

## 3.2 Air Quality and Greenhouse Gas Emissions



This section evaluates the regional air quality impacts of implementing the alternatives considered in this EIS. The analysis focuses on the following criteria pollutants: (1) carbon monoxide (CO) and (2) particulate matter (PM) emissions. It also considers other criteria pollutants such as ozone precursors and Toxic Air Pollutants (TAPs).

This EIS examines these potential air quality issues at a regional level. However, for TAPs and fine particulate matter (PM<sub>2.5</sub>), a localized analysis is provided to the degree feasible to identify potential public health impacts from locating new sensitive receptors within transportation corridors areas.

This section of the EIS also analyzes how implementation of the alternatives considered in this EIS may contribute to global climate change through greenhouse gas emissions related to transportation and land uses. Transportation systems contribute to climate change primarily through the emissions of certain greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O) from nonrenewable energy (primarily gasoline and diesel fuels) used to operate passenger, commercial and transit vehicles. Land use changes contribute to climate change through construction and operational use of electricity and natural gas, water demand and waste production.

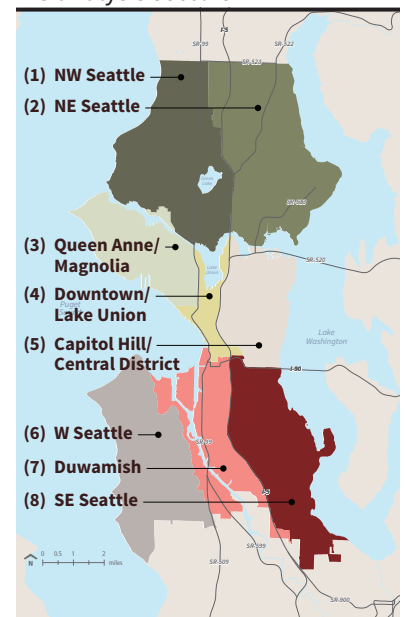
This analysis evaluates air quality and potential impacts on a citywide cumulative basis and, where appropriate, according to the EIS analysis sectors described in Chapter 2 and shown in Figure 2-17 and Figure 3.2-1.

### 3.2.1 Affected Environment

#### Regulatory Agencies and Requirements

Air quality in the Puget Sound region is regulated and enforced by federal, state and local agencies—the U.S. EPA, Ecology and the Puget Sound Clean Air Agency (PSCAA); each have their own role in regulating air quality. The City of Seattle has no policies in its Comprehensive Plan regarding air pollutants, but does have the SEPA policy SMC 25.05.675.A, which provides limited regulatory authority over actions that could degrade air quality.

**Figure 3.2-1**  
EIS analysis sectors



**3.2 Air Quality & GHG**

**U.S. ENVIRONMENTAL PROTECTION AGENCY**

The 1970 Clean Air Act (last amended in 1990) requires that regional planning and air pollution control agencies prepare a regional air quality plan to outline the measures by which both stationary and mobile sources of pollutants will be controlled to achieve all standards by the deadlines specified in the Act. These ambient air quality standards are intended to protect the public health and welfare, and they specify the concentration of pollutants (with an adequate margin of safety) to which the public can be exposed without adverse health effects. They are designed to protect those segments of the public most susceptible to respiratory distress, including asthmatics, the very young, the elderly, people weak from other illness or disease or persons engaged in strenuous work or exercise.

As required by the 1970 Clean Air Act, the U.S. EPA initially identified six criteria air pollutants that are pervasive in urban environments and for which state and federal health-based ambient air quality standards have been established. The U.S. EPA calls these *criteria air pollutants* because the agency has regulated them by developing specific public health- and welfare-based criteria as the basis for setting permissible levels. Ozone, CO, PM, nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>) and lead are the six criteria air pollutants originally identified by U.S. EPA. Since then, subsets of PM have been identified for which permissible levels have been established. These include PM<sub>10</sub> (matter that is less than or equal to 10 microns in diameter) and PM<sub>2.5</sub> (matter that is less than or equal to 2.5 microns in diameter).

The Clean Air Act established National Ambient Air Quality Standards (NAAQS), with primary and secondary standards, to protect the public health and welfare from air pollution. Areas of the U.S. that do not meet the NAAQS for any pollutant are designated by the U.S. EPA as nonattainment areas. Areas that were once designated nonattainment but are now achieving the NAAQS are termed maintenance areas. Areas that have air pollution levels below the NAAQS are termed attainment areas. In nonattainment areas, states must develop plans to reduce emissions and bring the area back into attainment of the NAAQS.

Table 3.2-1 displays the primary and secondary NAAQS for the six criteria pollutants. Ecology and PSCAA have authority to adopt more stringent standards, although many of the state and local standards are equivalent to the federal mandate.

An area remains a nonattainment area for that particular pollutant until concentrations are in compliance with the NAAQS. Only after measured concentrations have fallen below the NAAQS can the state apply for redesignation to attainment, and it must then submit a 10-year plan for continuing to meet and maintain air quality standards that follow the Clean Air Act. During this 10-year period, the area is designated as a maintenance area. The Puget Sound region is currently classified as a maintenance area for CO. With regard to ozone, however, U.S. EPA revoked its 1-hour ozone standard and the area currently meets the 8-hour standard; therefore, the maintenance designation for ozone no longer applies in the Puget Sound region. The U.S. EPA designated Seattle Duwamish area (EIS analysis Sector 7 of the Plan area) as a maintenance area for PM<sub>10</sub> in 2000 and in 2002.

**3.2 Air Quality & GHG****WASHINGTON STATE DEPARTMENT OF ECOLOGY**

Ecology maintains an air quality program with a goal of safeguarding public health and the environment by preventing and reducing air pollution. Washington's main sources of air pollution are motor vehicles, outdoor burning and wood smoke. Ecology strives to improve air quality throughout the state by overseeing the development and conformity of the State Implementation Plan (SIP), which is the state's plan for meeting and maintaining NAAQS. Ecology has maintained its own air quality standard for 1-hour ozone concentrations and established its own more stringent air quality standards for annual NO<sub>2</sub>, SO<sub>2</sub> and PM concentrations, as shown in Table 3.2-1.

**PUGET SOUND CLEAN AIR AGENCY**

The PSCAA has local authority for setting regulations and permitting of stationary air pollutant sources and construction emissions. PSCAA also maintains and operates a network of ambient air quality monitoring stations throughout its jurisdiction.

**Table 3.2-1** Federal and state ambient air quality standards

Pollutant	Averaging Time	(Federal) NAAQS <sup>1</sup>		State of WA
		Primary Standard	Secondary Standard	Standard
Ozone	8 hour	0.075 ppm	0.075 ppm	NSA
	1 hour	NSA <sup>2</sup>	NSA	0.12 ppm
Carbon monoxide (CO)	1 hour	35 ppm	NSA	35 ppm
	8 hour	9 ppm	NSA	9 ppm
Nitrogen dioxide (NO <sub>2</sub> )	1 hour	0.100 ppm	NSA	0.100 ppm
	Annual	0.053 ppm	0.053 ppm	0.05 ppm
Sulfur dioxide (SO <sub>2</sub> )	1 hour	0.075	0.5 ppm (3-hour)	0.40 ppm
	24 hour	0.14	NS	0.10
	Annual	0.03 ppm	NS	0.02 ppm
Particulate matter (PM <sub>10</sub> )	24 hour	150 µg/m <sup>3</sup>	150 µg/m <sup>3</sup>	150 µg/m <sup>3</sup>
	Annual	NSA	NSA	50 µg/m <sup>3</sup>
Fine particulate matter (PM <sub>2.5</sub> )	24 hour	35 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>	NSA
	Annual	12 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>	NSA
Lead	Rolling 3-month average	0.15 µg/m <sup>3</sup>	0.15 µg/m <sup>3</sup>	NSA

NAAQS = national ambient air quality standards; NSA = no applicable standard; ppm = parts per million; µg/m<sup>3</sup> = micrograms per cubic meter

- 1 NAAQS, other than ozone and particulates, and those based on annual averages or annual arithmetic means, are not to be exceeded more than once a year. The 8 hour ozone standard is attained when the 3-year average of the fourth highest daily concentration is 0.08 ppm or less. The 24 hour PM<sub>10</sub> standard is attained when the 3-year average of the 99th percentile of monitored concentrations is less than the standard. The 24 hour PM<sub>2.5</sub> standard is attained when the 3-year average of the 98th percentile is less than the standard.
- 2 The U.S. EPA revoked the national 1 hour ozone standard on June 15, 2005. This state 8 hour ozone standard was approved in April 2005 and became effective in May 2006.

Sources: U.S. EPA, 2012b and Ecology, 2011a.

## Climate and Air Quality

The City of Seattle is in the Puget Sound lowland. Buffered by the Olympic and Cascade mountain ranges and Puget Sound, the Puget Sound lowland has a relatively mild, marine climate with cool summers and mild, wet and cloudy winters.

The prevailing wind direction in the summer is from the north or northwest. The average wind velocity is less than 10 miles per hour. Persistent high-pressure cells often dominate summer weather and create stagnant air conditions. This weather pattern sometimes contributes to the formation of photochemical smog. During the wet winter season, the prevailing wind direction is south or southwest.

There is sufficient wind most of the year to disperse air pollutants released into the atmosphere. Air pollution is usually most noticeable in the late fall and winter, under conditions of clear skies, light wind and a sharp temperature inversion. Temperature inversions occur when cold air is trapped under warm air, thereby preventing vertical mixing in the atmosphere. These can last several days. If poor dispersion persists for more than 24 hours, the PSCAA can declare an “air pollution episode” or local “impaired air quality.”

## Pollutants of Concern

Air quality is affected by pollutants that are generated by both natural and manmade sources. In general, the largest manmade contributors to air emissions are transportation vehicles and power-generating equipment, both of which typically burn fossil fuels. The main criteria pollutants of interest for land use development are CO, PM, ozone and ozone precursors (volatile organic compounds (VOCs) and oxides of nitrogen ( $\text{NO}_x$ )). Both federal and state standards regulate these pollutants, along with two other criteria pollutants,  $\text{SO}_2$  and lead. The Puget Sound region is in attainment for ozone,  $\text{NO}_2$ , lead or  $\text{SO}_2$ .

The major sources of lead emissions have historically been mobile and industrial sources. As a result of the phase-out of leaded gasoline, metal processing is currently the primary source of lead emissions, and no lead emissions are associated with development under the Comprehensive Plan. Emissions of  $\text{NO}_2$  associated with the proposed project are estimated because they are a precursor to ozone formation and assessed relative to their potential impact on ozone concentrations.  $\text{SO}_2$  is produced by the combustion of sulfur-containing fuels, such as oil, coal and diesel. Historically, Washington has measured very low levels of  $\text{SO}_2$ . Because the levels were so low, most monitoring was stopped.  $\text{SO}_2$  emissions have dropped over the past 20 years because control measures were added for some sources, some larger  $\text{SO}_2$  sources shut down and the sulfur content of gasoline and diesel fuel was cut by nearly 90 percent (Ecology 2011b).  $\text{SO}_2$  emissions would not be appreciably generated by development under the Comprehensive Plan and, given the attainment status of the region, are not further considered in this analysis.

