INDUSTRIAL WAY
INTERSECTION PROJECT | LONGVIEW
OREGON WAY

Energy and Greenhouse Gas Technical Analysis

Prepared for:

Washington State Department of Transportation

Cowlitz County Washington

Prepared by:

WSP USA
851 SW Sixth Avenue, Suite 1600
Portland, Oregon 97204

FEBRUARY 2018

Table of Contents

Figures

Tables

Attachments

Acronyms and Abbreviations

BTU	British Thermal Unit
CO_2e	Carbon Dioxide Equivalent
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
GSA Alternative	Grade-Separated Option A Alternative
GWP	Global Warming Potential
ICE	Infrastructure Carbon Estimator
mBtu	Million British Thermal Unit
PGSB Alternative	Partial Grade-Separated Option B Alternative
SR	State Route
tBtu	Trillion British Thermal Unit
WSDOT	Washington State Department of Transportation

1.0 INTRODUCTION

The Industrial Way / Oregon Way Intersection Project is located in the industrial area of Longview, Washington at the intersection of Industrial Way (State Route (SR) 432), Oregon Way, and SR 433. This intersection provides a critical connection of two Highways of Statewide Significance that support significant passenger and freight truck movement. The purpose of the project is to develop an affordable long-term solution that:

- Maintains or improves emergency response
- Improves travel reliability for all vehicles
- Accommodates current and future freight truck and passenger vehicle movement through the intersection and across the region and states.

The purpose of this document is to describe the existing conditions of energy use and greenhouse gas emissions, discuss effects and benefits the project would have on those conditions, and recommend mitigation measures to address adverse effects. The information contained in this technical analysis supports the project's Environmental Impact Statement (EIS).

Methodology for the analysis contained in this document is presented in the Impact Assessment Methodology memorandum included as Attachment A.

2.0 DESCRIPTION OF ALTERNATIVES

Three alternatives are being evaluated to address the project's purpose and need: the No Build Alternative, the Grade-Separated Option A Alternative (GSA Alternative), and the Partial Grade-Separated Option B Alternative (PGSB Alternative). Each alternative is described in Chapter 2 of the project's EIS.

3.0 AFFECTED ENVIRONMENT

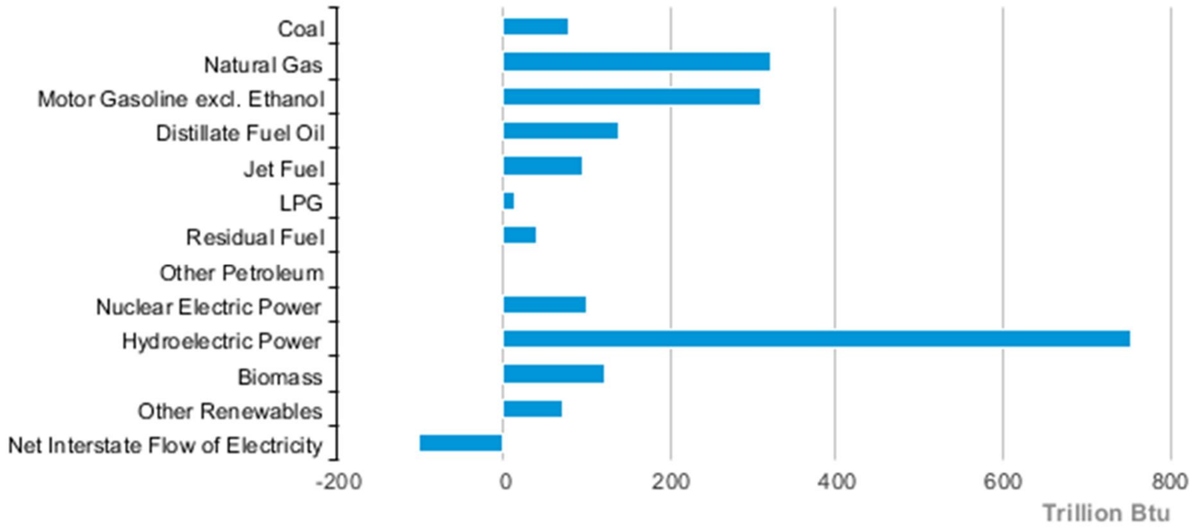
3.1 Transportation Energy

Washington State has a diverse array of energy production and energy consumption elements. While it leads the nation in electricity generation from renewable resources, it is also among the highest consumers of jet fuel in the nation.

