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Compact</td>
<td>0.0</td>
<td>4</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Full-Size</td>
<td>0.0</td>
<td>7</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: SUV/Pickup</td>
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<td>89</td>
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<td>&lt;0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Heavy Truck</td>
<td>1.2</td>
<td>2,086</td>
<td>14.8</td>
<td>0.6</td>
<td>11.4</td>
<td>1.5</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>20.7</td>
<td>13,941</td>
<td>44.4</td>
<td>2.4</td>
<td>343.2</td>
<td>35.7</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>VehicleType</td>
<td>Million VMT</td>
<td>CO₂ (Million)</td>
<td>NOₓ (Million)</td>
<td>SO₂ (Million)</td>
<td>CO (Million)</td>
<td>VOC (Million)</td>
<td>PM₁₀ (Million)</td>
<td>PM₂.5 (Million)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------</td>
<td>---------------</td>
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<td>---------------</td>
<td>--------------</td>
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<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Principal Arterial Roads</strong></td>
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<td></td>
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</tr>
<tr>
<td>Gas: Auto - Compact</td>
<td>69.1</td>
<td>26,499</td>
<td>101.9</td>
<td>5.5</td>
<td>1,093.3</td>
<td>112.1</td>
<td>2.4</td>
<td>2.2</td>
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<tr>
<td>Gas: Auto - Mid-Size</td>
<td>36.6</td>
<td>17,841</td>
<td>53.9</td>
<td>2.9</td>
<td>578.7</td>
<td>59.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Gas: Auto - Full-Size</td>
<td>29.3</td>
<td>15,289</td>
<td>43.2</td>
<td>2.3</td>
<td>463.4</td>
<td>47.5</td>
<td>1.0</td>
<td>0.9</td>
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<tr>
<td>Gasoline: SUV/Pickup</td>
<td>136.7</td>
<td>96,885</td>
<td>196.8</td>
<td>14.3</td>
<td>2,361.2</td>
<td>245.0</td>
<td>4.0</td>
<td>3.7</td>
</tr>
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<td>Gasoline: Heavy Truck</td>
<td>6.6</td>
<td>13,038</td>
<td>27.5</td>
<td>1.2</td>
<td>266.8</td>
<td>25.8</td>
<td>0.7</td>
<td>0.6</td>
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<tr>
<td>Gasoline: Motorcycle</td>
<td>1.5</td>
<td>569</td>
<td>1.3</td>
<td>&lt;0.1</td>
<td>35.3</td>
<td>4.4</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Compact</td>
<td>0.2</td>
<td>50</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>0.3</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Full-Size</td>
<td>0.2</td>
<td>96</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>0.3</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: SUV/Pickup</td>
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<td>1,287</td>
<td>2.4</td>
<td>0.3</td>
<td>2.5</td>
<td>0.9</td>
<td>0.4</td>
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<tr>
<td>Diesel: Heavy Truck</td>
<td>17.2</td>
<td>30,182</td>
<td>214.7</td>
<td>8.4</td>
<td>164.6</td>
<td>21.1</td>
<td>8.5</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>Minor Arterial Roads</strong></td>
<td>299.5</td>
<td>201,737</td>
<td>642.2</td>
<td>34.9</td>
<td>4,966.3</td>
<td>516.3</td>
<td>18.2</td>
<td>16.9</td>
</tr>
<tr>
<td>Gas: Auto - Compact</td>
<td>21.5</td>
<td>8,237</td>
<td>31.7</td>
<td>1.7</td>
<td>339.9</td>
<td>34.9</td>
<td>0.7</td>
<td>0.7</td>
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<tr>
<td>Gas: Auto - Mid-Size</td>
<td>11.4</td>
<td>5,545</td>
<td>16.8</td>
<td>0.9</td>
<td>179.9</td>
<td>18.4</td>
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<tr>
<td>Gas: Auto - Full-Size</td>
<td>9.1</td>
<td>4,752</td>
<td>13.4</td>
<td>0.7</td>
<td>144.0</td>
<td>14.8</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Gasoline: SUV/Pickup</td>
<td>42.5</td>
<td>30,116</td>
<td>61.2</td>
<td>4.4</td>
<td>733.9</td>
<td>76.1</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Gasoline: Heavy Truck</td>
<td>2.0</td>
<td>4,053</td>
<td>8.5</td>
<td>0.4</td>
<td>83.0</td>
<td>8.0</td>
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<tr>
<td>Gasoline: Motorcycle</td>
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<td>177</td>
<td>0.4</td>
<td>&lt;0.1</td>
<td>11.0</td>
<td>1.4</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Compact</td>
<td>0.1</td>
<td>16</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Full-Size</td>
<td>0.1</td>
<td>30</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: SUV/Pickup</td>
<td>0.7</td>
<td>400</td>
<td>0.7</td>
<td>0.1</td>
<td>0.8</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Diesel: Heavy Truck</td>
<td>5.3</td>
<td>9,381</td>
<td>66.7</td>
<td>2.6</td>
<td>51.1</td>
<td>6.6</td>
<td>2.6</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Collector Roads</strong></td>
<td>93.1</td>
<td>62,708</td>
<td>199.6</td>
<td>10.9</td>
<td>1,543.7</td>
<td>160.5</td>
<td>5.7</td>
<td>5.3</td>
</tr>
<tr>
<td>Gas: Auto - Compact</td>
<td>8.3</td>
<td>3,176</td>
<td>12.2</td>
<td>0.7</td>
<td>131.0</td>
<td>13.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Gas: Auto - Mid-Size</td>
<td>4.4</td>
<td>2,135</td>
<td>6.5</td>
<td>0.3</td>
<td>69.3</td>
<td>7.1</td>
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<td>0.1</td>
</tr>
<tr>
<td>Gas: Auto - Full-Size</td>
<td>3.5</td>
<td>1,830</td>
<td>5.2</td>
<td>0.3</td>
<td>55.5</td>
<td>5.7</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Gasoline: SUV/Pickup</td>
<td>16.4</td>
<td>11,597</td>
<td>23.6</td>
<td>1.7</td>
<td>282.6</td>
<td>29.3</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Gasoline: Heavy Truck</td>
<td>0.8</td>
<td>1,560</td>
<td>3.3</td>
<td>0.1</td>
<td>31.9</td>
<td>3.1</td>
<td>0.1</td>
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</tr>
<tr>
<td>Gasoline: Motorcycle</td>
<td>0.2</td>
<td>68</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>4.2</td>
<td>0.5</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Compact</td>
<td>&lt;0.1</td>
<td>6</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Auto - Full-Size</td>
<td>&lt;0.1</td>
<td>12</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: SUV/Pickup</td>
<td>0.3</td>
<td>154</td>
<td>0.3</td>
<td>&lt;0.1</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diesel: Heavy Truck</td>
<td>2.1</td>
<td>3,614</td>
<td>25.7</td>
<td>1.0</td>
<td>19.7</td>
<td>2.5</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35.9</td>
<td>24,151</td>
<td>76.9</td>
<td>4.2</td>
<td>594.6</td>
<td>61.8</td>
<td>2.2</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Exhibit 3-5 (continued)

<table>
<thead>
<tr>
<th>VehicleType</th>
<th>Million VMT</th>
<th>Equivalent CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas: Auto - Compact</td>
<td>39.7</td>
<td>15,233</td>
<td>58.6</td>
<td>3.1</td>
<td>628.5</td>
<td>64.4</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Gas: Auto - Mid-Size</td>
<td>21.0</td>
<td>10,255</td>
<td>31.0</td>
<td>1.7</td>
<td>332.6</td>
<td>34.1</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Gas: Auto - Full-Size</td>
<td>16.8</td>
<td>8,789</td>
<td>24.8</td>
<td>1.3</td>
<td>266.4</td>
<td>27.3</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Gasoline: SUV/Pickup</td>
<td>78.6</td>
<td>55,692</td>
<td>113.1</td>
<td>8.2</td>
<td>1,357.2</td>
<td>140.8</td>
<td>2.3</td>
<td>2.1</td>
</tr>
<tr>
<td>Gasoline: Heavy Truck</td>
<td>3.8</td>
<td>7,494</td>
<td>15.8</td>
<td>0.7</td>
<td>153.4</td>
<td>14.8</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Gasoline: Motorcycle</td>
<td>0.9</td>
<td>327</td>
<td>0.7</td>
<td>0.0</td>
<td>20.3</td>
<td>2.5</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Diesel: Auto - Compact</td>
<td>0.1</td>
<td>29</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Diesel: Auto - Full-Size</td>
<td>0.1</td>
<td>56</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Diesel: SUV/Pickup</td>
<td>1.3</td>
<td>740</td>
<td>1.4</td>
<td>0.2</td>
<td>1.5</td>
<td>0.5</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Diesel: Heavy Truck</td>
<td>9.9</td>
<td>17,348</td>
<td>123.4</td>
<td>4.8</td>
<td>94.6</td>
<td>12.1</td>
<td>4.9</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>172.2</td>
<td>115,962</td>
<td>369.1</td>
<td>20.1</td>
<td>2,854.7</td>
<td>296.8</td>
<td>10.5</td>
<td>9.7</td>
</tr>
<tr>
<td>Onroad Vehicle Total:</td>
<td>957.6</td>
<td>644,896</td>
<td>2,053</td>
<td>112</td>
<td>15,876</td>
<td>1,651</td>
<td>58</td>
<td>54</td>
</tr>
</tbody>
</table>

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 CO₂. 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.