**3.2 Air Quality & GHG**

The largest contributors of pollution related to land development activity are construction equipment, motor vehicles and off-road construction equipment. The main pollutants emitted from these sources are CO, PM, ozone precursors (VOC and NO<sub>x</sub>), GHGs and TAPs. Motor vehicles and diesel-powered construction equipment also emit pollutants that contribute to the formation of ground-level ozone. This section discusses the main pollutants of concern and their impact on public health and the environment.

**CARBON MONOXIDE**

CO is an odorless, colorless gas usually formed as the result of the incomplete combustion of fuels. The largest sources of CO are motor vehicle engines and traffic, and industrial activity and woodstoves. Exposure to high concentrations of CO reduces the oxygen-carrying capacity of the blood and can cause headaches, nausea, dizziness and fatigue; impair central nervous system function; and induce angina (chest pain) in persons with serious heart disease. Very high levels of CO can be fatal. The federal CO standards have not been exceeded in the Puget Sound area for the past 20 years (PSCAA 2014), but the Puget Sound region continues to be designated as a maintenance area for CO.

**PARTICULATE MATTER**

PM is a class of air pollutants that consists of heterogeneous solid and liquid airborne particles from manmade and natural sources. PM is measured in two size ranges: PM<sub>10</sub> and PM<sub>2.5</sub>. Fine particles are emitted directly from a variety of sources, including wood burning (both outside and indoor wood stoves and fireplaces), vehicles and industry. They also form when gases from some of these same sources react in the atmosphere.

Exposure to particle pollution is linked to a variety of significant health problems, such as increased hospital admissions and emergency department visits for cardiovascular and respiratory problems, including non-fatal heart attacks and premature death. People most at risk from fine and coarse particle pollution exposure include people with heart or lung disease (including asthma), older adults and children. Pregnant women, newborns and people with certain health conditions, such as obesity or diabetes, also may be more susceptible to PM-related effects.

The federal annual PM<sub>2.5</sub> standard has not been exceeded in the Puget Sound area since the U.S. EPA established its NAAQS in 2007. The daily federal PM<sub>2.5</sub> standard has not been exceeded in the Puget Sound dating back to the initiation of monitoring for this pollutant in 2001 (PSCAA 2014). The U.S. EPA recently adopted a more stringent federal standard for PM<sub>2.5</sub> in December 2012, but attainment designations are not expected until December 2014. Notwithstanding the continued attainment of federal PM<sub>10</sub> standards, portions of the Puget Sound region continue to be designated as a maintenance area for PM<sub>10</sub>. Specifically, the majority of EIS analysis Sector 7 is located within the Seattle Duwamish Particulate Matter Maintenance Area.

**3.2 Air Quality & GHG**

**OZONE**

Ozone is a secondary air pollutant produced in the atmosphere through a complex series of photochemical reactions involving VOCs (also sometimes referred to by some regulating agencies as reactive organic gases, or ROG) and  $\text{NO}_x$ . The main sources of VOC and  $\text{NO}_x$ , often referred to as ozone precursors, are combustion processes (including motor vehicle engines) and the evaporation of solvents, paints and fuels. Ozone levels are usually highest in the afternoon because of the intense sunlight and the time required for ozone to form in the atmosphere. Ecology currently monitors ozone from May through September because this is the period of concern for elevated ozone levels in the Pacific Northwest. No violations of the NAAQS for ozone have occurred at the Seattle monitoring station since monitoring commenced there in 1999.

Elevated concentrations of ground-level ozone can cause reduced lung function and respiratory irritation and can aggravate asthma. Ozone has also been linked to immune system impairment. People with respiratory conditions should limit outdoor exertion if ozone levels are elevated. Even healthy individuals may experience respiratory symptoms on a high-ozone day. Ground-level ozone can also damage forests and agricultural crops, interfering with their ability to grow and produce food. The Puget Sound region is designated as an attainment area for the federal ozone.

**TOXIC AIR POLLUTANTS**

Other pollutants known to cause cancer or other serious health effects are called air toxics. Ecology began monitoring air toxics at the Seattle Beacon Hill site in 2000. The Clean Air Act identifies 188 air toxics; the U.S. EPA later identified 21 of these air toxics as mobile source air toxics (MSATs) and then extracted a subset of seven priority MSATs: benzene, formaldehyde, diesel particulate matter/diesel exhaust organic gases, acrolein, naphthalene, polycyclic organic matter and 1,3-butadiene. Exposure to these pollutants for long durations and sufficient concentrations increases the chances of cancer, damage to the immune system, neurological problems, reproductive, developmental, respiratory and other serious health problems.

Diesel particulate matter poses the greatest potential cancer risk (70 percent of the total risk from air toxics) in the Puget Sound area (PSCAA 2011). This pollution comes from diesel-fueled trucks, cars, buses, construction equipment, rail, marine and port activities. Particulate matter from wood smoke (a result of burning in woodstoves and fireplaces or outdoor fires) presents the second-highest potential cancer health risk. Wood smoke and auto exhaust also contain formaldehyde, chromium, benzene, 1,3-butadiene and acrolein. Chromium is also emitted in industrial plating processes. The U.S. EPA also prioritizes reductions of these air toxics.

**Greenhouse Gases and Climate Change**

Gases that trap heat in the atmosphere are referred to as GHGs because, like a greenhouse, they capture heat radiated from the earth. The accumulation of GHGs has been identified

**3.2 Air Quality & GHG**

as a driving force in global climate change. Definitions of climate change vary between and across regulatory authorities and the scientific community. In general, however, climate change can be described as the changing of the earth's climate caused by natural fluctuations and anthropogenic activities (i.e., activities relating to, or resulting from the influence of, human beings) that alter the composition of the global atmosphere.

Increases in GHG concentrations in the earth's atmosphere are believed to be the main cause of human-induced climate change. GHGs naturally trap heat by impeding the exit of solar radiation that has hit the earth and is reflected back into space. This trapping of heat is called a "greenhouse effect." Some GHGs occur naturally and are necessary for keeping the earth's surface habitable. However, increases in the concentrations of these gases in the atmosphere during the last 100 years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase of global average temperature.

The principal GHGs of concern are CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, SF<sub>6</sub>, perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs). Electric utilities, including City Light, use SF<sub>6</sub> in electric distribution equipment. Each of the principal GHGs has a long atmospheric lifetime (1 year to several thousand years). In addition, the potential heat-trapping ability of each of these gases varies significantly. CH<sub>4</sub> is 23 times as potent as CO<sub>2</sub> at trapping heat, while SF<sub>6</sub> is 23,900 times more potent than CO<sub>2</sub>. Conventionally, GHGs have been reported as CO<sub>2</sub> equivalents (CO<sub>2</sub>e). CO<sub>2</sub>e takes into account the relative potency of non-CO<sub>2</sub> GHGs and converts their quantities to an equivalent amount of CO<sub>2</sub> so that all emissions can be reported as a single quantity.

The primary human-made processes that release GHGs include combustion of fossil fuels for transportation, heating and electricity generation; agricultural practices that release CH<sub>4</sub>, such as livestock production and crop residue decomposition; and industrial processes that release smaller amounts of high global warming potential gases such as SF<sub>6</sub>, PFCs and HFCs. Deforestation and land cover conversion also contribute to global warming by reducing the earth's capacity to remove CO<sub>2</sub> from the air and altering the earth's albedo (surface reflectance), thus allowing more solar radiation to be absorbed.

Like global mean temperatures, U.S. temperatures also warmed during the 20th century and have continued to warm into the 21st century. According to data compiled by the National Oceanic and Atmospheric Administration, average annual temperatures for the contiguous U. S. (or lower 48 states) are now approximately 1.25°F warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years (U.S. EPA 2009b). The rate of warming for the entire period of record (1901–2008) is 0.13°F per decade, while the rate of warming increased to 0.58°F per decade for the period 1979–2008. The last ten 5-year periods were the warmest 5-year periods (i.e., pentads) in the period of record (since 1901; U.S. EPA 2009b).

Ecology estimated that in 2010, Washington produced about 96 million gross metric tons (MMT) CO<sub>2</sub>e; about 106 million U.S. tons) of CO<sub>2</sub>e (Ecology 2012). Ecology found that transpor-

**MMT**CO<sub>2</sub>e or million metric tons of CO<sub>2</sub> equivalents, is how greenhouse gas emissions are typically expressed. CO<sub>2</sub> equivalents is a universal standard of measurement that recognizes the differences between greenhouse gases and their ability to trap heat in the atmosphere.

**3.2 Air Quality & GHG**

tation is the largest source, at 44 percent of the state's GHG emissions; followed by electricity generation (both in-state and out-of-state) at 22 percent and residential, commercial and industrial energy use at 20 percent. The sources of the remaining 14 percent of emissions are agriculture, waste management and industrial processes.

In December 2010, Ecology adopted Chapter 173-441 Washington Administrative Code—Reporting of Emissions of Greenhouse Gases. This rule institutes mandatory GHG reporting for the following:

- Facilities that emit at least 10,000 metric tons of GHGs per year in Washington; or
- Suppliers of liquid motor vehicle fuel, special fuel or aircraft fuel that supply products equivalent to at least 10,000 metric tons of CO<sub>2</sub> per year in Washington.

**CITY OF SEATTLE CLIMATE ACTION PLAN**

Seattle became the first city in the nation to adopt a green building goal for all new municipal facilities, and in 2001 the City created a Leadership in Energy and Environmental Design (LEED) incentive program for private projects. City Resolution 30144 established Seattle City Light's long-term goal of meeting all of Seattle's electrical needs with zero net GHG emissions. City Light achieved GHG neutrality in 2005 through eliminating and reducing emissions, inventorying remaining emissions and purchasing offsets to offset the remaining emissions (SCL 2012) and has maintained GHG neutrality since that date.