Washington consumes more energy than it produces (Figure 1). Of the 2,043 trillion Btu (tBtu) consumed in 2014 in the state, roughly 49 percent came from fossil fuels (coal, natural gas, and petroleum). Renewable energy, such as hydroelectric, was the second-highest energy source consumed, at approximately 46 percent, and nuclear energy was third at 5 percent (EIA 2016).

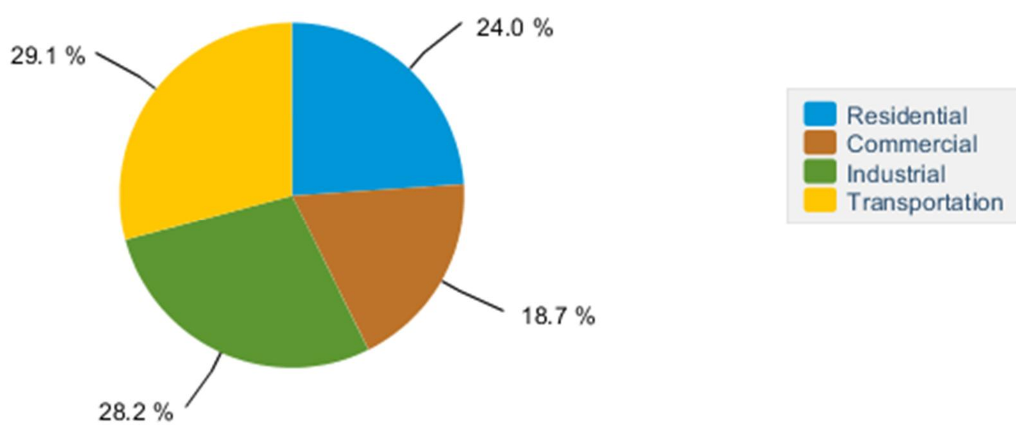
Energy use is generally discussed in terms of end-use sectors. Transportation energy is the energy consumed to move people and goods from place to place. In 2014, transportation was the highest end-use energy consumption sector in the state at roughly 29 percent, closely followed by industrial at nearly 28 percent, residential at 24 percent, and commercial at 19 percent (EIA 2016) (Figure 2).

Figure 1. 2014 Washington Energy Consumption Estimate



Source: EIA 2016

Figure 2. 2014 Washington Energy Consumption by End-Use Sector



Source: EIA 2016

Transportation energy is generally discussed in terms of operational and construction energy consumption. Operational energy consumption involves all energy consumed by vehicle propulsion. This energy is a function of traffic characteristics such as volume, speed, distance traveled, vehicle mix, and the thermal value of the fuel being used. Operational energy consumption also includes the energy required to maintain the transportation facilities. Construction energy consumption involves the non-recoverable, one-time energy expenditure involved in constructing the physical infrastructure associated with the project.

Energy is commonly measured in terms of British thermal units (BTUs). A BTU is defined as the amount of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit. Fossil fuels (e.g., gasoline, diesel fuel, and jet fuel) are the predominant source of energy for transportation in Washington.