### 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.
## Exhibit 3-6

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

<table>
<thead>
<tr>
<th>Fuel Type/Sector</th>
<th>CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CNG</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>103.2</td>
<td>1.3</td>
<td>&lt;0.1</td>
<td>9.7</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Industrial</td>
<td>80.1</td>
<td>1.6</td>
<td>&lt;0.1</td>
<td>7.8</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>183.3</td>
<td>2.9</td>
<td>&lt;0.1</td>
<td>17.5</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>

| **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   |
| **Total**              | 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  |
| **Total**              | 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  |
| **Total**              | 1,700.9| 26.3 | <0.0 | 120.5| 7.1  | 0.1  | 0.1   |

**Totals for Offroad Engines**
<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>19,766.2</td>
<td>138.7</td>
<td>9.0</td>
<td>6,506.2</td>
<td>402.2</td>
<td>16.8</td>
<td>15.3</td>
</tr>
</tbody>
</table>

**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.
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 on 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**

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Equiv CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>145</td>
<td>2.7</td>
<td>0.5</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Electricity</td>
<td>29,310</td>
<td>49.0</td>
<td>162.0</td>
<td>4.0</td>
<td>0.5</td>
<td>3.3</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Totals for Rail:</strong></td>
<td><strong>29,455</strong></td>
<td><strong>51.7</strong></td>
<td><strong>162.5</strong></td>
<td><strong>4.5</strong></td>
<td><strong>0.7</strong></td>
<td><strong>3.4</strong></td>
<td><strong>3.1</strong></td>
</tr>
</tbody>
</table>

### 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 CO₂, electric power plants also emit some CH₄, and N₂O, which are also GHG gases. The electricity generated, heat input, CO₂, CH₄, and N₂O 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 CO₂e emissions. CAP emissions for Mirant and Covanta were obtained from the VADEQ 2005 point source inventory (VADEQ, 2005).

The Covanta facility combuts 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 CO₂ 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)**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Gross Load (MWh)</th>
<th>Heat Input mmBtu</th>
<th>Equiv CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.₅</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mirant Potomac River Generating Station</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>298,442</td>
<td>4,024,530</td>
<td>376,657</td>
<td>687</td>
<td>1,867</td>
<td>33</td>
<td>4</td>
<td>48</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>232,554</td>
<td>2,746,203</td>
<td>257,018</td>
<td>422</td>
<td>1,413</td>
<td>25</td>
<td>3</td>
<td>37</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>316,072</td>
<td>3,049,041</td>
<td>285,361</td>
<td>379</td>
<td>1,496</td>
<td>27</td>
<td>3</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>292,198</td>
<td>2,802,634</td>
<td>262,299</td>
<td>396</td>
<td>1,352</td>
<td>25</td>
<td>3</td>
<td>37</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>313,367</td>
<td>3,173,040</td>
<td>296,966</td>
<td>400</td>
<td>1,565</td>
<td>27</td>
<td>3</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,452,633</strong></td>
<td><strong>15,795,448</strong></td>
<td><strong>1,478,301</strong></td>
<td><strong>2,284</strong></td>
<td><strong>7,694</strong></td>
<td><strong>136</strong></td>
<td><strong>16</strong></td>
<td><strong>202</strong></td>
<td><strong>129</strong></td>
</tr>
<tr>
<td><strong>Covanta Arlington/Alexandria Waste to Energy Facility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B100</td>
<td>59,810</td>
<td>1,178,466</td>
<td>105,153</td>
<td>178</td>
<td>2</td>
<td>25</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B200</td>
<td>60,380</td>
<td>1,189,695</td>
<td>106,155</td>
<td>177</td>
<td>2</td>
<td>24</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B300</td>
<td>60,737</td>
<td>1,196,735</td>
<td>106,783</td>
<td>180</td>
<td>5</td>
<td>19</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>180,926</td>
<td>3,564,895</td>
<td>318,092</td>
<td>535</td>
<td>9</td>
<td>69</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,633,559</strong></td>
<td><strong>19,360,343</strong></td>
<td><strong>1,796,393</strong></td>
<td><strong>2,819</strong></td>
<td><strong>7,703</strong></td>
<td><strong>205</strong></td>
<td><strong>19</strong></td>
<td><strong>205</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

* 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 landfiling. 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**

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Disposal Method</th>
<th>Estimated Amount Generated by City Residents (tons)</th>
<th>Equiv CO₂ (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSW residential (Division of Solid Waste collected)</td>
<td>Covanta Energy to Waste Plant</td>
<td>27,131</td>
<td>Included with Covanta GHG emissions</td>
</tr>
<tr>
<td>MSW multi-family and commercial (Privately collected)</td>
<td>Covanta Energy to Waste Plant</td>
<td>108,968</td>
<td>Included with Covanta GHG emissions</td>
</tr>
<tr>
<td>MSW multi-family and commercial (Privately collected)</td>
<td>Landfill outside of Alexandria</td>
<td>2,445</td>
<td>1,388</td>
</tr>
<tr>
<td>ASA Sludge**</td>
<td>Land Application at permitted sites in rural Virginia</td>
<td>1,376</td>
<td>0*</td>
</tr>
<tr>
<td>ASA Sludge**</td>
<td>Landfill in King George, VA</td>
<td>2,768</td>
<td>2,837</td>
</tr>
<tr>
<td>ASA Sludge**</td>
<td>Incinerated in Hopewell, VA</td>
<td>8,793</td>
<td>644</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>151,481</strong></td>
<td><strong>4,869</strong></td>
</tr>
</tbody>
</table>

* 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 emissions, 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. Some of those coatings contain a solvent-based liquid carrier; others use a water-based 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**

<table>
<thead>
<tr>
<th>Area Source Category</th>
<th>VOC Emissions (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline Service Stations</td>
<td>192</td>
</tr>
<tr>
<td>Cold Cleaning Solvents</td>
<td>104</td>
</tr>
<tr>
<td>Surface Coating</td>
<td>394</td>
</tr>
<tr>
<td>Graphic Arts</td>
<td>50</td>
</tr>
<tr>
<td>Commercial/consumer Products</td>
<td>578</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,318</strong></td>
</tr>
</tbody>
</table>
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:

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

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 CO₂e in 2005. These emissions are a subset of the community total GHG emissions, representing approximately 4 percent of the community-wide total of 2.2 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)**

<table>
<thead>
<tr>
<th>Source Category</th>
<th>GHG</th>
<th>CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equiv CO₂</td>
<td>NOₓ</td>
</tr>
<tr>
<td><strong>Scope 1 Emissions – All direct emissions sources located within the City’s boundary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Buildings - Fossil Fuel</td>
<td>4,486</td>
<td>6.1</td>
</tr>
<tr>
<td>Schools – Fossil Fuel</td>
<td>3,240</td>
<td>4.4</td>
</tr>
<tr>
<td>City Fleet</td>
<td>5,146</td>
<td>18.3</td>
</tr>
<tr>
<td>Fire Dept. Vehicles</td>
<td>675</td>
<td>2.6</td>
</tr>
<tr>
<td>School Buses</td>
<td>1,435</td>
<td>10.2</td>
</tr>
<tr>
<td>Solid Waste Disposal</td>
<td>1,671</td>
<td>12.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16,653</td>
<td>53.8</td>
</tr>
<tr>
<td><strong>Scope 2 Emissions – Indirect emissions limited to electricity consumption within the City, but the associated emissions occur outside of the City’s boundary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Buildings - Electricity</td>
<td>29,243</td>
<td>49.2</td>
</tr>
<tr>
<td>Schools – Electricity</td>
<td>16,413</td>
<td>27.6</td>
</tr>
<tr>
<td>Lighting - Electricity</td>
<td>7,406</td>
<td>12.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>53,062</td>
<td>89.2</td>
</tr>
<tr>
<td><strong>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</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employee Commute</td>
<td>10,105</td>
<td>24.4</td>
</tr>
<tr>
<td><strong>Total for City Government Operations</strong></td>
<td>10,105</td>
<td>24.4</td>
</tr>
<tr>
<td><strong>Totals for City Government Operations</strong></td>
<td>79,820</td>
<td>167.5</td>
</tr>
</tbody>
</table>

Note: the CACP software does not calculate emissions for particulate matter less than 2.5 microns in diameter (PM₂.₅); see Exhibit B-10 for the methodology to estimate PM₂.₅ 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$_2$e. Emissions of CO$_2$e from school buildings were the second largest source and made up 25 percent of the total government CO$_2$e 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$_2$e.

Exhibit 4-3 shows clearly the dominance of electricity when 2005 government CO$_2$e 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$_2$e. Emissions of CO$_2$e 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$_2$e emissions. The third largest energy source was natural gas used in City government buildings and schools.
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)**

<table>
<thead>
<tr>
<th>Energy Source/ Sector</th>
<th>Energy (MMBtu)</th>
<th>Equiv CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Owned</td>
<td>89,553</td>
<td>17,450</td>
<td>29.4</td>
<td>96.4</td>
<td>2.2</td>
<td>0.2</td>
<td>1.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Libraries</td>
<td>8,876</td>
<td>1,730</td>
<td>2.9</td>
<td>9.6</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Leased (Landlord)</td>
<td>21,498</td>
<td>4,189</td>
<td>7.0</td>
<td>23.1</td>
<td>0.5</td>
<td>0.1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Leased (Tenant)</td>
<td>30,145</td>
<td>5,874</td>
<td>9.9</td>
<td>32.4</td>
<td>0.7</td>
<td>0.1</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Schools</td>
<td>84,233</td>
<td>16,413</td>
<td>27.6</td>
<td>90.6</td>
<td>2.1</td>
<td>0.2</td>
<td>1.8</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>234,305</td>
<td>45,656</td>
<td>76.8</td>
<td>252.1</td>
<td>5.8</td>
<td>0.6</td>
<td>5.0</td>
<td>2.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Source/ Sector</th>
<th>Energy (MMBtu)</th>
<th>Equiv CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Natural Gas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Owned</td>
<td>60,053</td>
<td>3,366</td>
<td>4.6</td>
<td>0.2</td>
<td>1.2</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Libraries</td>
<td>4,621</td>
<td>259</td>
<td>0.4</td>
<td>&lt;0.1</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Leased (Landlord)</td>
<td>6,191</td>
<td>347</td>
<td>0.5</td>
<td>&lt;0.1</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Leased (Tenant)</td>
<td>9,164</td>
<td>514</td>
<td>0.7</td>
<td>&lt;0.1</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Schools</td>
<td>57,807</td>
<td>3,240</td>
<td>4.4</td>
<td>0.2</td>
<td>1.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>137,836</td>
<td>7,726</td>
<td>10.5</td>
<td>0.4</td>
<td>2.7</td>
<td>0.5</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