In 2011, the City Council adopted a long-term climate protection vision for Seattle (through Resolution 31312) which included achieving net zero GHG Emissions by 2050 and preparing for the likely impacts of climate change. To achieve these goals the City has prepared a Climate Action Plan (2013 CAP) which details the strategy for realizing this vision. The strategy focuses on City actions that reduce GHG emissions while also supporting other community goals, including building vibrant neighborhoods, fostering economic prosperity and enhancing social equity. City actions in the 2013 CAP focus on those sources of emissions where City action and local community action will have the greatest impact: road transportation, building energy and waste, which comprise the majority of local emissions. The City's Comprehensive Plan is identified in the 2013 CAP as one of many plans through which the Climate Action Plan is to be implemented. With 2008 as the baseline year, the 2013 CAP identifies the following as targets by 2030:

- 20 percent reduction in vehicle miles traveled
- 75 percent reduction in GHG emissions per mile of Seattle vehicles
- 10 percent reduction in commercial building energy use
- 20 percent reduction in residential building energy use
- 25 percent reduction in combined commercial and residential building energy use

The 2013 CAP also calls for identification of equitable development policies to support growth and development near existing and planned high capacity transit without displacement.



**CITY OF SEATTLE COMPREHENSIVE PLAN 2004-2024**

The existing City of Seattle Comprehensive Plan contains climate change-related goals and policies within its Environmental Element. These are listed in Appendix A.1.

## Air Quality Information Sources, Monitoring and Trends

The PSCAA monitors criteria air pollutant concentrations at five facilities within Seattle city limits. The primary monitoring station within Seattle is located in Beacon Hill in EIS analysis Sector 8. This station collects data for ozone, CO, NO<sub>2</sub> and SO<sub>2</sub>. The other four stations are located at Queen Anne Hill (Sector 3), Olive Way and Boren Avenue (Sector 4), Duwamish (Sector 7) and South Park (Sector 7). These other four stations monitor only PM<sub>2.5</sub>.

Table 3.2–2 displays the most recent four years of available monitoring data at these locations and shows that the air pollutant concentration trends for these pollutants remain below the NAAQS.

Emission projections and ongoing monitoring throughout the central Puget Sound region indicate that the ambient air pollution concentrations for CO and PM<sub>2.5</sub> have been decreasing over the past decade. Measured ozone concentrations, in contrast, have remained fairly static. The decline of CO is primarily due to improvements made to emission controls on motor

**Table 3.2–2** Ambient air quality monitoring data for monitoring stations in Seattle

Pollutant	Station	Averaging Time	2009 max concentration	2010 max concentration	2011 max concentration	2012 max concentration	NAAQS <sup>1</sup> Standard
Ozone	Beacon Hill (Sector 8)	8 hour <sup>2</sup>	0.049 ppm	0.043 ppm	0.046 ppm	0.049 ppm	0.075 ppm
		1 hour	1.4 ppm	1.2 ppm	1.1 ppm	1.0 ppm	35 ppm
Carbon monoxide (CO)	Beacon Hill (Sector 8)	8 hour	1.0 ppm	0.8 ppm	0.9 ppm	0.7 ppm	9 ppm
		24 hour	23 µg/m <sup>3</sup>	21.4 µg/m <sup>3</sup>	21.6 µg/m <sup>3</sup>	21.8 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>
Fine particulate matter (PM <sub>2.5</sub> )	Queen Anne (Sector 3)	Annual	5.9 µg/m <sup>3</sup>	6.3 µg/m <sup>3</sup>	6.3 µg/m <sup>3</sup>	5.7 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
		24 hour	20 µg/m <sup>3</sup>	20.4 µg/m <sup>3</sup>	20.8 µg/m <sup>3</sup>	23.5 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>
Fine particulate matter (PM <sub>2.5</sub> )	Olive & Boren (Sector 4)	Annual	5.7 µg/m <sup>3</sup>	5.9 µg/m <sup>3</sup>	6.4 µg/m <sup>3</sup>	6.1 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
		24 hour	38 µg/m <sup>3</sup>	26.1 µg/m <sup>3</sup>	26.2 µg/m <sup>3</sup>	26.6 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>
Fine particulate matter (PM <sub>2.5</sub> )	Duwamish (Sector 7)	Annual	8.0 µg/m <sup>3</sup>	8.5 µg/m <sup>3</sup>	9.0 µg/m <sup>3</sup>	8.2 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
		24 hour	34 µg/m <sup>3</sup>	23.5 µg/m <sup>3</sup>	25.1 µg/m <sup>3</sup>	19.5 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>
Fine particulate matter (PM <sub>2.5</sub> )	South Park (Sector 7)	Annual	7.6 µg/m <sup>3</sup>	8.5 µg/m <sup>3</sup>	9.0 µg/m <sup>3</sup>	8.9 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
		1 hour	0.070 ppm	0.052 ppm	0.054 ppm	0.057 ppm	0.100 ppm
Nitrogen dioxide (NO <sub>2</sub> )	Beacon Hill (Sector 8)	Annual	0.015 ppm	0.013 ppm	0.012 ppm	0.012 ppm	0.053 ppm
		1 hour	0.053 ppm	0.030 ppm	0.028 ppm	0.030 ppm	0.075 ppm
Sulfur dioxide (SO <sub>2</sub> )	Beacon Hill (Sector 8)	24 hour	0.008 ppm	0.009 ppm	0.011 ppm	0.006 ppm	0.14 ppm
		Annual	0.002 ppm	0.001 ppm	0.001 ppm	0.001 ppm	0.02 ppm

NAAQS = national ambient air quality standards; NSA = no applicable standard; ppm = parts per million; µg/m<sup>3</sup> = micrograms per cubic meter

- 1 NAAQS, other than ozone and particulates, and those based on annual averages or annual arithmetic means, are not to be exceeded more than once a year. The 8 hour ozone standard is attained when the 3-year average of the fourth highest daily concentration is 0.08 ppm or less. The 24 hour PM<sub>2.5</sub> standard is attained when the 3-year average of the 98th percentile is less than the standard.
- 2 The U.S. EPA revoked the national 1 hour ozone standard on June 15, 2005. This state 8 hour ozone standard was approved in April 2005 and became effective in May 2006.

Sources: PSCAA, 2012b.

**3.2 Air Quality & GHG**

vehicles and the retirement of older, higher-polluting vehicles. However, the Puget Sound Regional Council estimates that by 2040, the Puget Sound region population will grow by 1.7 million people, increasing 52 percent, to reach a population of 5 million people (PSRC 2009). The highest population increase is estimated to be in King County. Estimates such as this indicate that CO, PM<sub>2.5</sub> and ozone emissions will increase, which could lead to future violations of the NAAQS. Future regulations on fuel and motor vehicles are expected to reduce air pollutant emissions from 1990 by more than 75 percent by 2020 (U.S. EPA 2012a).

Air toxic pollutant emissions are also of concern because of the projected growth in vehicle miles traveled. The U.S. EPA has been able to reduce benzene, toluene and other air toxics emissions from mobile sources by placing stringent standards on tailpipe emissions and requiring the use of reformulated gasoline.

### **Sources of Air Pollution in Seattle**

Air pollution sources within Seattle and its environs can be categorized into point sources, transportation sources and area sources.

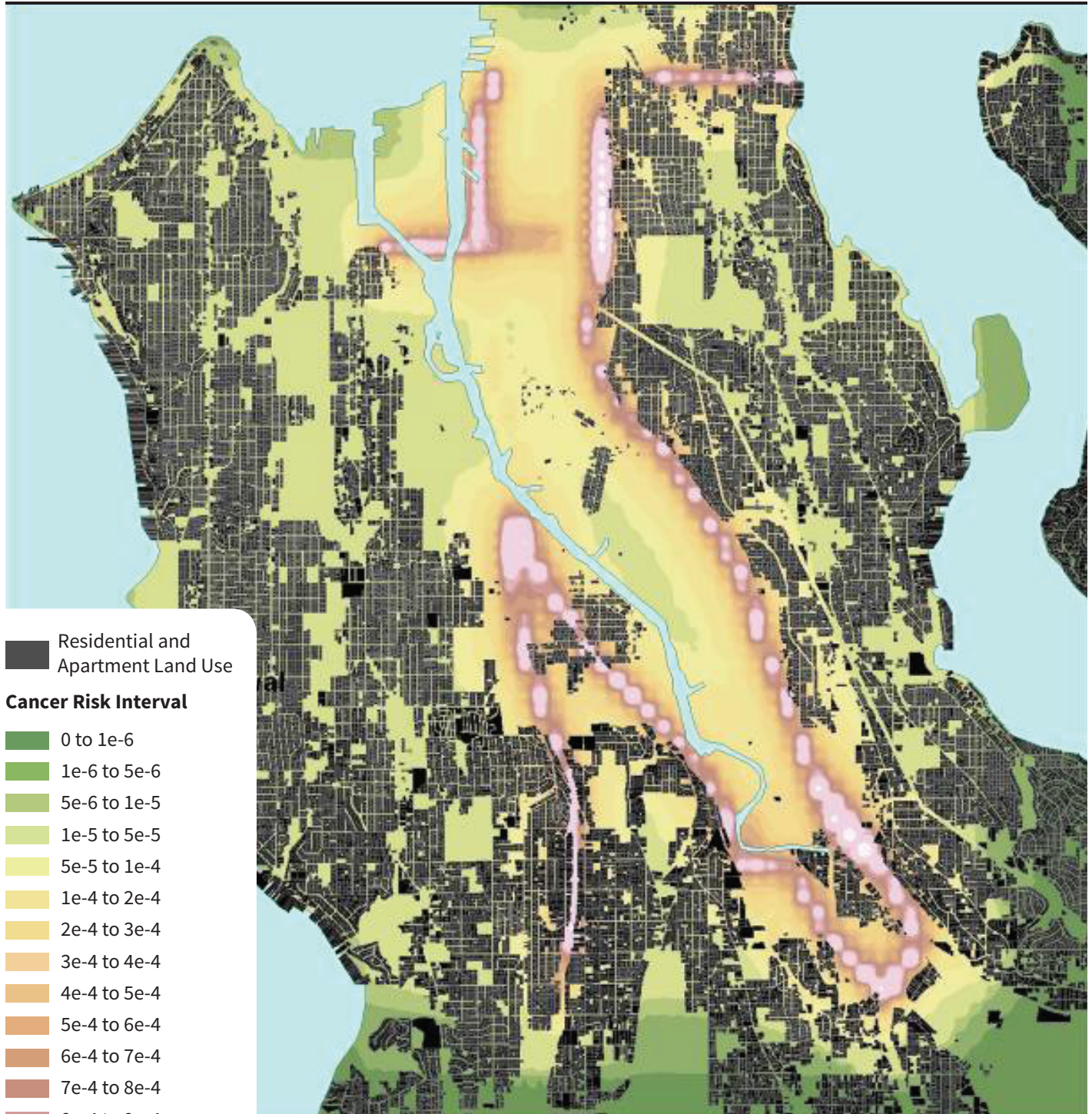
Transportation sources include freeways, highways and major arterial roadways, particularly those supporting a high percentage of diesel truck traffic such as State Routes 99 and 599. A health risk assessment conducted by the Washington State Department of Health (DOH) found that on-road mobile sources contribute to the highest cancer and non-cancer risks near major roadways over a large area of south Seattle and that risks and hazards are greatest near major highways and drop dramatically about 200 meters (656 feet) from the center of highways (WSDH 2008).