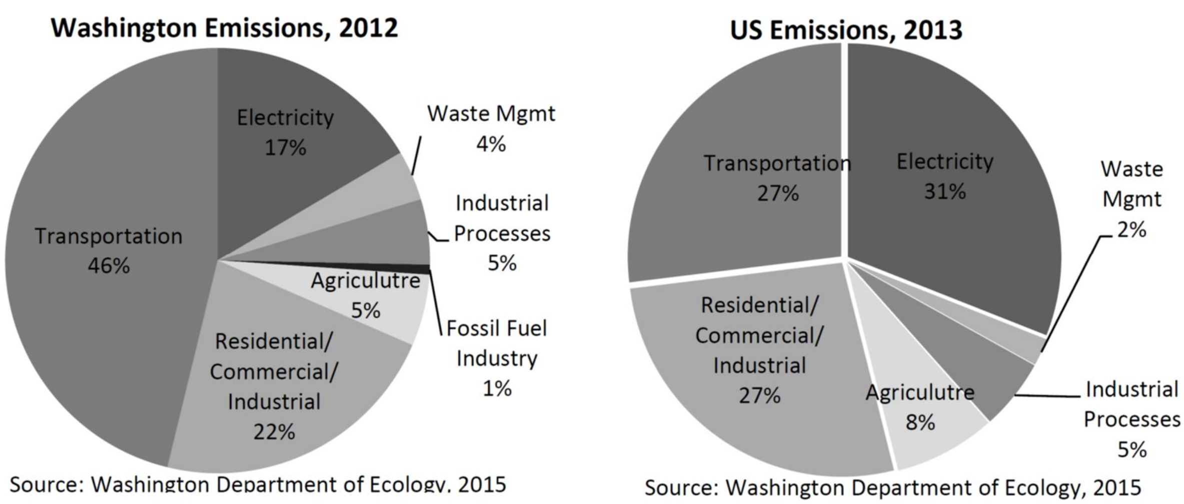
3.2 Greenhouse Gases and Transportation

Vehicles emit a variety of gases during their operation; some of these are greenhouse gases. The greenhouse gases associated with transportation include water vapor, carbon dioxide, methane, and nitrous oxide. Any process that burns fossil fuel releases carbon dioxide into the air. Carbon dioxide makes up the bulk of the emissions from transportation.

Greenhouse gases differ in their ability to trap heat. For example, 1 ton of carbon dioxide has a different effect than 1 ton of methane. To compare emissions of different greenhouse gases, inventory compilers use a weighting factor called Global Warming Potential (GWP). To use a GWP, the heat-trapping ability of 1 metric ton (1,000 kilograms) of carbon dioxide is taken as the standard, and emissions are expressed in terms of carbon dioxide equivalent (CO_2e). The CO_2e for a gas is derived by multiplying the tons of the gas by the associated GWP. The GWP of carbon dioxide is 1. In EPA's MOVES2014a model the GWP of methane is 25, whereas the GWP of nitrous oxide is 298, using a 100-year basis.

Vehicles are a significant source of greenhouse gas emissions and contribute to global warming primarily through the burning of gasoline and diesel fuels. National estimates show that the transportation sector (including on-road vehicles, construction activities, airplanes, and boats) accounts for about 27 percent of total domestic CO_2e emissions. However, in Washington State, transportation accounts for nearly half of greenhouse gas emissions because the state relies heavily on hydropower for electricity generation, unlike other states that rely on fossil fuels such as coal, petroleum, and natural gas to generate electricity. The next largest contributors to total greenhouse gas emissions in Washington are fossil fuel combustion in the residential, commercial, and industrial sectors at 22 percent and electricity consumption at 17 percent. Figure 3 shows the gross greenhouse gas emissions by sector, for Washington State and nationally.

Figure 3. Greenhouse Gas Emissions by Sector in the US and Washington State (2012) and the U.S. (2013)



Source: WSDOT 2016

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 No Build Alternative

4.1.1 Direct Effects

Greenhouse gas tailpipe emissions and energy consumption from vehicle operations during the AM and PM peak hours have been quantified using the U.S. Environmental Protection Agency's (EPA) MOVES2014a model. MOVES2014a takes into account area specific parameters such as vehicle mix, vehicle age, inspection and maintenance programs, and ambient temperatures, along with specific project parameters in order to calculate greenhouse gas emission burdens and energy consumption. Greenhouse gas emissions are described in terms of CO_2e released. The CO_2e emissions take into account the global warming potential of greenhouse gases. Energy consumption is given in terms of million Btus (mBtus).

In addition to the vehicle operations modeled using MOVES2014a, the fuel cycle CO_2e emissions and energy consumed have been calculated. The fuel cycle includes emissions released through extraction, refining, and transportation of fuels used by vehicles traveling in the project area. Fuel cycle emissions were calculated by applying the Federal Highway Administration (FHWA) fuel cycle factor (0.27) to the MOVES2014a modeled results.

Hourly modeled tailpipe and calculated fuel cycle CO_2e emissions and energy consumption would increase under all future (2040) alternatives, including the No Build Alternative, as compared to the existing conditions (2015) due to increased traffic volumes predicted to occur with regional growth (Table 1). Similarly, annual energy consumption and CO_2e emissions are anticipated to increase, as shown in Table 2. Regional traffic volume growth is described in the project's Transportation Discipline Report.