1. City of Alexandria GHG/CAP Emissions Inventory
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)

<table>
<thead>
<tr>
<th>Energy Source Sector</th>
<th>Number of Vehicles</th>
<th>Energy (MMBtu)</th>
<th>Equiv CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₂.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>City Government Fleet</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>819</td>
<td>52,438</td>
<td>4,059</td>
<td>10.5</td>
<td>0.6</td>
<td>117.3</td>
<td>12.1</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Diesel</td>
<td>115</td>
<td>13,817</td>
<td>1,087</td>
<td>7.7</td>
<td>0.3</td>
<td>5.9</td>
<td>0.8</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>934</td>
<td>66,255</td>
<td>5,146</td>
<td>18.3</td>
<td>0.9</td>
<td>123.3</td>
<td>12.9</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Fire Department</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>80</td>
<td>4,978</td>
<td>385</td>
<td>0.8</td>
<td>0.1</td>
<td>9.7</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Diesel</td>
<td>35</td>
<td>3,681</td>
<td>290</td>
<td>1.8</td>
<td>0.1</td>
<td>1.4</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>115</td>
<td>8,659</td>
<td>675</td>
<td>2.6</td>
<td>0.1</td>
<td>11.1</td>
<td>1.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>School Buses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>98</td>
<td>18,240</td>
<td>1,435</td>
<td>10.2</td>
<td>0.4</td>
<td>7.8</td>
<td>1.0</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>98</td>
<td>18,240</td>
<td>1,435</td>
<td>10.2</td>
<td>0.4</td>
<td>7.8</td>
<td>1.0</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,147</td>
<td>93,154</td>
<td>7,256</td>
<td>31.1</td>
<td>1.5</td>
<td>142.2</td>
<td>15.1</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>
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 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 summarize 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)**

<table>
<thead>
<tr>
<th>Employee Commute</th>
<th>Energy (MMBtu)</th>
<th>Equiv CO₂</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Gasoline</td>
<td>130,372</td>
<td>10,105</td>
<td>24.4</td>
<td>1.5</td>
<td>281.7</td>
<td>29.1</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Type of Lighting</th>
<th>Energy (MMBtu)</th>
<th>Equiv CO₂</th>
<th>NO₂</th>
<th>SO₂</th>
<th>CO</th>
<th>VOC</th>
<th>PM₁₀</th>
<th>PM₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Signals</td>
<td>20,257</td>
<td>1,999</td>
<td>3.4</td>
<td>11.1</td>
<td>0.3</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Street Lighting</td>
<td>27,749</td>
<td>5,407</td>
<td>9.1</td>
<td>29.8</td>
<td>0.7</td>
<td>0.1</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>48,006</td>
<td>7,406</td>
<td>12.4</td>
<td>40.9</td>
<td>1.0</td>
<td>0.2</td>
<td>0.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Gross Load (MWh)</th>
<th>Heat Input mmBtu</th>
<th>CO2</th>
<th>NOx</th>
<th>SO2</th>
<th>CO</th>
<th>VOC</th>
<th>PM10</th>
<th>PM2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>B100</td>
<td>59,554</td>
<td>1,183,780</td>
<td>23,912</td>
<td>178.4</td>
<td>1.9</td>
<td>25.3</td>
<td>0.8</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>B200</td>
<td>60,277</td>
<td>1,198,164</td>
<td>24,281</td>
<td>178.4</td>
<td>1.9</td>
<td>25.3</td>
<td>0.8</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>B300</td>
<td>60,819</td>
<td>1,208,920</td>
<td>24,446</td>
<td>176.9</td>
<td>1.8</td>
<td>24.5</td>
<td>0.7</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>180,650</td>
<td>3,590,864</td>
<td>72,639</td>
<td>533.8</td>
<td>5.6</td>
<td>75.2</td>
<td>2.4</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**Proportion Resulting from Solid Waste Generated by City Government Operations**

<table>
<thead>
<tr>
<th></th>
<th>Gross Load</th>
<th>Heat Input</th>
<th>CO2</th>
<th>NOx</th>
<th>SO2</th>
<th>CO</th>
<th>VOC</th>
<th>PM10</th>
<th>PM2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4,155</td>
<td>82,590</td>
<td>1,671</td>
<td>12.3</td>
<td>0.1</td>
<td>1.7</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Growth Factor</th>
<th>Source Category</th>
<th>Percent Change from 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2010</td>
</tr>
<tr>
<td>Community Activities</td>
<td>Population</td>
<td>5.0%</td>
</tr>
<tr>
<td></td>
<td>Residential Fuel</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Residential Electricity</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Offroad Equipment</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Rail Traffic</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>8.3%</td>
</tr>
<tr>
<td></td>
<td>Commercial Fuel</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Commercial Electricity</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Industrial Fuel</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Industrial Electricity</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>VMT</td>
<td>8.3%</td>
</tr>
<tr>
<td>State Permit</td>
<td>Mirant</td>
<td>8.3%</td>
</tr>
<tr>
<td>Title V Permit</td>
<td>Covanta</td>
<td>8.3%</td>
</tr>
</tbody>
</table>

City Government Operations

<table>
<thead>
<tr>
<th>Growth Factor</th>
<th>Source Category</th>
<th>Percent Change from 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2010</td>
</tr>
<tr>
<td>Population</td>
<td>All Government Sectors</td>
<td>5.0%</td>
</tr>
</tbody>
</table>
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, 2008c).

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Proposed Reduction Target</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Reduce Business As Usual (BAU) Emissions by 10 Percent Below 2012 Levels</td>
<td>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.</td>
</tr>
<tr>
<td>2020</td>
<td>Reduce BAU Emissions by 20 Percent Below 2005 Levels</td>
<td>Medium-range goal to encourage expansion of recommended policies and programs on a national, state, and local level.</td>
</tr>
<tr>
<td>2050</td>
<td>Reduce BAU Emissions by 80 Percent Below 2005 Levels</td>
<td>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.</td>
</tr>
</tbody>
</table>
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, about 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 2.17 million tonnes in 2005 to 2.33 million tonnes in 2012 and 3.7 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**

<table>
<thead>
<tr>
<th>Source Category</th>
<th>2005</th>
<th>2012</th>
<th>2020</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope 1 Emissions – All direct emissions sources located within the city’s boundary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil Fuel - Residential</td>
<td>169,816</td>
<td>181,633</td>
<td>195,233</td>
<td>256,599</td>
</tr>
<tr>
<td>Fossil Fuel – Comm/Govt</td>
<td>67,520</td>
<td>70,588</td>
<td>77,599</td>
<td>122,485</td>
</tr>
<tr>
<td>Fossil Fuel - Industrial</td>
<td>74,020</td>
<td>77,383</td>
<td>85,070</td>
<td>134,276</td>
</tr>
<tr>
<td>Onroad Vehicles</td>
<td>644,896</td>
<td>720,134</td>
<td>806,120</td>
<td>1,084,715</td>
</tr>
<tr>
<td>Offroad Equipment</td>
<td>19,766</td>
<td>21,142</td>
<td>22,724</td>
<td>29,867</td>
</tr>
<tr>
<td>Locomotives – Diesel</td>
<td>145</td>
<td>155</td>
<td>167</td>
<td>219</td>
</tr>
<tr>
<td><strong>Scope 1 Consumption Based Emissions:</strong></td>
<td>976,163</td>
<td>1,071,035</td>
<td>1,186,914</td>
<td>1,628,161</td>
</tr>
<tr>
<td>Mirant Potomac River Generating Station</td>
<td>1,478,301</td>
<td>2,433,417</td>
<td>2,433,417</td>
<td>2,433,417</td>
</tr>
<tr>
<td>Covanta Energy from Waste Facility</td>
<td>318,092</td>
<td>371,107</td>
<td>371,107</td>
<td>371,107</td>
</tr>
<tr>
<td><strong>Scope 1 Generation Based Emissions:</strong></td>
<td>1,796,393</td>
<td>2,804,525</td>
<td>2,804,525</td>
<td>2,804,525</td>
</tr>
<tr>
<td><strong>Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city’s boundary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity - Residential</td>
<td>264,490</td>
<td>282,896</td>
<td>304,078</td>
<td>399,655</td>
</tr>
<tr>
<td>Electricity - Commercial</td>
<td>889,242</td>
<td>929,644</td>
<td>1,021,988</td>
<td>1,613,135</td>
</tr>
<tr>
<td>Electricity - Industrial</td>
<td>8,737</td>
<td>9,134</td>
<td>10,041</td>
<td>15,849</td>
</tr>
<tr>
<td>Electricity - Rail Traffic</td>
<td>29,310</td>
<td>31,350</td>
<td>33,697</td>
<td>44,289</td>
</tr>
<tr>
<td><strong>Scope 2 Emissions:</strong></td>
<td>1,191,779</td>
<td>1,253,023</td>
<td>1,369,804</td>
<td>2,072,927</td>
</tr>
<tr>
<td><strong>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</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Municipal Solid Waste sent to landfills outside of Alexandria</td>
<td>1,388</td>
<td>1,457</td>
<td>1,485</td>
<td>1,596</td>
</tr>
<tr>
<td>Wastewater Sludge sent to landfill or incinerator, or used as fertilizer outside of Alexandria</td>
<td>3,481</td>
<td>3,654</td>
<td>3,723</td>
<td>4,002</td>
</tr>
<tr>
<td><strong>Scope 3 Emissions:</strong></td>
<td>4,869</td>
<td>5,110</td>
<td>5,208</td>
<td>5,598</td>
</tr>
</tbody>
</table>
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 5-6
### Business-as-Usual Emission Forecasts for the Government Operations Inventory