Figure 3.2–2 presents the geographical prediction of increased cancer risks from roadway sources in the south Seattle area as determined by the Department of Health. This figure and its corresponding DOH analysis focus on the south Seattle/Duwamish Valley area. The Residents of Georgetown and South Park neighborhoods in south Seattle asked the DOH to conduct an assessment of pollutant impacts on their health and to date this is the only such assessment for the greater Seattle area. The majority of land use in the Duwamish Valley is commercial or industrial with the exception of the two residential communities of Georgetown and South Park. Data from this study, particularly as related to exposure from highway sources would also be expected to be similar to the northern areas of Seattle.

As a point of reference, risks above 100 per one million persons (100 excess cancer risk) is a criterion identified by U.S. EPA guidance for conducting air toxic analyses and making risk management decisions at the facility and community-scale level and, consequently, may be interpreted as a relatively high cancer risk value from a single air pollutant source (BAAQMD 2009). Other states have identified recommended separation distances of residential uses from rail yard source of 1,000 feet. This 1000-foot distance correlates to increased cancer risks below 500 in one million and which may be interpreted as a risk level above which would be considered inappropriate for sensitive land uses and potentially represent a moderate to severe air quality impact (CARB 2005). In relation to these criteria, the mapped areas illustrate

3.2 Air Quality & GHG

**Figure 3.2-2** Cancer risk attributable to on-road sources

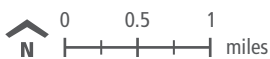


Residential and Apartment Land Use

**Cancer Risk Interval**

- 0 to 1e-6
- 1e-6 to 5e-6
- 5e-6 to 1e-5
- 1e-5 to 5e-5
- 5e-5 to 1e-4
- 1e-4 to 2e-4
- 2e-4 to 3e-4
- 3e-4 to 4e-4
- 4e-4 to 5e-4
- 5e-4 to 6e-4
- 6e-4 to 7e-4
- 7e-4 to 8e-4
- 8e-4 to 9e-4
- 9e-4 to 1e-3
- 1e-3 to 2e-3
- 2e-3 to 3e-3

Source: ESA, 2014; WA Department of Health, 2008; City of Seattle, 2012.



**3.2 Air Quality & GHG**

risks that are quantified as increased cancer risk. Cancer estimates are expressed in scientific notation, for example  $1e-6$  or  $1 \times 10^{-6}$ , is interpreted as 1 excess cancer per million individuals exposed, or an individual's probability of getting cancer from exposure to air pollutants is 1 in 1,000,000. These risks should not be interpreted as estimates of disease in the community, only as a tool to define potential risk. Color-coded risks presented in Figure 3.2–2 range from below one in one million (dark green shading) to 3,000 in one million (white shading).

Additional transportation sources include railway lines supporting diesel locomotive operations. BNSF Railway Company (BNSF) owns and operates a mainline dual-track from Portland to Seattle. Union Pacific owns and operates a single mainline track with two-way train operations between Tacoma and Seattle. BNSF owns and operates tracks that extend north from downtown Seattle to Snohomish County and then east to Spokane. A connecting spur, operated by the Ballard Terminal Rail Company, serves the Ballard and the western ship canal area. Aircraft (from Boeing Field) and marine sources (ferries, tugs, container ships etc.) are also transportation sources which contribute to regional and localized pollutant concentrations.

Point sources (also termed stationary sources) are generally industrial equipment and are almost always required to have a permit to operate from PSCAA. Industrial turbines and cement manufacturing plants are examples of point sources of air pollution. Figure 3.2–3 presents the distribution of point sources in south Seattle, where the majority of industrial land use is located. Examples of area sources include ports, truck-to train intermodal terminals and distribution centers.

Recent goals set by the Port of Seattle aims to reduce PM emissions from ships by 70 percent while they are in port, and to reduce emissions from land-based equipment by 30 percent (Port of Seattle et al. 2007). Providing power plug-ins to ships is an example of measures being taken to reduce emissions while ships are in port. Color-coded risks presented in Figure 3.2–2 range from below one in one million (dark green shading) to 1,100 in one million (white shading).

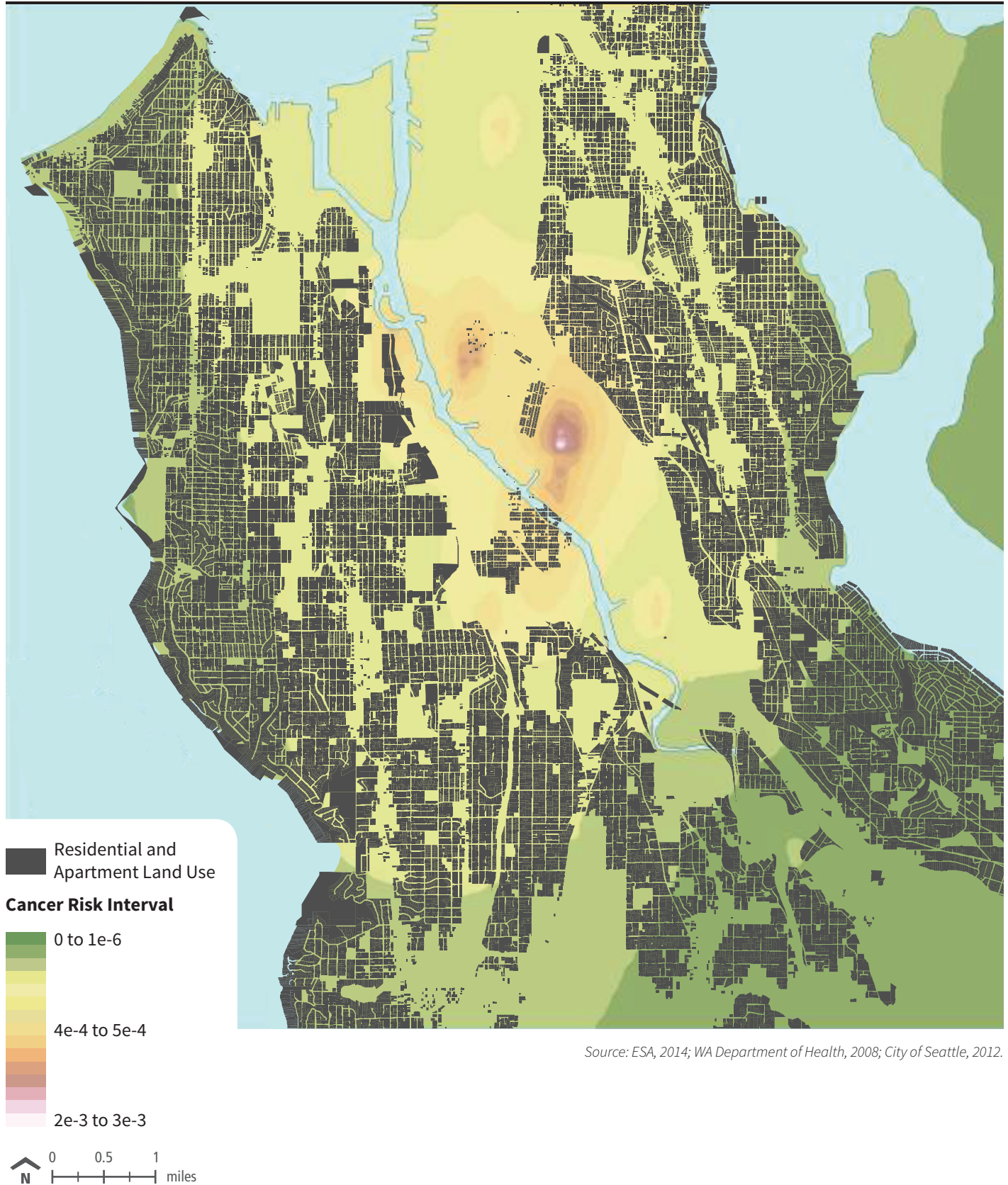
## **Sensitive Populations**

Populations that are more sensitive to the health effects of air pollutants include the elderly and the young; population subgroups with higher rates of respiratory disease, such as asthma and chronic obstructive pulmonary disease; and populations with other environmental or occupational health exposures (e.g., indoor air quality) that affect cardiovascular or respiratory diseases. Therefore, land uses and facilities such as schools, children's daycare centers, hospitals and nursing and convalescent homes are considered to be more sensitive than the general public to poor air quality because the population groups associated with these uses are more susceptible to respiratory distress.

Parks and playgrounds are considered moderately sensitive to poor air quality because persons engaged in strenuous work or exercise have increased sensitivity to poor air quality; however, exposure times are generally shorter in parks and playgrounds than in residential locations and schools. Residential areas are considered more sensitive to air quality condi-

**3.2 Air Quality & GHG**

**Figure 3.2-3** Cancer risk attributable to point sources



Source: ESA, 2014; WA Department of Health, 2008; City of Seattle, 2012.

**3.2 Air Quality & GHG**

tions compared to commercial and industrial areas because people generally spend longer periods of time at their residences, with proportionally greater exposure to ambient air quality conditions. Workers are not considered sensitive receptors because all employers must follow regulations set forth by the Occupational Safety and Health Administration to ensure the health and well-being of their employees with regard to their own operations.

## **Trends: Greenhouse Gas Emissions in Seattle**

In April 2014, the City of Seattle published its 2012 Seattle Community Greenhouse Gas Emissions Inventory. Primary sources (core emissions) of GHG emissions include on-road transportation, building energy and waste generation. Transportation sources comprise approximately 64 percent of inventoried emissions, while building energy (electricity generation and natural gas and other fuel combustion) comprise an additional 33 percent. Core emissions of GHGs declined from 3.8 million metric tons of CO<sub>2</sub>e in 1990 to 3.6 million metric tons of CO<sub>2</sub>e in 2012, a 4 percent decline. This decline occurred despite an overall increase in population during the same period of 23 percent.

### **TRANSPORTATION RELATED GREENHOUSE GAS EMISSIONS**

The analysis completed for this EIS builds off of the findings in the 2014 report. This analysis calculates transportation GHG emissions at the citywide level.<sup>1</sup> The Seattle inventory estimates 2,389,000 metric tons of CO<sub>2</sub>e (MTCO<sub>2</sub>e) in 2012.

Based on a review of traffic and fuel economy trends, the 2012 GHG emissions estimate is assumed to adequately represent 2015 conditions, and may be conservatively high. Additional details may be found in Appendix A.1. Figure 3.2–4 summarizes the 2015 road transportation greenhouse gas emissions.