Table 1. Hourly Operational Energy Consumption and CO_2e Emissions

Year	Alternative	Tailpipe or Fuel Cycle	Estimated CO_2e Emitted (Metric Tons per hour)[1]	Estimated Gallons of Gasoline Used (Gallons per hour)[2]	Total Estimated Energy Consumed (mBTU)[3]
AM Peak Hour					
2015	Existing Conditions	Tailpipe	2.18	248	31
		Fuel Cycle	0.59	66.96	8.37
2040	No Build Alternative	Tailpipe	3.10	353	44
		Fuel Cycle	0.84	95.31	11.88
	GSA Alternative	Tailpipe	3.07	350	44
		Fuel Cycle	0.83	94.50	11.88
	PGSB Alternative	Tailpipe	2.85	324	41
		Fuel Cycle	0.77	87.48	11.07
PM Peak Hour					
2015	Existing Conditions	Tailpipe	3.55	404	50
		Fuel Cycle	0.96	109.08	13.50
2040	No Build Alternative	Tailpipe	6.40	729	91
		Fuel Cycle	1.73	196.83	24.57
	GSA Alternative	Tailpipe	5.29	602	75
		Fuel Cycle	1.43	162.54	20.25
	PGSB Alternative	Tailpipe	5.13	585	73
		Fuel Cycle	1.39	157.95	19.71

Notes:
1. EPA's MOVES2014a model used to calculate CO_2e emitted
2. Gasoline use calculated using an emission factor of 8.78 CO_2e Kg per gallon of motor Gasoline (EPA 2016)
3. Energy consumed using an emission factor of 0.125 mBtu per gallon of Gasoline (EPA 2016)

Table 2. 2040 Yearly AM and PM Peak Operational Energy Consumption and CO_2e Emissions

Year	Alternative	Estimated CO_2e Emitted (Metric Tons per year)	Estimated Gallons of Gasoline Used (gallons per year)	Total Estimated Energy Consumed (mBTU per year)
2015	Existing Conditions	7,958	906,704	112,643
2040	No Build Alternative	13,216	1,504,683	187,738
	GSA Alternative	11,627	1,323,899	165,487
	PGSB Alternative	11,095	1,264,101	158,534
2040	GSA Alternative decrease compared to the No Build Alternative	1,589	180,784	22,251
2040	PGSB Alternative decrease compared to the No Build Alternative	2,121	240,582	29,204

Notes:
1. The AM and PM peak hours were assumed to represent 3-hour time periods each.
2. The 2040 Yearly emissions include both tailpipe and fuel cycle emissions.

4.1.2 Indirect Effects

The traffic analyses for the project considered the long-term traffic forecasted to operate within the study area. Maintenance energy consumption and greenhouse gas emissions were calculated using FHWA's new Infrastructure Carbon Estimator (ICE) spreadsheet tool, which incorporates project features and construction traffic delays to calculate CO_2e emissions and energy consumption from routine maintenance. Routine maintenance of the No Build Alternative would result in some energy consumption and greenhouse gas emissions. There would be no additional indirect effects from the No Build Alternative.

4.2 Grade-Separated Option A (GSA) Alternative

4.2.1 Effects during Construction

Construction and maintenance energy consumption and greenhouse gas emissions were calculated using FHWA's Infrastructure Carbon Estimator (ICE) spreadsheet tool, which incorporates project features and construction traffic delays to calculate CO_2e emissions and energy consumption from construction equipment, materials, and routine maintenance. The GSA Alternative analysis includes the effects of re-aligning or constructing approximately 6.9 lane miles and the relocation of approximately 2000 feet of the Reynolds Lead rail line. Table 3 reports FHWA's ICE tool CO_2e emissions and energy consumption results annualized per year over a 20-year period. Construction energy impacts are temporary or short-term in nature. Energy used during construction of the GSA Alternative and in the manufacture of construction materials would be irretrievable. However, construction of this alternative would not adversely affect the continued availability of energy because the scale of the project is negligible when compared to energy production in Washington, the United States, or globally.