<table>
<thead>
<tr>
<th>Source Category</th>
<th>CO₂e Emissions (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
</tr>
<tr>
<td><strong>Scope 1 Emissions – All direct emissions sources located within the city’s boundary</strong></td>
<td></td>
</tr>
<tr>
<td>City Buildings - Fossil Fuel</td>
<td>4,486</td>
</tr>
<tr>
<td>Schools – Fossil Fuel</td>
<td>3,240</td>
</tr>
<tr>
<td>City Fleet</td>
<td>5,146</td>
</tr>
<tr>
<td>Fire Dept. Vehicles</td>
<td>675</td>
</tr>
<tr>
<td>School Buses</td>
<td>1,435</td>
</tr>
<tr>
<td>Solid Waste Disposal</td>
<td>1,671</td>
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<td><strong>Scope 1 Emissions</strong></td>
<td>16,653</td>
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<td><strong>Scope 2 Emissions – Indirect emissions limited to electricity consumption within the city, but the associated emissions occur outside of the city’s boundary</strong></td>
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<td>City Buildings - Electricity</td>
<td>29,243</td>
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<td>Lighting - Electricity</td>
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<td><strong>Scope 2 Emissions</strong></td>
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<td><strong>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</strong></td>
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</tr>
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<td>Employee Commute</td>
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<td><strong>Scope 3 Emissions</strong></td>
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<tr>
<td><strong>Total for All Government Operations</strong></td>
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</table>
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 CO₂ 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.

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.

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 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

Exhibit 6-3
MWCOG Recommendations for Emission Reduction Measures That Can Be Implemented by Local Governments

ENERGY

Energy Efficiency Measures


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.
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.
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.
2. Promote equalization of transit and parking benefits.
3. Promote car-sharing.
4. Examine parking policies and relation to VMT. Implement new parking policies to reduce VMT.
5. 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.

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. 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
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.

7.0 References

**AFD, 2008.** Alexandria Fire Department, email dated May 8, 2008 from Joe Saputo (AFD) to Erica Bannerman (Alexandria T&ES) transferring Fire Department Fleet Data for FY 2006.

**ACPS, 2008.** Alexandria City Public Schools, email dated May 5, 2008 from David Rose (ACPS) to Erica Bannerman (Alexandria T&ES) transferring data on school buses.

**ASA, 2008.** Alexandria Sanitation Authority, email dated April 24, 2008 from Paul Carbary (ASA) to Erica Bannerman (T&ES) transferring data on digester gas amounts in 2005.


**Census, 2008b.** U.S. Census Bureau, *2005 County Business Patterns*, [http://factfinder.census.gov](http://factfinder.census.gov)


T&ES, 2008a. Alexandria Department of Transportation and Environmental Services, Solid Waste Division, solid waste collection and disposal data provided on May 15, 2008 by Alton Weaver (Alexandria T&ES) to Erica Bannerman (Alexandria T&ES).
T&ES, 2008b. Alexandria Department of Transportation and Environmental Services, building information and energy consumption provided on April 30 and May 22, 2008 by Alem Zewoldai (Alexandria T&ES) to Erica Bannerman (Alexandria T&ES).


T&ES, 2008d. Alexandria Department of Transportation and Environmental Services, home addresses of City employees provided on April 22, 2008 by Donna Norfleet (Department?) to Erica Bannerman (Alexandria T&ES). This information also included the number of employees enrolled in the City’s transportation benefits program who travel via mass transit.

T&ES, 2008e. Alexandria Department of Transportation and Environmental Services, data on traffic signal counts and electricity consumption provided on April 21, 2008 by Bob Garbacz (Alexandria T&ES) to Erica Bannerman (Alexandria T&ES).

T&ES, 2008f. Alexandria Department of Transportation and Environmental Services, data on street light counts and electricity consumption provided on April 18, 2008 by Bonnie Wine (Alexandria T&ES) to Erica Bannerman (Alexandria T&ES).


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 (CO₂)**: 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 (CO₂e)**: 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 CO₂ and metric tons of CO₂e 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 CO₂e 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 sulfur dioxide.
City of Alexandria GHG/CAP Emissions Inventory

**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

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

Exhibit A-2

Sources of Data for Community Inventory

<table>
<thead>
<tr>
<th>Sector</th>
<th>Contact/Organization</th>
<th>Data Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary Energy</td>
<td>Jeff King MWCOG</td>
<td>Natural gas therm sales for 2005 from Washington Gas</td>
</tr>
<tr>
<td>Stationary Energy</td>
<td>Jeff King MWCOG</td>
<td>Electricity consumption for 2005 from Dominion Virginia Power</td>
</tr>
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<td>Mobile Source</td>
<td>Eulalie Gower-Lucas MWCOG</td>
<td>VMT by vehicle type and road type for 2002</td>
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<td>Mobile Sources</td>
<td>Thomas Foster VA DEQ</td>
<td>Diesel fuel consumption by railroad locomotives in 2005</td>
</tr>
<tr>
<td>Mobile Sources</td>
<td>Jeff King MWCOG</td>
<td>Electricity consumption by WMATA for Metro trains</td>
</tr>
<tr>
<td>Wastewater Treatment</td>
<td>Paul Carbary ASA</td>
<td>Fuel (including methane) consumption at the ASA treatment plant; quantity of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sludge disposed of by land application, landfilling, and incineration.</td>
</tr>
<tr>
<td>Solid Waste Disposal</td>
<td>Alton Weaver T&amp;ES</td>
<td>Data on solid waste collection and disposal</td>
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### Exhibit A-3

#### Sources of Data for City Government Operations Inventory

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

DATA FOR THE COMMUNITY INVENTORY
### Exhibit B-1


<table>
<thead>
<tr>
<th>County</th>
<th>Commercial &amp; Industrial</th>
<th>Group Metered Apts.</th>
<th>Interruptible</th>
<th>Residential</th>
<th>Grand Total</th>
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<td>0</td>
<td>324,332</td>
<td>424,686</td>
<td>2,425,756</td>
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<td>Charles</td>
<td>3,169,773</td>
<td>3,997</td>
<td>3,152</td>
<td>8,463,044</td>
<td>11,639,965</td>
</tr>
<tr>
<td>Montgomery</td>
<td>77,319,683</td>
<td>20,361,366</td>
<td>54,590,366</td>
<td>182,499,247</td>
<td>334,770,662</td>
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<tr>
<td>Prince Georges</td>
<td>73,899,868</td>
<td>31,497,089</td>
<td>37,042,364</td>
<td>132,061,682</td>
<td>274,501,004</td>
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<tr>
<td>Frederick</td>
<td>17,642,856</td>
<td>536,105</td>
<td>11,454,548</td>
<td>17,634,983</td>
<td>47,268,492</td>
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<tr>
<td>St. Mary's</td>
<td>5,147,078</td>
<td>31,087</td>
<td>1,175,857</td>
<td>6,635,022</td>
<td>20,628,952</td>
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<tr>
<td><strong>MD Total</strong></td>
<td>178,855,997</td>
<td>52,398,557</td>
<td>103,726,849</td>
<td>318,372,431</td>
<td>677,240,901</td>
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<tr>
<td>Arlington</td>
<td>20,108,690</td>
<td>8,042,857</td>
<td>18,724,137</td>
<td>31,945,234</td>
<td>73,945,234</td>
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<tr>
<td>Alexandria</td>
<td>13,760,044</td>
<td>7,180,855</td>
<td>6,273,868</td>
<td>18,743,462</td>
<td>45,958,229</td>
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<tr>
<td>City of Fairfax</td>
<td>4,551,650</td>
<td>754,292</td>
<td>3,325,261</td>
<td>4,191,220</td>
<td>12,222,223</td>
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<tr>
<td>Falls Church</td>
<td>1,836,527</td>
<td>645,615</td>
<td>83,875</td>
<td>2,524,957</td>
<td>5,064,898</td>
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<tr>
<td>Manassas</td>
<td>245,579</td>
<td>0</td>
<td>10,985</td>
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<tr>
<td>Manassas Park</td>
<td>111,154</td>
<td>0</td>
<td>1,178,429</td>
<td>1,289,583</td>
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<tr>
<td>Fairfax County</td>
<td>57,777,283</td>
<td>16,570,763</td>
<td>27,339,297</td>
<td>278,103,963</td>
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<tr>
<td>Loudoun</td>
<td>11,067,866</td>
<td>406,127</td>
<td>1,696,476</td>
<td>15,557</td>
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<tr>
<td>Prince William</td>
<td>12,702,616</td>
<td>2,276,491</td>
<td>1,782,678</td>
<td>62,360,619</td>
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</tr>
<tr>
<td>Town of Leesburg</td>
<td>3,056,594</td>
<td>449,303</td>
<td>226,660</td>
<td>13,204,996</td>
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<tr>
<td>Town of Middleburg</td>
<td>78,574</td>
<td>0</td>
<td>15,557</td>
<td>94,132</td>
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<td>Town of Occoquan</td>
<td>97,712</td>
<td>6,413</td>
<td>104,539</td>
<td>208,663</td>
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<tr>
<td>Town of Vienna</td>
<td>1,531,126</td>
<td>320,805</td>
<td>3,836,942</td>
<td>5,688,872</td>
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<tr>
<td><strong>VA Total</strong></td>
<td>126,925,414</td>
<td>36,653,519</td>
<td>59,452,251</td>
<td>555,260,051</td>
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<tr>
<td>Grand Total</td>
<td>377,382,530</td>
<td>119,147,165</td>
<td>271,215,337</td>
<td>1,550,873,383</td>
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</table>