## **3.2.2 Impacts**

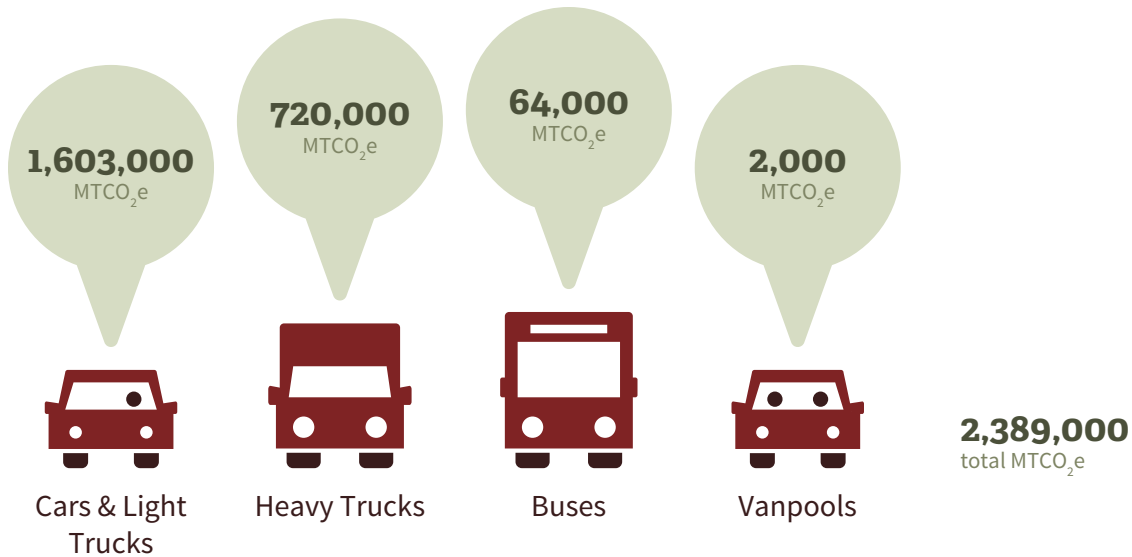
### **Impacts Common to All Alternatives**

#### **AIR QUALITY**

##### **Construction-related Emissions**

Future growth under any alternative would result in development of new residential, retail, light industrial, office and community/art space. Most development projects in the city would entail demolition and removal of existing structures or parking lots, excavation and

<sup>1</sup> The Transportation Chapter of this EIS generally summarizes transportation conditions at a sector or neighborhood level. However, given the amount of travel between sectors, accounting for sector-specific GHG emissions is not relevant. Therefore, only citywide GHG emissions are calculated. This approach is also consistent with the 2014 report.

**Figure 3.2-4** Road transportation emissions (2015)

Source: 2012 Seattle Community Greenhouse Gas Emissions Inventory, 2014.

site preparation and construction of new buildings. Emissions generated during construction activities would include exhaust emissions from heavy duty construction equipment, trucks used to haul construction materials to and from sites, worker vehicle emissions, as well as fugitive dust emissions associated with earth-disturbing activities and other demolition and construction work.

Fugitive dust emissions are typically generated during construction phases. Activities that generate dust include building and parking lot demolition, excavation and equipment movement across unpaved construction sites. The PSCAA requires dust control measures (emissions control) be applied to construction projects through Article 9, Section 9.15. Of these measures, those applicable to fugitive dust include (1) use control equipment, enclosures or wet suppression techniques, (2) paving or otherwise covering unpaved surfaces as soon as possible, (3) Treating construction sites with water or chemical stabilizers, reduce vehicle speeds and cleaning vehicle undercarriages before entering public roadways and (4) covering or wetting truck loads or providing freeboard in truck loads. In light of these requirements, impacts related to construction dust are concluded to be less than significant.

Criteria air pollutants would be emitted during construction activities from demolition and construction equipment, much of it diesel-powered. Other emissions during construction would result from trucks used to haul construction materials to and from sites, and from vehicle emissions generated during worker travel to and from construction sites. Exhaust emission from diesel off-road equipment represent a relatively small percentage of the overall emission inventory in King County: 0.6 percent of county-wide CO, 8.8 percent of countywide NO<sub>x</sub>, 6.7 percent of countywide PM<sub>2.5</sub> and 0.9 percent of county wide VOC (PSCAA 2008). Consequently the primary emissions of concern (greater than 1 percent

**Fugitive dust** is dust that is generated during construction and that escapes from a construction site and is not emitted through an exhaust pipe.

**3.2 Air Quality & GHG**

contribution) with regard to construction equipment are  $\text{NO}_x$  and  $\text{PM}_{2.5}$  (the latter a priority air toxic).  $\text{NO}_x$  is primarily an air quality concern with respect to its role in (regional) ozone formation and the Puget Sound air shed has long been designated as an attainment area (meeting standards) with respect to ozone. Construction-related  $\text{NO}_x$  emissions are not expected to generate significant adverse air quality impacts nor lead to violation of standards under any of the Comprehensive Plan alternatives. The same conclusion is reached for diesel-related emissions of  $\text{PM}_{2.5}$ , which could generate temporary localized adverse impacts within a few hundred feet of construction sites.

A number of federal regulations require cleaner off-road equipment. Specifically, the U.S. EPA has set emissions standards for new off-road equipment engines, classified as Tier 1 through Tier 4. Tier 1 emission standards were phased in between 1996 and 2000, and Tier 4 interim and final emission standards for all new engines are being phased in between 2008 and 2015. To meet the Tier 4 emission standards, engine manufacturers will be required to produce new engines with advanced emission-control technologies. Although the full benefits of these regulations will not be realized for several years, the U.S. EPA estimates that by implementing the federal Tier 4 standards,  $\text{NO}_x$  and PM emissions will be reduced by more than 90 percent (U.S. EPA 2004). Consequently, it is anticipated that as the region-wide construction fleet converts to newer equipment the potential for health risks from off-road diesel equipment will be substantially reduced. So, given the transient nature of construction-related emissions and regulatory improvements scheduled to be phased in, construction related emissions associated with all four alternatives of the Comprehensive Plan would be considered only a minor adverse air quality impact.

**Land Use Compatibility and Public Health Considerations**

Future growth and development patterns conceivably might be influenced by Comprehensive Plan growth strategies in ways that would affect future residences' (or other "sensitive receptors") relationships to mobile and stationary sources of air toxics and particulate matter  $\text{PM}_{2.5}$ . The degree of potential for adverse impacts on new sensitive receptors would depend on proximity to sources, the emissions from these sources and the density of future sensitive development.

As discussed in Section 3.2.1 and shown on Figure 3.2-2, portions of Seattle located along major roadways (freeways and the most-traveled highways) are exposed to relatively high cancer risk values. Modeling indicates increased cancer risks in existing residential areas of up to 800 in one million.<sup>2</sup> Risks above 100 per one million persons (100 excess cancer risk) is a criterion identified by U.S. EPA guidance for conducting air toxic analyses and making risk management decisions at the facility and community-scale level. Residential parcels are located near such highway traffic corridors in south Seattle (although often at higher elevations on Beacon Hill than Interstate 5 and in some areas buffered by greenbelts), and thus at least some such parcels are located in areas of higher exposure and risk. Risks and hazards drop

<sup>2</sup> These risks should not be interpreted as estimates of disease in the community, only as a tool to define potential risk.



**3.2 Air Quality & GHG**

dramatically in places farther than 200 meters (656 feet) from the center of highways. A similar phenomenon occurs in proximity to rail lines that support diesel locomotive operations. Given this, it would be prudent to consider risk-reducing mitigation strategies such as setbacks for residential and other sensitive land uses from major traffic corridors and rail lines and/or to identify measures for sensitive land uses proposed to be in areas near such sources.

As indicated in Figure 3.2–3, portions of Seattle are also exposed to relatively high cancer risk values from stationary sources. Risks could be similarly high near port operations where ship emissions and diesel locomotive emissions and diesel forklift emissions can all occur. Similarly distribution centers that involve relatively high volume of diesel truck traffic can also represent a risk hazard to nearby sensitive land uses. This would also warrant a comprehensive plan to consider setbacks for residential and other sensitive land uses from industrial sources and/or to identify measures for receptors proposed in areas proximate to such sources to reduce the potential risk. This is considered a moderately adverse impact to air quality.

Figure 3.2–5 shows a 200 meter buffer around major freeways, rail lines and major port terminals. This shows that several urban centers, hub urban villages and residential urban villages are already within 200 meters of these pollution sources. Under any alternative, increased residential densities could be expected within this buffer. Variations in potential density increases in these areas under each alternative are discussed further below.

The following urban centers, hub urban villages and residential urban villages are within the 200 meter buffers:

***Urban Centers***

- Downtown
- First/Capitol Hill
- University District
- Northgate
- South Lake Union
- Uptown

***Hub Urban Villages***

- Bitter Lake
- Fremont
- Lake City
- Mount Baker

***Residential Urban Villages***

- 23rd & Union-Jackson
- Aurora-Licton Springs
- Eastlake
- Green lake
- North Beacon Hill
- Roosevelt
- South Park
- Wallingford



This potential increased exposure to cancer risk is considered a potential moderate adverse impact related to air quality.

Given this, it would be prudent to consider risk-reducing mitigation strategies such as setbacks for residential and other sensitive land uses from major traffic corridors, rail lines, port terminals and similar point sources of particulates from diesel fuel and/or to identify measures for sensitive populations proposed to be in areas near such sources.