Table 3. Annualized Construction and Maintenance Energy Consumption and CO_2e Emissions, per year over 20 years

Alternative	Estimated CO2e Emitted (metric tons per year over 20 years)	Total Estimated Energy Consumed (mBTU per year over 20 years)
No Build Alternative[1]	11	156
GSA Alternative[2]	216	3,142
PGSB Alternative[2]	216	3,159

Notes:
1. Only includes routine maintenance activities.
2. Includes both construction and routine maintenance activities.

4.2.2 Direct Effects

The GSA Alternative is predicted to lower combined CO_2e emission burdens and energy consumption compared to the No Build Alternative (Table 2). These reductions are the result of predicted reduced vehicular congestion under the GSA Alternative. As such, the GSA Alternative is not predicted to cause a significant environmental impact regarding greenhouse gas emissions or impact regarding energy consumption.

4.2.3 Indirect Effects

The traffic analyses for the GSA Alternative considered the long-term traffic forecasted to operate within the study area. Indirect energy and greenhouse gas benefits would occur because construction of the GSA Alternative would help to reduce future traffic delays within the study area compared to the No Build Alternative, as well as reduce traffic-related greenhouse gas emissions and energy consumed. Negative indirect energy and greenhouse gas effects would be unlikely.

4.3 Partial Grade-Separated Option B (PGSB) Alternative

4.3.1 Effects during Construction

The effects of construction of the PGSB Alternative would be the same as those discussed for the GSA Alternative. The PGSB Alternative included effects of re-aligning or constructing approximately 7.7 lane miles. The PGSB Alternative would have slightly higher energy consumed than the GSA Alternative (Table 3) due to increase roadway surface of the PGSB Alternative. CO_2e emissions would be similar.

4.3.2 Direct Effects

The direct effects of the PGSB Alternative would be similar to those described for the GSA Alternative with reduced future traffic delays and reduced CO_2e emissions and energy consumption as compared with the future conditions under the No Build Alternative, as shown in Table 1. Traffic operations are described in the Transportation Discipline Report.

The PGSB Alternative would have lower CO_2e emissions and energy consumed than the GSA Alternative, as shown in Table 2, due to further reduced future traffic delays within the study area. Traffic operations are described in the project's Transportation Discipline Report.

4.3.3 Indirect Effects

Indirect effects of the PGSB Alternative would be the same as those described for the GSA Alternative in Section 4.2.3.

5.0 MEASURES TO AVOID OR MINIMIZE PROJECT EFFECTS

WSDOT's policy is to implement best management practices for preventing greenhouse gas emissions and energy consumption. Measures to avoid or minimize project effects during construction may include:

- Include detours and strategic construction timing (such as night work) in the project traffic plan to continue moving traffic through the area and reduce backups to the traveling public to the extent possible.
- Set up active construction areas, staging areas, and material transfer sites in a way that reduces standing wait times for equipment.
- Work with its partners to promote ridesharing and other commute trip reduction efforts for employees working on the project.

No additional mitigation measures are proposed as part of this analysis.

6.0 REFERENCES

Energy Information Administration (EIA). 2016. Washington State Total Energy Consumption for 2014. December. http://www.eia.gov/state/?sid=WA Retrieved from website April 14, 2016.

U.S. Environmental Protection Agency (EPA). 2016. Greenhouse Gas Inventory Guidance Direct Emissions from Mobile Combustion Sources. https://www.epa.gov/sites/production/files/2016-03/documents/mobileemissions_3_2016.pdf. Retrieved from website May 15, 2015.

WSDOT. 2016. Guidance for project-Level Greenhouse Gas Evaluations under NEPA and SEPA. http://www.wsdot.wa.gov/NR/rdonlyres/8F4C392F-1647-45A7-A2CD-37FB79D45D62/0/ProjectGHGGuidance2016.pdf. Retrieved from website May 15, 2016.

Attachment A: Energy and Greenhouse Gas Impact Assessment Methodology Memorandum

Memorandum	
To:	Joanna Lowrey, PE, WSDOT Kelso Area Engineer Claude Sakr, Cowlitz County Project Manager
From:	Ginette Lalonde, WSP
Date:	April 1, 2016 Revised August 4, 2017
Subject:	Impact Assessment Methodology: Energy and Greenhouse Gas

1. Methodology Introduction

This memorandum presents the methodology used to analyze potential effects of the proposed Industrial Way/Oregon Way Intersection Project on energy and greenhouse gas. This analysis is included in Appendix G (Energy and Greenhouse Gas Technical Analysis) of the environmental impact statement (EIS) prepared for the project.