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

**City of Alexandria**

<table>
<thead>
<tr>
<th></th>
<th>Therms</th>
<th>Commercial (mmBTU)</th>
<th>Industrial (mmBTU)</th>
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<tr>
<td></td>
<td>13,760,044</td>
<td>7,180,855</td>
<td>6,273,868</td>
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<tr>
<td>million cubic feet</td>
<td>1,349</td>
<td>704</td>
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<tr>
<td>million BTU</td>
<td>1,376,004</td>
<td>718,086</td>
<td>627,387</td>
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<tr>
<td></td>
<td>1,874,346</td>
<td>2,592,432</td>
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**Apportionment of Alexandria Natural Gas Use to CACPS Categories**

<table>
<thead>
<tr>
<th></th>
<th>50% Commercial</th>
<th>50% Industrial</th>
<th>All Residential</th>
<th>50% Commercial</th>
<th>50% Industrial</th>
<th>All Residential</th>
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</thead>
<tbody>
<tr>
<td>Residential (mmBTu)</td>
<td>-</td>
<td>718,086</td>
<td>-</td>
<td>1,874,346</td>
<td>-</td>
<td>2,592,432</td>
</tr>
<tr>
<td>Commercial (mmBTu)</td>
<td>688,002</td>
<td>-</td>
<td>313,693</td>
<td>-</td>
<td>1,001,696</td>
<td></td>
</tr>
<tr>
<td>Industrial (mmBTu)</td>
<td>688,002</td>
<td>-</td>
<td>313,693</td>
<td>-</td>
<td>1,001,696</td>
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</table>
## Exhibit B-2

### Electricity Consumption Calculations

<table>
<thead>
<tr>
<th>Utility</th>
<th>Location</th>
<th>Residential (kwh)</th>
<th>Commercial (kwh)</th>
<th>Industrial/Large Commercial (kwh)</th>
<th>Government (kwh)</th>
<th>Total (kwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pepco</td>
<td>Montgomery</td>
<td>3,824,038,626</td>
<td>4,337,300,574</td>
<td>127,359,789</td>
<td>1,443,210,386</td>
<td>9,731,909,375</td>
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<tr>
<td>Pepco</td>
<td>Prince Georges</td>
<td>2,481,379,778</td>
<td>2,408,531,112</td>
<td>26,098,877</td>
<td>1,179,009,677</td>
<td>4,914,415,629</td>
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<tr>
<td>Allegheny</td>
<td>Frederick</td>
<td>1,104,777,633</td>
<td>463,650,842</td>
<td>3,492,135,921</td>
<td></td>
<td>5,061,024,589</td>
</tr>
<tr>
<td>Allegheny</td>
<td>City of Frederick</td>
<td>297,663,138</td>
<td>387,185,162</td>
<td>97,085,972</td>
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<td>786,503,442</td>
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<tr>
<td>Allegheny</td>
<td>Montgomery</td>
<td>378,953,049</td>
<td>170,635,073</td>
<td>62,919,720</td>
<td></td>
<td>612,507,842</td>
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<tr>
<td>Pepco</td>
<td>DC</td>
<td>1,932,578,574</td>
<td>6,411,719,754</td>
<td></td>
<td></td>
<td>11,735,691,057</td>
</tr>
<tr>
<td>Dominion</td>
<td>Alexandria</td>
<td>397,699,466</td>
<td>1,050,770,919</td>
<td>26,276,156</td>
<td>273,199,209</td>
<td>1,747,945,750</td>
</tr>
<tr>
<td>Dominion</td>
<td>Arlington</td>
<td>621,495,580</td>
<td>1,762,946,199</td>
<td>790,200</td>
<td>712,127,350</td>
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<td>Dominion</td>
<td>Fairfax City</td>
<td>91,202,212</td>
<td>209,616,936</td>
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<td>27,065,620</td>
<td>327,884,768</td>
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<tr>
<td>Dominion</td>
<td>Fairfax</td>
<td>4,259,913,371</td>
<td>5,289,046,511</td>
<td>168,048,949</td>
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<tr>
<td>Dominion</td>
<td>Falls Church</td>
<td>43,139,115</td>
<td>78,210,788</td>
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<td>4,368,785</td>
<td>125,718,688</td>
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<td>Loudoun</td>
<td>863,131,849</td>
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<td>36,196,406</td>
<td>122,116,836</td>
<td>2,120,027,311</td>
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<tr>
<td>Dominion</td>
<td>Prince William</td>
<td>712,766,647</td>
<td>323,117,358</td>
<td>1,370,688</td>
<td>145,241,113</td>
<td>1,182,495,806</td>
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<tr>
<td>NOVEC</td>
<td>Prince William</td>
<td>1,000,400,575</td>
<td>645,173,020</td>
<td>118,664,108</td>
<td></td>
<td>1,764,237,703</td>
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<tr>
<td>NOVEC</td>
<td>Fairfax</td>
<td>388,128,298</td>
<td>158,664,633</td>
<td>41,634,677</td>
<td></td>
<td>588,427,608</td>
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<tr>
<td>NOVEC</td>
<td>Loudoun</td>
<td>232,420,614</td>
<td>77,875,656</td>
<td>12,154,569</td>
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<td>322,450,839</td>
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<td>45,644,137</td>
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<td>22,907,359,051</td>
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<td>Pepco</td>
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<td>6,411,719,754</td>
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<td></td>
<td></td>
<td></td>
<td>55,754,410,985</td>
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</tbody>
</table>

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

### Apportionment of Alexandria Electricity Use to CACPS Categories

<table>
<thead>
<tr>
<th></th>
<th>All Residential (kwh)</th>
<th>All Commercial (kwh)</th>
<th>50% Comm. 50% Ind.</th>
<th>All Commercial (kwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential (kwh)</td>
<td>397,699,466</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Commercial (kwh)</td>
<td>0</td>
<td>1,050,770,919</td>
<td>13,138,078</td>
<td>273,199,209</td>
</tr>
<tr>
<td>Industrial (kwh)</td>
<td>0</td>
<td>0</td>
<td>13,138,078</td>
<td>0</td>
</tr>
</tbody>
</table>
# Exhibit B-3

"Top-Down" Residential Fuel Consumption Calculations

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distillate Fuel</td>
<td>Light Fuel Oil</td>
<td>31,395,376</td>
<td>362,618</td>
<td>2,469</td>
<td>0.0068</td>
<td>213,765</td>
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<tr>
<td>Kerosene</td>
<td>Light Fuel Oil</td>
<td>8,083,621</td>
<td>362,618</td>
<td>2,469</td>
<td>0.0068</td>
<td>55,040</td>
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<tr>
<td>LPG</td>
<td>Propane</td>
<td>13,710,233</td>
<td>138,595</td>
<td>668</td>
<td>0.0048</td>
<td>66,081</td>
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<tr>
<td>Wood</td>
<td>Fuelwood</td>
<td>8,859,882</td>
<td>78,994</td>
<td>21</td>
<td>0.0003</td>
<td>2,355</td>
</tr>
</tbody>
</table>

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**

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

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**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distillate Fuel</td>
<td>Light Fuel Oil</td>
<td>41,387,900</td>
<td>290,052</td>
<td>1,516</td>
<td>0.0052</td>
<td>216,320</td>
</tr>
<tr>
<td>Kerosene</td>
<td>Light Fuel Oil</td>
<td>379,176</td>
<td>290,052</td>
<td>1,516</td>
<td>0.0052</td>
<td>1,982</td>
</tr>
<tr>
<td>LPG</td>
<td>Propane</td>
<td>4,502,885</td>
<td>290,052</td>
<td>1,516</td>
<td>0.0052</td>
<td>23,535</td>
</tr>
<tr>
<td>Wood</td>
<td>Fuel wood</td>
<td>0</td>
<td>290,052</td>
<td>1,516</td>
<td>0.0052</td>
<td>0</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate</td>
<td>The interstate system consists of all presently designated routes of the Interstate System. In Alexandria, interstates include I-95, I-395, and I-495.</td>
</tr>
<tr>
<td>Other Freeways/Expressways</td>
<td>Other non-Interstate freeways/expressways that are controlled access divided highways with grade separated junctions and without traffic lights or stop signs.</td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>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).</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>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.</td>
</tr>
<tr>
<td>Collector</td>
<td>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.</td>
</tr>
<tr>
<td>Local</td>
<td>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.</td>
</tr>
</tbody>
</table>

Source: FHWA website: [http://www.fhwa.dot.gov/planning/fcsec2_1.htm](http://www.fhwa.dot.gov/planning/fcsec2_1.htm)
## Exhibit B-7

Crosswalk for Matching MOBILE6 Vehicle Types to CACPS Vehicle Types

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

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

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.