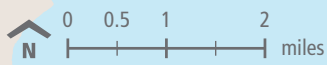
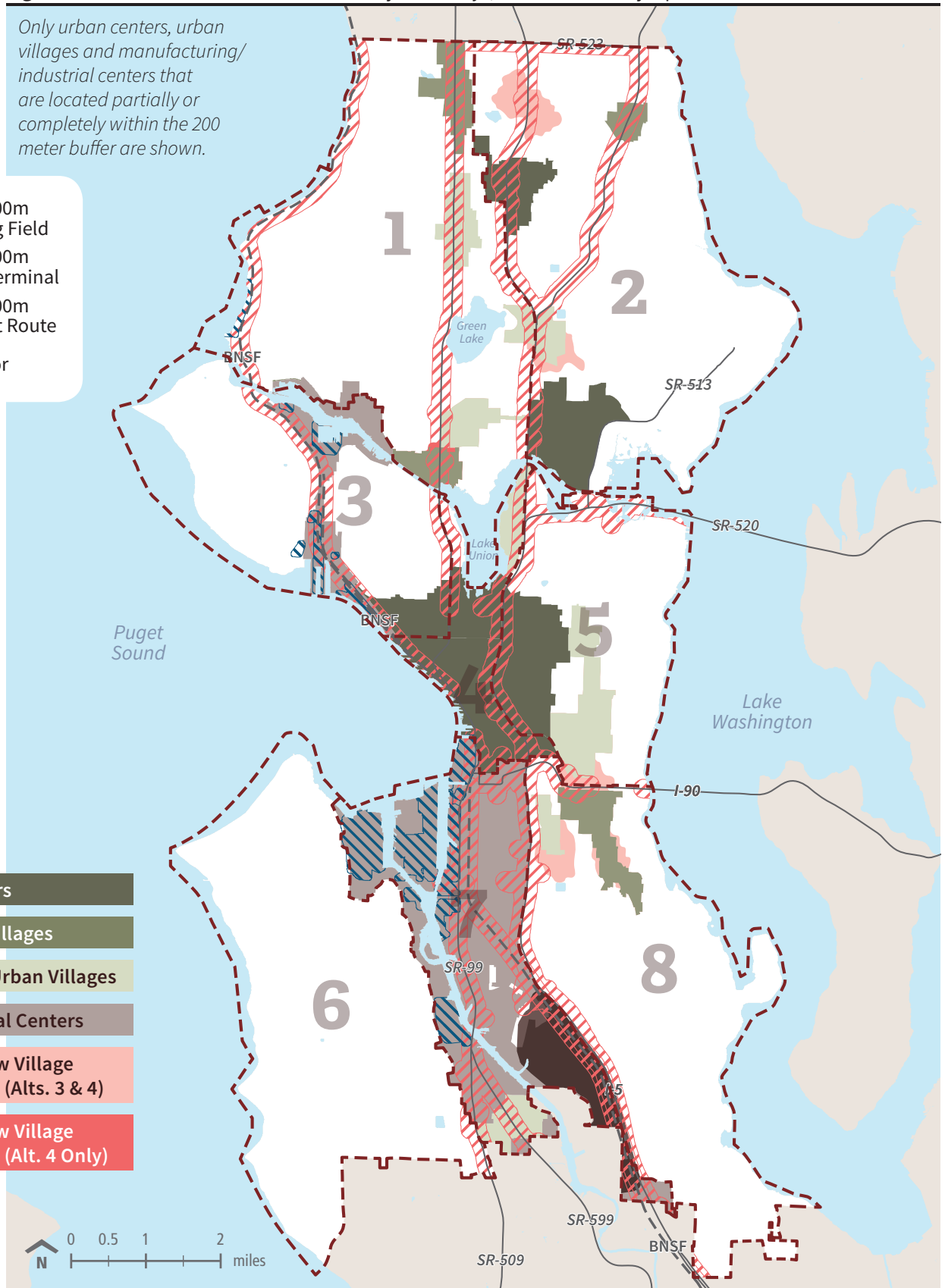
**3.2 Air Quality & GHG**

**Figure 3.2-5** 200 meter buffer around major freeways, rail lines and major port terminals

*Only urban centers, urban villages and manufacturing/ industrial centers that are located partially or completely within the 200 meter buffer are shown.*

-  Within 200m of Boeing Field
-  Within 200m of Port Terminal
-  Within 200m of Transit Route
-  EIS Sector

-  Urban Centers
-  Hub Urban Villages
-  Residential Urban Villages
-  Mfg/Industrial Centers
-  Potential New Village or Expansion (Alts. 3 & 4)
-  Potential New Village or Expansion (Alt. 4 Only)



## GREENHOUSE GAS EMISSIONS

The scale of global climate change is so large that one action's impacts can only be considered on a "cumulative" scale. It is not anticipated that a single development project or programmatic action, even on the citywide scale of the development alternatives in this Draft EIS, would have an individually discernible impact on global climate change. It is more appropriate to conclude that GHG emissions from future development in Seattle would combine with emissions across the state, country and planet to cumulatively contribute to global climate change.

### Construction-related Greenhouse Gas Emissions

GHGs would be emitted during construction activities from demolition and construction equipment, much of it diesel-powered. Other emissions during construction would result from trucks used to haul construction materials to and from sites, and from vehicle emissions generated during worker travel to and from construction sites. Industrial equipment operations, which include the operation of construction equipment, represent approximately 3.3 percent of the emissions estimated in the 2012 GHG emissions inventory (City of Seattle 2014a).

Construction-related GHG emissions from any given development project that may occur in the next 20 years would be temporary and would not represent an on-going burden to the City's inventory. However, cumulatively it can be assumed that varying levels of construction activities within the city would be ongoing under any of the Plan alternatives and hence, cumulative construction related emissions would be more than a negligible contributor to GHG emissions within the city. An estimate of the GHG emissions resulting from 20 years of construction envisioned under the Comprehensive Plan alternatives was calculated using the City of Seattle's SEPA GHG Emissions Worksheet. The estimated total construction-related emissions of 22 million metric tons of CO<sub>2</sub>E over 20 years also include "embodied" or "life cycle" emissions related to construction such as those generated by the extraction, processing and transportation of construction materials.

The City's Climate Action Plan recognizes the relevance of construction related GHG emissions and has included actions to be implemented by 2030 to address them. These include:

- Support new and expanded programs to reduce construction and demolition waste, such as creating grading standards for salvaged structural lumber so that it can be more readily reused;
- Expand source reduction efforts to City construction projects, and incorporate end-of-life management considerations into City procurement guidelines; and
- Phase-in bans on the following construction and demolition waste from job sites and private transfer stations: recyclable metal, cardboard, plastic film, carpet, clean gypsum, clean wood and asphalt shingles.

Additionally, the West Coast Collaborative, a public-private partnership including EPA, equipment manufacturers, fleet owners, state and local governments and non-profit or-

**3.2 Air Quality & GHG**

ganizations leverages federal funds to reduce emissions from the highest polluting engines. With Ecology and privately owned construction companies, the Collaborative recently installed diesel oxidation catalysts on construction equipment and trucks. The project will reduce emissions of carbon by 121.4 tons annually (City of Seattle 2013b).

Consequently, although construction related emissions would not be negligible, because of the combination of regulatory improvements and Climate Plan Actions under way, construction related GHG emissions associated with all four alternatives of the Comprehensive Plan would be considered a minor adverse air quality impact.

**Transportation-related Greenhouse Gas Emissions**

The approach to estimating future year transportation-related GHG emissions considers two factors:

- The projected change in vehicle miles traveled (VMT)
- The projected change in fuel economy of the vehicle fleet

***VMT in 2035.*** Travel demand models include findings about projected vehicle-miles traveled in future years for various classes of vehicles (e.g. cars, trucks, buses). The model generally assumes continuation of current economic and demographic trends, with minor shifts toward shorter trips and more trips made by modes other than automobile travel. This will reduce VMT per capita, but total VMT in the region would continue to rise modestly due to population and employment growth.

If emissions were projected based solely on the increase in VMT, with no changes assumed to fuel economy, emissions under each of the 2035 alternatives would increase by approximately 15 percent compared to 2015. However, the trend toward more stringent federal standards means it is reasonable to assume improved fuel economy by 2035.

***Fuel Economy in 2035.*** Federal programs are mandating improved fuel economy and reduced GHG emissions for passenger cars and light trucks in 2017–2025. According to those standards, fuel economy for passenger cars and light trucks would improve from 33.8 miles per gallon (mpg) in 2015 to 54.5 mpg by 2025. This equates to a GHG emissions decrease of roughly 38 percent for new passenger cars and light trucks entering the vehicle fleet (U.S. EPA 2010, 4; 2012c, 4). Similarly, the EPA and NHTSA issued an initial set of fuel efficiency standards for medium and heavy trucks for model years 2014 to 2018 and plan to issue updated regulations for model years beyond 2018. Based on the initial regulations, GHG emissions are expected to decrease between 9 and 23 percent compared to 2010 models (U.S. EPA 2011, 5).

Although these regulations will result in improved fuel economy for new vehicles, older vehicles would still make up some portion of the 2035 fleet. To account for this, the analysis used the California Air Resource Board’s EMFAC 2011 tool which includes GHG emissions forecasts adjusted for future vehicle fleet composition. The resulting estimate is that GHG emissions of the 2035 vehicle fleet would be 30 percent lower than the 2015 vehicle fleet for passenger cars and light trucks. For heavy trucks, 2035 GHG emissions are projected to

**3.2 Air Quality & GHG**

be four percent lower than 2015 emissions. Note that these are conservative assumptions since no additional gains in new vehicle fuel economy are assumed beyond 2025.

Fuel economy for buses was also considered. King County Metro (KCM) and Sound Transit (ST) set their goals for GHG emission reductions in their respective Sustainability Plans. KCM's goal equates to a roughly 40 percent reduction in emissions between 2015 and 2030 (King County Metro 2014, 8). ST's goal equates to a roughly 30 percent reduction in emissions between 2015 and 2030 (Sound Transit 2014, 15). For this analysis, bus emissions were assumed to be reduced by 35 percent between 2015 and 2030. This is a conservatively low assumption given that the majority of the fleet is operated by KCM which has a higher reduction goal, and the horizon year is 2035 which is five years beyond the goal date set by each transit agency.

**Results.** All four 2035 alternatives generate roughly the same annual GHG emissions, as shown in Table 3.2–3. Alternative 1, the No Action Alternative, is expected to have the highest GHG emissions among the alternatives. Alternative 2, which includes the most concentrated growth pattern, is expected to have the lowest GHG emissions among the alternatives. However, the variation is within one half of one percent. All of the 2035 alternatives are expected to generate lower GHG emissions than in 2015. This is because the projected improvements in fuel economy outweigh the projected increase in VMT.

**Table 3.2–3** Road transportation emissions (2035)

GHG Emissions in MTCO <sub>2</sub> e					
Type of Vehicle	2015 Existing	2035 Alt. 1	2035 Alt. 2	2035 Alt. 3	2035 Alt. 4
Cars and Light Trucks	1,603,000	1,233,000	1,224,000	1,229,000	1,233,000
Heavy Trucks	720,000	892,000	892,000	892,000	891,000
Buses	64,000	42,000	42,000	42,000	42,000
Vanpools	2,000	2,000	2,000	2,000	2,000
<b>Total</b>	<b>2,389,000</b>	<b>2,169,000</b>	<b>2,160,000</b>	<b>2,165,000</b>	<b>2,168,000</b>

Source: Fehr & Peers, 2014.

When evaluated in comparison to the No Action Alternative, emissions under alternatives 2, 3 and 4 would be lower and thus have no identified adverse impacts.

GHG emissions can also be considered from a regional perspective. While the variation between the alternatives' projected emissions within Seattle is minor, the same amount of growth in other jurisdictions in the area would result in very different results. To that end, VMT for auto trips with at least one endpoint outside Seattle was compared to VMT for trips with at least one endpoint in Seattle. The VMT per population/job is nearly 55 percent higher outside of Seattle (but within the four county—Snohomish, King, Kitsap, Pierce—region) than inside of Seattle. This indicates that placing the same amount of development outside Seattle would result in substantially higher emissions (since 2035 fuel economy would remain equivalent regardless of the jurisdiction).

## **Alternative 1: Continue Current Trends (No Action)**

Under Alternative 1 future growth would continue based on current plans and development trends. No changes to current urban village boundaries are proposed. About 77 percent of new residential and employment growth would occur within urban villages and centers and 23 percent would occur outside of the villages. Compared to the other alternatives, Alternative 1 contemplates the largest proportion of growth outside the urban villages overall.

### **TRANSPORTATION-RELATED AIR QUALITY EMISSIONS**

Vehicle miles traveled within the City of Seattle would increase as a result of population and employment growth under Alternative 1. Projected changes in VMT were extracted from the projected travel demand model for cars, light duty trucks, heavy trucks, buses and vanpools. The travel demand model generally assumes existing economic and demographic trends continue with minor changes due primarily to mode share shifts and shortened trips due to increased traffic congestion. These changes cause projected VMT per capita to decline slightly by 2035. However, total VMT would continue to rise modestly due to population and employment growth.

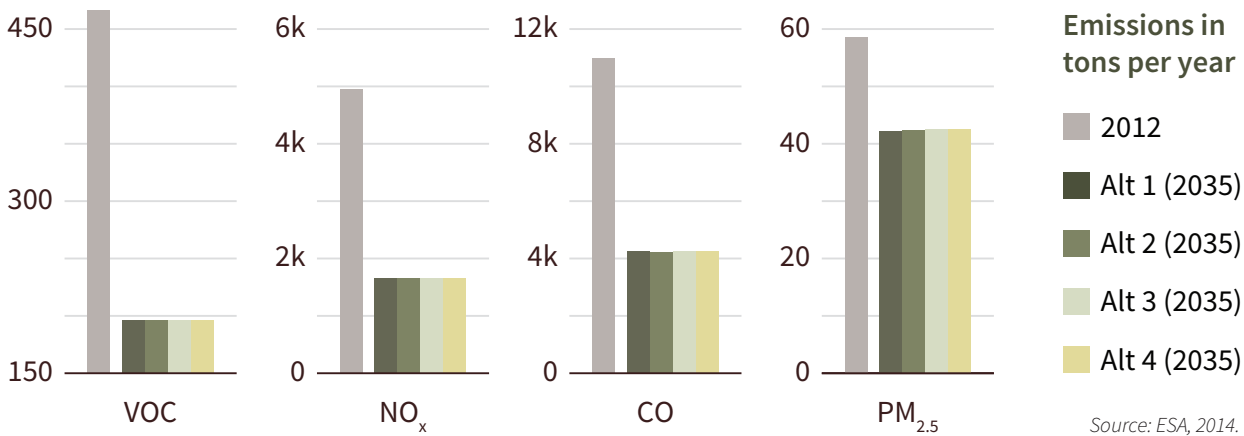
All of the 2035 alternatives are expected to generate lower air pollutant emissions than in 2015, resulting in a net decrease in transportation-related air pollutant emissions. This is because the projected improvement in fuel economy outweighs the projected increase in VMT. Transportation-related air pollutant emissions under existing conditions and each of the four alternatives are presented in Figure 3.2–6 and Appendix A.1. Note that these emissions are City-wide assuming development under each alternative and do not reflect a development-specific increment attributable to each Comprehensive Plan alternative.

In addition to the tailpipe emissions presented in Figure 3.2–6, vehicle travel would also generate PM<sub>2.5</sub> through tire and brake wear and, more significantly, from entrained road dust. These non-tailpipe emissions would not benefit from future improvements to the vehicle fleet as a whole or from improvements to fuel composition.

As can be seen from Figure 3.2–6, regional pollutant emissions under Alternative 1 would be substantially lower than under existing background conditions. This is because the projected improvement in fuel economy, emission controls and fuel composition will outweigh the projected increase in VMT. This would represent a beneficial future air quality outcome. As indicated in Figure 3.2–6, Alternative 1 would have the lowest degree of air quality improvements of the four alternatives.

### **LAND USE COMPATIBILITY AND PUBLIC HEALTH CONSIDERATIONS**

As shown in Figure 3.2–5, 18 urban centers and villages are within 200 meters of a major highway, rail line or port terminal. Of these, the areas where the highest proportion of the urban center village would be affected are: Downtown, South Lake Union, Bitter Lake,

**Figure 3.2-6** Road transportation pollutant emissions

Fremont, Lake City, Northgate, Aurora-Licton Springs, Eastlake, Green Lake, Roosevelt and South Park.

Collectively these urban centers and villages represent 36 percent of all projected residential growth in the city through 2035. Only a portion of each center or village is within the 200 meter buffer, so the potentially affected portion of the new residents would be smaller.

### GREENHOUSE GAS EMISSIONS

Changes in operational GHG emissions associated with development under Alternative 1 would result from increases in VMT and improvements to the vehicle fleet, increased electrical and natural gas usage and solid waste generation. GHG emissions from electrical usage are generated when energy consumed is generated by the non-renewable resources of an electrical supplier such as Seattle City Light. However, Seattle City Light is carbon neutral and, consistent with the City's Climate Action Plan, no emissions related to electricity are assumed because City Light will maintain its commitment to carbon neutrality. GHG emissions from natural gas are direct emissions resulting from on-site combustion for heating and other purposes. Solid waste-related emissions are generated when the increased waste generated by development is disposed in a landfill where it decomposes, producing methane gas.<sup>3</sup>

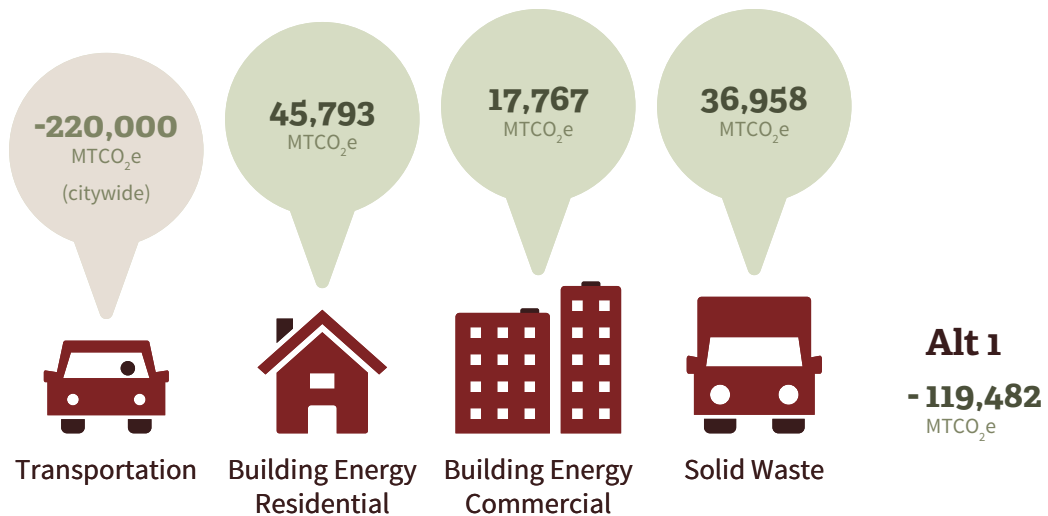
#### Energy Generated GHG

GHG emissions from energy demand are calculated using The CalEEMod land use model (version 2013.2.2). This model is recognized by the Washington State Department of Ecology as an estimation tool (Ecology 2011). These emissions are then adjusted to account for increased efficiency implemented through performance requirements fostered by the Climate Action Plan.

<sup>3</sup> CH<sub>4</sub> from decomposition of municipal solid waste deposited in landfills is counted as an anthropogenic (human-produced) GHG (U.S. EPA, 2006).

**3.2 Air Quality & GHG**

**Figure 3.2-7** Operational GHG emissions of Alternative 1



Source: ESA, 2014; Fehr & Peers, 2014.

**Solid Waste Generated GHG**

Because the total increase in population and jobs would be the same under all four alternatives, increased waste generation and its associated GHG emissions would also be the same among all four alternatives. Increased emissions from solid waste generation were estimated using the most recent (2012) waste generation rate of the Seattle Climate Action Plan. These emissions were then adjusted to account for waste diversion implemented through waste reduction, recycling and composting fostered by the City’s carbon-neutral goal target of 70 percent waste diversion by 2030.

**Total Emissions**

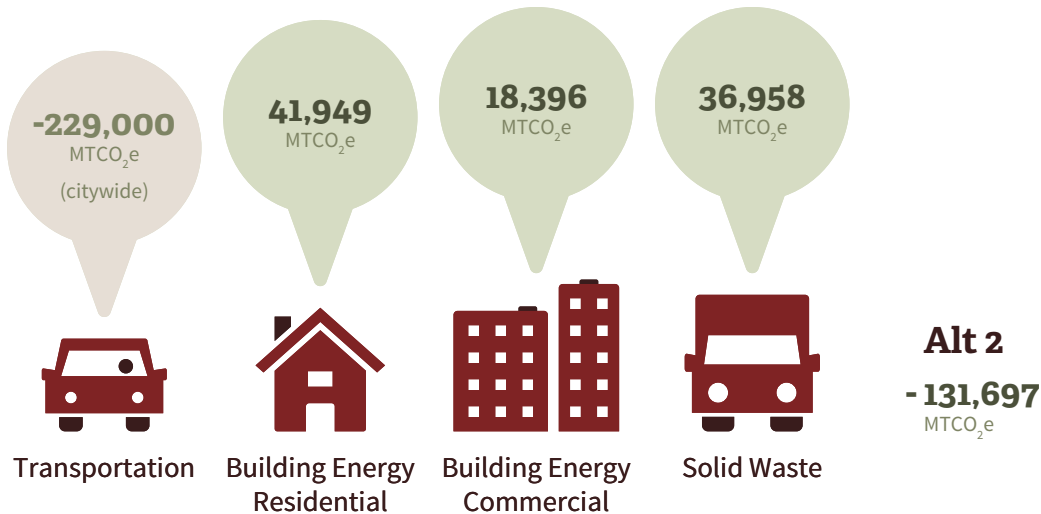
Operational GHG emissions from Alternative 1 are presented in Figure 3.2-7 and Appendix A.1. No significant adverse impacts are identified with respect to these GHG emissions. The emissions reductions from Alternative 1 would be the lowest of any of the four alternatives, largely as the result of greater predicted VMT than the other alternatives, which is a reflection of the greater number of residential development and jobs in the more peripheral urban villages in the city and in places outside urban villages.

**Alternative 2: Guide Growth to Urban Centers**

**TRANSPORTATION AIR QUALITY EMISSIONS**

Transportation-related air pollutant emissions under existing conditions and each of the four alternatives are presented in Figure 3.2-6 and Appendix A.1.