• 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

<table>
<thead>
<tr>
<th>Sector</th>
<th>Equipment Type</th>
</tr>
</thead>
</table>
| 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)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Equipment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleasure Craft</td>
<td>Inboard/Sterndrive</td>
</tr>
<tr>
<td></td>
<td>Outboard</td>
</tr>
<tr>
<td></td>
<td>Personal Water Craft</td>
</tr>
<tr>
<td>Industrial Equipment</td>
<td>AC/Refrigeration</td>
</tr>
<tr>
<td></td>
<td>Aerial Lifts</td>
</tr>
<tr>
<td></td>
<td>Forklifts</td>
</tr>
<tr>
<td></td>
<td>Other General Industrial Equipment</td>
</tr>
<tr>
<td></td>
<td>Other Material Handling Equipment</td>
</tr>
<tr>
<td></td>
<td>Other Oil Field Equipment</td>
</tr>
<tr>
<td></td>
<td>Sweepers/Scrubbers</td>
</tr>
<tr>
<td></td>
<td>Terminal Tractors</td>
</tr>
<tr>
<td>Lawn and Garden Equipment</td>
<td>Chain Saws &lt; 6 HP (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Chain Saws &lt; 6 HP (Residential)</td>
</tr>
<tr>
<td></td>
<td>Chippers/Stump Grinders (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Front Mowers (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Lawn and Garden Tractors (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Lawn and Garden Tractors (Residential)</td>
</tr>
<tr>
<td></td>
<td>Lawn Mowers (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Lawn Mowers (Residential)</td>
</tr>
<tr>
<td></td>
<td>Leafblowers/Vacuums (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Leafblowers/Vacuums (Residential)</td>
</tr>
<tr>
<td></td>
<td>Other Lawn and Garden Equipment (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Other Lawn and Garden Equipment (Residential)</td>
</tr>
<tr>
<td></td>
<td>Rear Engine Riding Mowers (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Rear Engine Riding Mowers (Residential)</td>
</tr>
<tr>
<td></td>
<td>Rotary Tillers &lt; 6 HP (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Rotary Tillers &lt; 6 HP (Residential)</td>
</tr>
<tr>
<td></td>
<td>Shredders &lt; 6 HP (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Shredders &lt; 6 HP (Residential)</td>
</tr>
<tr>
<td></td>
<td>Snowblowers (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Snowblowers (Residential)</td>
</tr>
<tr>
<td></td>
<td>Trimmers/Edgers/Brush Cutters (Commercial)</td>
</tr>
<tr>
<td></td>
<td>Trimmers/Edgers/Brush Cutters (Residential)</td>
</tr>
<tr>
<td></td>
<td>Turf Equipment (Commercial)</td>
</tr>
<tr>
<td>Logging Equipment</td>
<td>Chain Saws &gt; 6 HP</td>
</tr>
<tr>
<td></td>
<td>Forest Eqp - Feller/Bunch/Skidder</td>
</tr>
<tr>
<td></td>
<td>Shredders &gt; 6 HP</td>
</tr>
<tr>
<td>Railway Maintenance</td>
<td>Railway Maintenance</td>
</tr>
<tr>
<td>Recreational Equipment</td>
<td>All Terrain Vehicles</td>
</tr>
<tr>
<td></td>
<td>Golf Carts</td>
</tr>
<tr>
<td></td>
<td>Motorcycles: Offroad</td>
</tr>
<tr>
<td></td>
<td>Snowmobiles</td>
</tr>
<tr>
<td></td>
<td>Specialty Vehicles/Carts</td>
</tr>
</tbody>
</table>
### Exhibit B-9

Types of Solid Waste Generated and Disposal Methods

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

* 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

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

References:


APPENDIX C:

DATA FOR GOVERNMENT OPERATIONS INVENTORY
## Exhibit C-1

### Energy Use by Buildings Owned by the City of Alexandria

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Facility Address</th>
<th>Square Footage</th>
<th>Annual Electricity Usage (kwh)</th>
<th>Electricity Cost</th>
<th>Annual Natural Gas Usage (therms)</th>
<th>Gas Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ALX 2300 Commonwealth Motor</td>
<td>400 COMMONWEALTH AVE</td>
<td>108</td>
<td></td>
<td>$64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 ALX 2300 Commonwealth Motor</td>
<td>2300 COMMONWEALTH AVE</td>
<td>105</td>
<td></td>
<td>$35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 ALX Ben Brenman Park</td>
<td>4800 Duke St</td>
<td>672</td>
<td>333,920</td>
<td>$22,758</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 ALX Ben Brenman Park</td>
<td>4725 Duke St</td>
<td>3,198</td>
<td></td>
<td>$249</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 AMPHITHEATER</td>
<td>4301 W BRADDOCK RD</td>
<td>2,400</td>
<td>53,581</td>
<td>$4,072</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 ALX Animal Shelter new</td>
<td>4101 EISENHOWER AVE</td>
<td>13,362</td>
<td>394,320</td>
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## Facility Name

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<th>Facility Name</th>
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<th>Square Footage</th>
<th>Annual Electricity Usage (kwh)</th>
<th>Electricity Cost</th>
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<td>94 ALX Lee Center</td>
<td>1108 JEFFERSON ST</td>
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<td>1108 JEFFERSON ST</td>
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<td>220 N WASHINGTON ST</td>
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<td>201 S WASHINGTON ST</td>
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<td>101 ALX Marshall Lane Park</td>
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<td>102 ALX MH Community Shelter DTX</td>
<td>2355 MILL RD</td>
<td>24,650</td>
<td>398,640</td>
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<td>3801 W BRADDOCK RD</td>
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<td>104 ALX Montgomery Tennis Courts</td>
<td>301 MONTGOMERY ST</td>
<td>10,016</td>
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<td>105 ALX Mt Vernon Recreation Ctr</td>
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<td>106 ALX Mt Vernon Ave Field</td>
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<td>Facility Address</td>
<td>Square Footage</td>
<td>Annual Electricity Usage (kwh)</td>
<td>Electricity Cost</td>
<td>Annual Natural Gas Usage (therms)</td>
<td>Gas Cost</td>
</tr>
<tr>
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<td>107 ALX Multi Use Bldg 116 Quaker</td>
<td>116 S QUAKER LN (DASH)</td>
<td>33,150</td>
<td>847,477</td>
<td>$47,644</td>
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<td>108 ALX Multi Use Bldg 133 Quaker</td>
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<td>30,690</td>
<td>302,752</td>
<td>$29,938</td>
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<td>109 ALX Office on Aging</td>
<td>718 N COLUMBUS ST</td>
<td>2,940</td>
<td>28,851</td>
<td>$2,138</td>
<td>1,762</td>
<td>$2,799</td>
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<td>110 ALX Office on Women</td>
<td>311 E CUSTIS AVE</td>
<td>2,980</td>
<td>44,202</td>
<td>$3,283</td>
<td>2,178</td>
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<td>1609 CAMERON ST</td>
<td>5,336</td>
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<td>275</td>
<td>$531</td>
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<td>112 ALX Oronoco N Pitt Pkng Lot</td>
<td>500 ORONOC ST</td>
<td>1,661</td>
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<td>$128</td>
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<td>113 ALX Oronoco Park Sprinkler Systm</td>
<td>100 MADISON ST</td>
<td>30</td>
<td></td>
<td>$66</td>
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<tr>
<td>114 ALX Oronoco Park Lights</td>
<td>100 MADISON ST</td>
<td>12,716</td>
<td>$967</td>
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<td>115 ALX Oronoco Park Lights</td>
<td>1 ORONOCO ST</td>
<td>4,046</td>
<td>$308</td>
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<td>116 ALX Patrick Henry Rec Center</td>
<td>4643 TANEY AVE</td>
<td>8,850</td>
<td>124,656</td>
<td>$8,662</td>
<td>4,596</td>
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<td>4623 TANEY AVE</td>
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<td>118 ALX Patrick St Parking Lot</td>
<td>111 S PATRICK ST</td>
<td>1,616</td>
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<td>119 ALX Point Lumley</td>
<td>202 THE STRAND</td>
<td>2,267</td>
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<td>120 ALX Police K9 Facility</td>
<td>1108 JEFFERSON ST</td>
<td>36,080</td>
<td>$2,549</td>
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<td>121 ALX Police Pistol Range</td>
<td>5261 EISENHOWER AVE</td>
<td>864</td>
<td>37,301</td>
<td>$2,823</td>
<td>602</td>
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<td>122 ALX Print Shop and Archives</td>
<td>801 PAYNE ST</td>
<td>34,759</td>
<td>389,680</td>
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<td>17,716</td>
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<td>123 ALX PTO Pedestrian Tunnel</td>
<td>300 TELEGRAPH RD</td>
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<td>124 ALX Public Safety Center (POLICE)</td>
<td>2355 MILL RD</td>
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<td>5650 SANGER AVE</td>
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<td>557,080</td>
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<td>7,193</td>
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<td>127 ALX Ramsay Tennis Courts</td>
<td>SANGER/BEAULEGARD ST</td>
<td>2,154</td>
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<td>128 ALX Recovery Home/mr/mh/sa</td>
<td>116 N GRAYSON ST</td>
<td>3,088</td>
<td>25,814</td>
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<td>1,825</td>
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<td>129 ALX Rivergate PI Park Lights</td>
<td>815 RIVERGATE PL</td>
<td>12,114</td>
<td>$923</td>
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<tr>
<td>130 ALX Roth Street Building</td>
<td>2908 BUSINESS CENTER DR</td>
<td>31,145</td>
<td>58,208</td>
<td>$4,286</td>
<td>2,190</td>
<td>$3,568</td>
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<td>131 ALX Roth Street Building</td>
<td>2914 BUSINESS CENTER DR</td>
<td>9,584</td>
<td>17,737</td>
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<td>674</td>
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<td>132 ALX Roth Street Building</td>
<td>2914 BUSINESS CENTER DR</td>
<td>19,167</td>
<td>36,338</td>
<td>$2,693</td>
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<td>133 ALX RP and CA Maint Facility</td>
<td>3618 WHEELER AVE</td>
<td>5,351</td>
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<tr>
<td>Facility Name</td>
<td>Facility Address</td>
<td>Square Footage</td>
<td>Annual Electricity Usage (kwh)</td>
<td>Electricity Cost</td>
<td>Annual Natural Gas Usage (therms)</td>
<td>Gas Cost</td>
</tr>
<tr>
<td>---------------------------------------</td>
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<td>ALX Simpson Stadium</td>
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<td>39,000</td>
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<tr>
<td>ALX Soccer Field and Flower Bed</td>
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<td>$697</td>
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<tr>
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<td>15,997</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALX The Lyceum</td>
<td>201 S WASHINGTON ST</td>
<td>9,460</td>
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<td>ALX Torpedo Factory</td>
<td>105 N Union St</td>
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<td>1,797,132</td>
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<td>105 N Union St</td>
<td>166,680</td>
<td>$11,083</td>
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<tr>
<td>ALX Torpedo Factory</td>
<td>10 THOMPSON ALY unit b</td>
<td>39,040</td>
<td>$2,963</td>
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<tr>
<td>ALX Torpedo Factory garage</td>
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<td>119,418</td>
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<tr>
<td>ALX Transit Store</td>
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<td>16,752</td>
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<tr>
<td>ALX Trash Compactor</td>
<td>102 N UNION ST</td>
<td>1,009</td>
<td>$90</td>
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<tr>
<td>ALX Van Dorn Tunnel</td>
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<td>1,610</td>
<td>$151</td>
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<tr>
<td>ALX Virginia Ave City Shop</td>
<td>222 VIRGINIA AVE</td>
<td>2</td>
<td>$66</td>
<td></td>
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</tr>
<tr>
<td>ALX Warwick Pool</td>
<td>3301 LANDOVER ST</td>
<td>4,736</td>
<td>62,524</td>
<td>$4,306</td>
<td>51</td>
<td>$266</td>
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<td>ALX Waterfront Park</td>
<td>100 S UNION ST</td>
<td>4,493</td>
<td>$351</td>
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<td>ALX Watson Reading Room</td>
<td>906 WYTHE ST</td>
<td>950</td>
<td>11,747</td>
<td>$885</td>
<td>174</td>
<td>$467</td>
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<td>ALX Wheeler Ave Facility Salt Yrd</td>
<td>3608 WHEELER AVE</td>
<td>57,979</td>
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<tr>
<td>ALX Wheeler Ave Facility Fuel Isld</td>
<td>3550 WHEELER AVE</td>
<td>96</td>
<td>8,007</td>
<td>$583</td>
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<td></td>
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<td>ALX Wilkes St Tunnel</td>
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<tr>
<td>ALX Wolfe St Park</td>
<td>2 WOLFE ST</td>
<td>7,963</td>
<td>$608</td>
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</tr>
<tr>
<td>ALX Wythe St Park</td>
<td>601 N FAIRFAX ST</td>
<td>2,342</td>
<td>$184</td>
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<td></td>
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<tr>
<td>Irrigation S Washington</td>
<td>1201 S. Washington St</td>
<td>0</td>
<td>$66</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>1,399,278</strong></td>
<td><strong>26,239,088</strong></td>
<td><strong>$1,721,943</strong></td>
<td><strong>600,532</strong></td>
<td><strong>$875,937</strong></td>
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### Exhibit C-2

**Energy Use by Libraries Owned by the City of Alexandria**

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

**Energy Use by Leased Facilities with the City as Tenant**

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<tr>
<th>Facility Address</th>
<th>Use</th>
<th>Square Footage</th>
<th>Annual Electricity Usage (kwh)</th>
<th>Annual Natural Gas Usage (therms)</th>
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</thead>
<tbody>
<tr>
<td>1 100 N. PITT ST. #301&amp;307</td>
<td>OFFICE</td>
<td>8,803</td>
<td>205,990</td>
<td>2,025</td>
</tr>
<tr>
<td>2 2525 MT. VERNON AVE.</td>
<td>OFFICE</td>
<td>41,175</td>
<td>963,495</td>
<td>9,470</td>
</tr>
<tr>
<td>3 2 HERBERT ST.</td>
<td>OFFICE</td>
<td>3,150</td>
<td>73,710</td>
<td>725</td>
</tr>
<tr>
<td>4 421 KING ST., FL 2,3,4&amp;5</td>
<td>OFFICE</td>
<td>18,424</td>
<td>431,122</td>
<td>4,238</td>
</tr>
<tr>
<td>5 110 N. ROYAL FL3/123 N. PITT FL2</td>
<td>OFFICE</td>
<td>32,504</td>
<td>760,594</td>
<td>7,476</td>
</tr>
<tr>
<td>6 132 N. ROYAL ST., FL 1&amp;2</td>
<td>OFFICE</td>
<td>14,143</td>
<td>330,946</td>
<td>3,253</td>
</tr>
<tr>
<td>7 132 N. ROYAL ST., FL 2</td>
<td>STORAGE</td>
<td>195</td>
<td>4,563</td>
<td>45</td>
</tr>
<tr>
<td>8 720 N. ST. ASAPH ST.</td>
<td>OFFICE</td>
<td>24,552</td>
<td>574,517</td>
<td>5,647</td>
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<tr>
<td>9 3105 COLVIN ST.</td>
<td>OFFICE/TRAINING</td>
<td>7,871</td>
<td>184,181</td>
<td>1,810</td>
</tr>
<tr>
<td>10 220 N. WASHINGTON ST.</td>
<td>OFFICE</td>
<td>6,240</td>
<td>146,016</td>
<td>1,435</td>
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<tr>
<td>11 2900 EISENHOWER AVE.</td>
<td>OFFICE</td>
<td>15,000</td>
<td>351,000</td>
<td>3,450</td>
</tr>
<tr>
<td>12 POLICE/SPECIAL OPERATIONS</td>
<td>OFFICE</td>
<td>17,030</td>
<td>398,502</td>
<td>3,917</td>
</tr>
<tr>
<td>13 2034 EISENHOWER AVE.</td>
<td>OFFICE</td>
<td>29,888</td>
<td>699,379</td>
<td>6,874</td>
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<td>14 1900 N. BEAUREGARD ST. #200</td>
<td>OFFICE</td>
<td>10,012</td>
<td>234,281</td>
<td>2,303</td>
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<tr>
<td>15 1900 N. BEAUREGARD ST. #300</td>
<td>OFFICE</td>
<td>13,281</td>
<td>310,775</td>
<td>3,055</td>
</tr>
<tr>
<td>16 309 HOOFFS RUN DRIVE</td>
<td>STORAGE</td>
<td>8,000</td>
<td>187,200</td>
<td>1,840</td>
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<tr>
<td>17 422 N. ARMISTEAD ST. #301</td>
<td>GROUP HOME</td>
<td>925</td>
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</tr>
<tr>
<td>18 424 N. ARMISTEAD ST. #T-1</td>
<td>GROUP HOME</td>
<td>925</td>
<td>11,563</td>
<td>342</td>
</tr>
<tr>
<td>19 479 N. ARMISTEAD ST. #102</td>
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<td>15,675</td>
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<tr>
<td>20 525 N. ARMISTEAD ST. #102</td>
<td>GROUP HOME</td>
<td>1,254</td>
<td>15,675</td>
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<tr>
<td>21 301 N. BEAUREGARD ST. #205</td>
<td>GROUP HOME</td>
<td>1,225</td>
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<td>22 8 CANTURBURY SQ. #102</td>
<td>GROUP HOME</td>
<td>1,300</td>
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<tr>
<td>23 22 CANTURBURY SQ. #201</td>
<td>GROUP HOME</td>
<td>1,300</td>
<td>16,250</td>
<td>481</td>
</tr>
<tr>
<td>24 633 N. COLUMBUS ST.</td>
<td>GROUP HOME</td>
<td>2,500</td>
<td>31,250</td>
<td>925</td>
</tr>
<tr>
<td>Facility Address</td>
<td>Use</td>
<td>Square Footage</td>
<td>Annual Electricity Usage (kwh)</td>
<td>Annual Natural Gas Usage (therms)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
<td>----------------</td>
<td>-------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>25 3305B COMMONWEALTH AVE.</td>
<td>GROUP HOME</td>
<td>800</td>
<td>10,000</td>
<td>296</td>
</tr>
<tr>
<td>26 1521 DOGWOOD DR.</td>
<td>GROUP HOME</td>
<td>1,792</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>27 1758 DOGWOOD DR. #B</td>
<td>GROUP HOME</td>
<td>1,246</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>28 5911 EDSALL RD. #111</td>
<td>GROUP HOME</td>
<td>1,169</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>29 5911 EDSALL RD. #413</td>
<td>GROUP HOME</td>
<td>1,018</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>30 6230 EDSALL RD. #101C</td>
<td>GROUP HOME</td>
<td>1,006</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>31 6240 EDSALL RD. #402</td>
<td>GROUP HOME</td>
<td>1,004</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>32 726 S. FAYETTE ST. #G1 &amp; G2</td>
<td>GROUP HOME</td>
<td>1,322</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>33 716 FOUR MILE RD.</td>
<td>GROUP HOME</td>
<td>1,056</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>34 718 FOUR MILE RD.</td>
<td>GROUP HOME</td>
<td>1,056</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>35 116 N. GRAYSON ST.</td>
<td>GROUP HOME</td>
<td>2,719</td>
<td>33,988</td>
<td>1,006</td>
</tr>
<tr>
<td>36 5300 HOLMES RUN PKWY. #516</td>
<td>GROUP HOME</td>
<td>1,362</td>
<td>17,025</td>
<td>504</td>
</tr>
<tr>
<td>37 803 N. HOWARD ST. #360</td>
<td>GROUP HOME</td>
<td>1,028</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>38 805 N. HOWARD ST. #140</td>
<td>GROUP HOME</td>
<td>1,028</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>39 1114 N. HOWARD ST.</td>
<td>GROUP HOME</td>
<td>2,464</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>40 1639 KENWOOD AVE. UNIT B</td>
<td>GROUP HOME</td>
<td>1,246</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>41 3 W. LINDEN ST.</td>
<td>GROUP HOME</td>
<td>2,304</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>42 4525 PEACOCK AVE.</td>
<td>GROUP HOME</td>
<td>2,926</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>43 213 E. RANDOLPH AVE.</td>
<td>GROUP HOME</td>
<td>4,280</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>44 4547 SEMINARY RD.</td>
<td>GROUP HOME</td>
<td>2,295</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>45 1105 E. TAYLOR RUN PKWY.</td>
<td>GROUP HOME</td>
<td>3,726</td>
<td>0</td>
<td>0</td>
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<tr>
<td>46 5250 VALLEY FORGE DR. #607</td>
<td>GROUP HOME</td>
<td>1,323</td>
<td>16,538</td>
<td>490</td>
</tr>
<tr>
<td>47 2500 N. VAN DORN ST. #127</td>
<td>GROUP HOME</td>
<td>1,310</td>
<td>16,375</td>
<td>485</td>
</tr>
<tr>
<td>48 2500 N. VAN DORN ST. #328</td>
<td>GROUP HOME</td>
<td>1,310</td>
<td>16,375</td>
<td>485</td>
</tr>
<tr>
<td>49 4900 SEMINARY RD.</td>
<td>ANTENNA/EQUIPMENT</td>
<td>300</td>
<td>7,020</td>
<td>69</td>
</tr>
<tr>
<td>50 101 CALLAHAN DR.</td>
<td>ANTENNA/EQUIPMENT</td>
<td>300</td>
<td>7,020</td>
<td>69</td>
</tr>
<tr>
<td>51 3201 LANDOVER ST.</td>
<td>ANTENNA/EQUIPMENT</td>
<td>96</td>
<td>2,246</td>
<td>22</td>
</tr>
<tr>
<td>Facility Address</td>
<td>Use</td>
<td>Square Footage</td>
<td>Annual Electricity Usage (kwh)</td>
<td>Annual Natural Gas Usage (therms)</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------</td>
<td>----------------</td>
<td>-------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>52 211 YOAKUM PKWY</td>
<td>ANTENNA/EQUIPMENT</td>
<td>192</td>
<td>4,493</td>
<td>44</td>
</tr>
<tr>
<td>53 836 N. ALFRED ST.</td>
<td>RESIDENT OFFICER</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>54 441 N. ARMISTEAD ST. #13</td>
<td>RESIDENT OFFICER</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>55 5801 DUKE ST. #F-161</td>