**Figure 3.2-8** Operational GHG emissions of Alternative 2

Source: ESA, 2014; Fehr & Peers, 2014.

As can be seen from Figure 3.2-6, regional pollutant emissions under Alternative 2 would be substantially less than under existing background conditions. This is because the projected improvement in fuel economy, emission controls and fuel composition will outweigh the projected increase in VMT. This would result in a beneficial future air quality outcome. As indicated in Figure 3.2-6, Alternative 2 would have the highest degree of air quality improvements of the four alternatives.

#### LAND USE COMPATIBILITY AND PUBLIC HEALTH CONSIDERATIONS

This alternative would place the emphasis for growth in the urban centers, all of which have portions within 200 meters of a major highway, rail line or port terminal. As such a greater portion of projected growth in the city would be closer to these sources of pollution and thus at higher risk than under Alternative 1. Of the 18 urban centers and villages that are within 200 meters of a major highway, rail line or port terminal, the ones with the highest proportion of the urban center or village affected represent 52 percent of all projected residential growth in the city through 2035, as compared to 36 percent for Alternative 1. Only a portion of each center or village is within the 200 meter buffer, so the potentially affected portion of the new residents would be smaller.

#### GREENHOUSE GAS EMISSIONS

GHG emissions under development of Alternative 2 were calculated using the same methodologies as those described for Alternative 1, but reflect the land use differences of increased density of residential development in the urban core. Operational GHG emissions from Alternative 2 are presented in Figure 3.2-8 and Appendix A.1. No significant adverse impacts are identified with respect to these GHG emissions. The emissions reductions from Alternative 2 would be the greatest of any of the four alternatives, largely as the result

**3.2 Air Quality & GHG**

of reduced VMT which is a reflection of the greater number of residential development and jobs in the more central urban centers and villages.

## Alternative 3: Guide Growth to Urban Villages near Light Rail

### TRANSPORTATION AIR QUALITY EMISSIONS

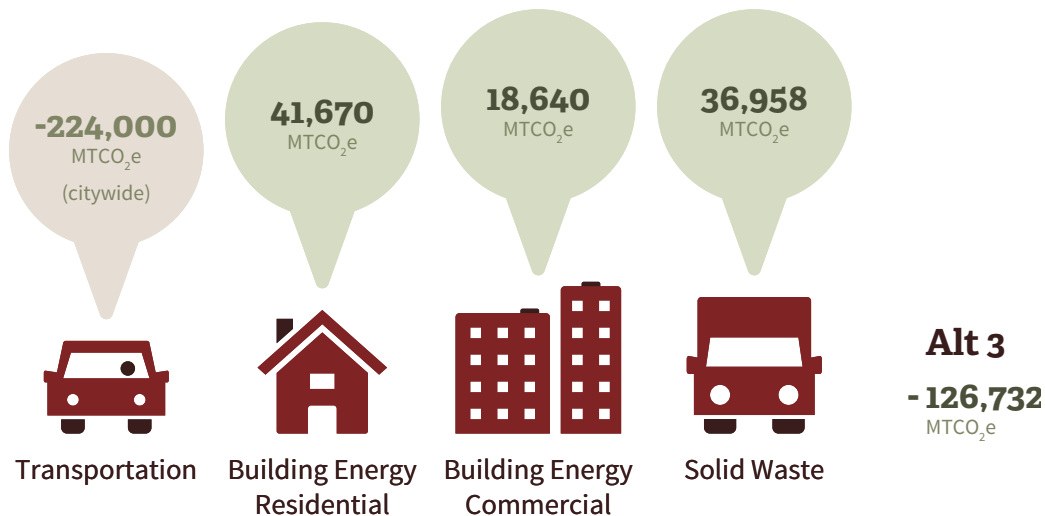
Transportation-related air pollutant emissions under existing conditions and each of the four alternatives are presented in Figure 3.2–6 and Appendix A.1.

As can be seen from Figure 3.2–6, regional pollutant emissions under Alternative 3 would be substantially less than under existing background conditions. This is because the projected improvement in fuel economy, emission controls and fuel composition will outweigh the projected increase in VMT. This would result in a beneficial future air quality outcome. As indicated in Figure 3.2–6, emissions reductions realized from implementation of from Alternative 3 would be less than those of Alternative 2 but greater than those of Alternative 1.

### LAND USE COMPATIBILITY AND PUBLIC HEALTH CONSIDERATIONS

This alternative would place the emphasis for growth near the light rail stations, many of which have portions within 200 meters of a major highway, rail line or port terminal, particularly those in the northern portions of the city. It would also add a new urban village near I-5. As such, a greater portion of projected growth in the city would be closer to these sources of pollution and thus at higher risk than under Alternative 1. Of the 18 urban centers and villages that are within 200 meters of a major highway, rail line or port terminal, the ones with the highest proportion of the urban center or village affected represent 44 percent of all projected residential growth in the city through 2035, as compared to 36 percent for

**Figure 3.2–9** Operational GHG emissions of Alternative 3



Source: ESA, 2014; Fehr & Peers, 2014.

Alternative 1. Only a portion of each center or village is within the 200 meter buffer, so the potentially affected portion of the new residents would be smaller.

#### GREENHOUSE GAS EMISSIONS

GHG emissions under development of Alternative 3 were calculated using the same methodologies as those described for Alternative 1, but reflect the land use differences of increased density of residential development in the urban core and places served by light rail. Operational GHG emissions from Alternative 3 are presented in Figure 3.2–9 and Appendix A.1. No significant adverse impacts are identified with respect to these GHG emissions. The emissions reductions realized from implementation of Alternative 3 would be less than those of Alternative 2 but greater than those of Alternative 1.

### **Alternative 4: Guide Growth to Urban Villages near Transit**

#### TRANSPORTATION AIR QUALITY EMISSIONS

Transportation-related air pollutant emissions under existing conditions and each of the four alternatives are presented in Figure 3.2–6 and Appendix A.1.

As can be seen from Figure 3.2–6, regional pollutant emissions under Alternative 4 would be substantially less than under existing background conditions. This is because the projected improvement in fuel economy, emission controls and fuel composition will outweigh the projected increase in VMT. This would result in a beneficial future air quality outcome. As indicated in Figure 3.2–6, emissions reductions realized from implementation of Alternative 4 would be similar to those of Alternative 3.

#### LAND USE COMPATIBILITY AND PUBLIC HEALTH CONSIDERATIONS

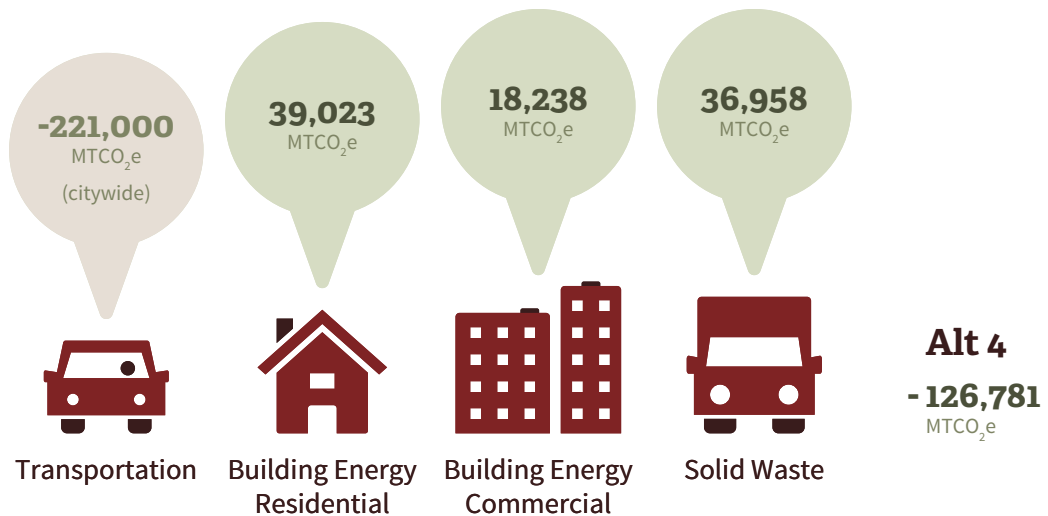
This alternative would place the emphasis for growth in near transit centers, including both frequent bus service and light rail stations, many of which have portions within 200 meters of a major highway, rail line or port terminal, particularly those in the northern portions of the city. Similar to Alternative 3, it would also add a new urban village near I-5, and a greater portion of projected growth in the city would be closer to these sources of pollution and thus at higher risk than under Alternative 1. Of the 18 urban centers and villages that are within 200 meters of a major highway, rail line or port terminal, the ones with the highest proportion of the urban center or village affected represent 44 percent of all projected residential growth in the city through 2035, as compared to 36 percent for Alternative 1. Only a portion of each center or village is within the 200 meter buffer, so the potentially affected portion of the new residents would be smaller.

#### GREENHOUSE GAS EMISSIONS

GHG emissions under development of Alternative 4 were calculated using the same methodologies as those described for Alternative 1, but reflect the land use differences of increased density of residential development in the urban core and selected places served

**3.2 Air Quality & GHG**

**Figure 3.2-10** Operational GHG emissions of Alternative 4



Source: ESA, 2014; Fehr & Peers, 2014.

by light rail or bus service. Operational GHG emissions from Alternative 4 are presented in Figure 3.2-10 and Appendix A.1. No significant adverse impacts are identified with respect to these GHG emissions. The emissions reductions realized from implementation of from Alternative 4 would be similar to those of Alternative 3.

### 3.2.3 Mitigation Strategies

#### Land Use Compatibility with Sources of Air Pollution

Although mitigation strategies are not required due to a lack of significant adverse impact findings, to address the moderate adverse impact potential for exposure of residences and other sensitive land uses to air toxic in high risk areas identified by PSCAA throughout the Seattle area:

- The 2015–2035 Comprehensive Plan could include policy guidance that recommends that residences and other sensitive land uses (i.e., schools, day care) be separated from freeways, railways and port facilities by a buffer area of approximately 200 meters (656 feet), to reduce the potential exposure of sensitive populations to air toxics.
- If sensitive land uses are proposed in such areas, ventilation systems that are capable of filtering pollutant transportation generated particulates could be considered. Specifically, U.S. EPA identifies that mechanical ventilation/filtration systems with a Minimum Efficiency Reporting Value (MERV) of 9 through 12 are adequate for removing 25 to 80 percent of automobile emission particles (U.S. EPA 2009a).

## **Greenhouse Gas Emissions**

Since no significant adverse impacts have been identified, no mitigation strategies are required.

### **3.2.4 Significant Unavoidable Adverse Impacts**

No significant unavoidable adverse impacts to air quality and greenhouse gas emissions are anticipated.

**3.2 Air Quality & GHG**

< intentionally blank >