<td>SATELLITE FACILITY</td>
<td>800</td>
<td>18,720</td>
<td>184</td>
</tr>
<tr>
<td>56 3620 EDISON ST. #201</td>
<td>SATELLITE FACILITY</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>57 800 FRANKLIN ST.</td>
<td>SATELLITE FACILITY</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>58 1025 W. GLEBE ROAD</td>
<td>SATELLITE FACILITY</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>59 3671 JEFFERSON DAVIS HWY.</td>
<td>SATELLITE FACILITY</td>
<td>102</td>
<td>2,387</td>
<td>23</td>
</tr>
<tr>
<td>60 3410 KING ST.</td>
<td>SATELLITE FACILITY</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>61 3113 MT. VERNON AVE.</td>
<td>SATELLITE FACILITY</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>62 3823-A MT. VERNON AVE.</td>
<td>SATELLITE FACILITY</td>
<td>100</td>
<td>2,340</td>
<td>23</td>
</tr>
<tr>
<td>63 4949 SEMINARY RD.</td>
<td>SATELLITE FACILITY</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>64 5442 BRADFORD CT. #A</td>
<td>SATELLITE FACILITY</td>
<td>800</td>
<td>18,720</td>
<td>184</td>
</tr>
<tr>
<td>65 551 JOHN CARLYLE ST.</td>
<td>SATELLITE FACILITY</td>
<td>800</td>
<td>18,720</td>
<td>184</td>
</tr>
<tr>
<td>66 2960 EISENHOWER AVE.</td>
<td>PARKING</td>
<td>parking</td>
<td>parking</td>
<td>parking</td>
</tr>
<tr>
<td>67 3612 MT. VERNON AVE.</td>
<td>PARKING</td>
<td>7,500</td>
<td>175,500</td>
<td>1,725</td>
</tr>
<tr>
<td>68 717 QUEEN ST.</td>
<td>LIBRARY</td>
<td>25,000</td>
<td>585,000</td>
<td>5,750</td>
</tr>
<tr>
<td>69 1775-C DUKE ST.</td>
<td>RETAIL STORE</td>
<td>680</td>
<td>15,912</td>
<td>156</td>
</tr>
<tr>
<td>70 3301 LANDOVER ST.</td>
<td>RECREATION</td>
<td>34,927</td>
<td>817,292</td>
<td>8,033</td>
</tr>
<tr>
<td>71 3301 LANDOVER ST.</td>
<td>RECREATION</td>
<td>45,176</td>
<td>1,057,118</td>
<td>10,390</td>
</tr>
<tr>
<td>72 5920 STEVENSON AVE.</td>
<td>DETENTION CENTER</td>
<td>ground</td>
<td>ground</td>
<td>ground</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Facility Address</th>
<th>Use</th>
<th>Square Footage</th>
<th>Annual Electricity Usage (kwh)</th>
<th>Annual Natural Gas Usage (therms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200 N. HOWARD ST.</td>
<td>OFFICE</td>
<td>18,310</td>
<td>428,454</td>
<td>4,211</td>
</tr>
<tr>
<td>520 KING ST.</td>
<td>OFFICE</td>
<td>270</td>
<td>6,318</td>
<td>62</td>
</tr>
<tr>
<td>110 N. ROYAL ST. #300</td>
<td>OFFICE</td>
<td>2,200</td>
<td>51,480</td>
<td>506</td>
</tr>
<tr>
<td>116 S. QUAKER LANE</td>
<td>OFFICE/GARAGE</td>
<td>33,150</td>
<td>775,710</td>
<td>7,625</td>
</tr>
<tr>
<td>405 CAMERON ST.</td>
<td>RETAIL STORE</td>
<td>1,100</td>
<td>25,740</td>
<td>253</td>
</tr>
<tr>
<td>138 N. ROYAL ST.</td>
<td>RESTAURANT</td>
<td>4,896</td>
<td>114,566</td>
<td>1,126</td>
</tr>
<tr>
<td>520 KING ST.</td>
<td>ANTENNA/EQUIPMENT</td>
<td>378</td>
<td>8,845</td>
<td>87</td>
</tr>
<tr>
<td>N. UNION ST. (Air Rights)</td>
<td>AIR RIGHTS</td>
<td>45,000</td>
<td>1,053,000</td>
<td>10,350</td>
</tr>
<tr>
<td>5920 STEVENSON AVE.</td>
<td>DETENTION HOME</td>
<td>7,500</td>
<td>175,500</td>
<td>1,725</td>
</tr>
<tr>
<td>5301 EISENHOWER AVE.</td>
<td>FACILITY SITE</td>
<td>n/a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EISENHOWER AVE. (LOTS 500&amp;701)</td>
<td>ADDITIONAL SITE</td>
<td>36,876</td>
<td>862,898</td>
<td>8,481</td>
</tr>
<tr>
<td>100 CALLAHAN DR.</td>
<td>PARKING</td>
<td>1,200</td>
<td>28,080</td>
<td>276</td>
</tr>
<tr>
<td>105 N. UNION ST.</td>
<td>ART CENTER</td>
<td>47,450</td>
<td>1,110,330</td>
<td>10,914</td>
</tr>
<tr>
<td>4480 KING ST.</td>
<td>OFFICE</td>
<td>36,000</td>
<td>842,400</td>
<td>8,280</td>
</tr>
<tr>
<td>200 STRAND ST.</td>
<td>PARKING</td>
<td>11,562</td>
<td>270,551</td>
<td>2,659</td>
</tr>
<tr>
<td>0 PRINCE ST.</td>
<td>PIER &amp; BUILDING</td>
<td>n/a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4401 W. BRADDOCK RD.</td>
<td>ATHLETIC FIELD</td>
<td>5 acres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1108 JEFFERSON ST.</td>
<td>PARKING</td>
<td>n/a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>401 SWANN AVE.</td>
<td>PARKING</td>
<td>20,967</td>
<td>490,628</td>
<td>4,822</td>
</tr>
<tr>
<td>25 W. REED ST.</td>
<td>CHILD CARE</td>
<td>n/a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4001 EISENHOWER AVE.</td>
<td>PARK</td>
<td>26 acres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2704 MT VERNON AVE.</td>
<td>ART ACTIVITIES</td>
<td>2,326</td>
<td>54,428</td>
<td>535</td>
</tr>
</tbody>
</table>

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**

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

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

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<th>Miles or Hours Driven</th>
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### Exhibit C-7

**Daily Miles Traveled During Employee Commute by Zip Code**

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<th>Post Office Name</th>
<th>State</th>
<th>Count</th>
<th>UTM EAST (meters)</th>
<th>UTM NORTH (meters)</th>
<th>UTM ZONE</th>
<th>Distance (miles)</th>
<th>Daily Miles Travelled</th>
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### City of Alexandria GHG/CAP Emissions Inventory

#### Appendix C

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<th>State</th>
<th>Count</th>
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<th>UTM NORTH (meters)</th>
<th>UTM ZONE</th>
<th>Distance (miles)</th>
<th>Daily Miles Travelled</th>
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### Methodology:

1. Get home addresses of City Employees from Human Resources
2. Sort by Zip Code
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

---

**Total:**

- Daily Miles Travelled: 3,020
- Total Distance: 75,765
Exhibit C-8

Methodology to Calculate Annual Vehicle Miles Traveled During Employee Commutes

1 Calculate Raw Annual VMT

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<th>Number of City Employees</th>
<th>Average Daily Travel (miles/day) from Exhibit C-7</th>
<th>Days per week worked</th>
<th>Weeks per year worked</th>
<th>Days per year worked</th>
<th>Vehicle Miles Travelled (miles/year)</th>
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2 Adjust for Employees not Driving to Work

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<td>DASH</td>
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<tr>
<td>70</td>
<td>Metrobus</td>
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<tr>
<td>55</td>
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<td>333</td>
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<th>% of employees in Benefit Program; assumed not to drive to work</th>
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<th>Reduce VMT by % of employees in Benefits Program</th>
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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 Parameters
Table D-15 Summer VMT Mix Fractions for Auto Access (Alexandria)

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<td>HDV 6 – 15 Heavy-Duty Trucks and Buses</td>
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<tr>
<td>1.000</td>
<td>16,851,027</td>
<td>MC 16 MC Motorcycles (All)</td>
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4 Match CACPS Vehicle Categories to Mobile6 vehicle categories

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<td>Auto Mid Size</td>
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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