2. Study Area

The study area for energy and greenhouse gas is shown in Figure A-1 below. The study area encompasses the area of direct and indirect impacts to energy and greenhouse gas resulting from the project.

Figure A-1. Study Area for Energy and Greenhouse Gas

3. Regulations, Standards, or Guidelines

WSDOT's guidance for project-level energy and greenhouse gas analysis was developed through collaboration with internal and external experts (including the U.S. Department of Transportation [USDOT], U.S. Environmental Protection Agency [EPA], Washington State Departments of Ecology and Commerce, Puget Sound Regional Council, and clean air agencies), evaluation of other agency approaches, and assessment of the tools available for calculating greenhouse gas emissions. Federal and state regulations, standard, and guidelines are listed below.

Federal

- National Environmental Policy Act (NEPA) 42 USC 4321 and Federal implementing regulations 23 CFR 771 (FHWA) and 40 CFR 1500.1-1500.8 (CEQ)
- President's Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management
- FHWA Technical Advisory T 6640.8A for NEPA documents
- U.S. Department of Transportation Guidance on Fuel Consumption and Air Pollution, including USDOT Order 5610.1C, Energy Requirements for Transportation Systems, and Procedure for Estimating Highway User Costs, Fuel Consumption, and Air Pollution

State

- State Environmental Policy Act (SEPA) and state implementing regulations WAC 197-11 and WAC 468-12
- Chapter 39.35D RCW requires that new "major facility projects" achieve the Leadership in Energy and Environmental Design (LEED) silver building rating standard
- WSDOT Guidance – Project-Level Greenhouse Gas Evaluations under NEPA and SEPA

4. Sources of Existing Data

MOVES2014 input files were used to estimate emission factors. For input files that cannot be reformatted, or are unavailable, default county-level data were used.

5. Data Gathering or Development

Construction cost estimates were used to estimate construction energy consumption. The construction energy results were converted to greenhouse gas emissions based on project assumptions regarding fuel quantities and types.

Operational emissions analysis was completed using information supplied by the traffic analysis (e.g., year of analysis, traffic volumes, operating speed, link length for each section speeds and volumes, time period of the data [hours of the day], vehicle fleet mix).

6. Analytical Techniques and Models

6.1. Construction Impacts

Construction and maintenance energy consumption was calculated using FHWA's new Infrastructure Carbon Estimator (ICE) spreadsheet tool which incorporates project features and construction traffic delays to calculate emissions from construction equipment, materials, and routine maintenance.

This section describes the temporary effects of fuel consumption for construction of the project and the effect of the project on local fuel availability during construction. It also describes the amount and source of materials and energy needed for project construction, to the extent known.

6.2. Direct Impacts

Greenhouse gas emissions and energy consumption from vehicle operations on the project were quantified. Energy consumed was documented in terms of BTUs or quantities of fuel. Vehicles emit a variety of gases during their operation; some of these are greenhouse gases. The major greenhouse gases associated with transportation are carbon dioxide (CO2), methane, and nitrous oxide. Greenhouse gas emissions will be described in terms of CO2 equivalent (CO2e) released. The CO2e emissions take into account the global warming potential of greenhouse gases.

Operational energy consumption and greenhouse gas emissions were estimated using EPA's MOVES2014 and information supplied by the traffic team. Energy consumption and greenhouse gas emissions were evaluated and compared among alternatives (build vs. no-build). Documentation follows the template language from Appendix B of the WSDOT Guidance – Project-level Greenhouse Gas Evaluations under NEPA and SEPA.

Fuel Cycle Emissions are the emissions from fuel extraction, refining, and transportation to end user. These emissions are reported as a component of operational emissions because they are directly proportional to the amount of fuel used. FHWA has determined that emissions from the fuel cycle are about 27 percent of the emissions from combusting the fuel. Fuel Cycle Emissions were calculated by multiplying the operational emissions by the fuel cycle factor of 0.27.

6.3. Indirect Impacts

The traffic analyses for the project considers the long-term traffic forecasted to operate within the study area. The long-term energy and greenhouse gas analysis includes the indirect traffic impacts.

7. Summary of Potential Impacts and Mitigation

7.1. Potential Benefits

Any reduction in the consumption and greenhouse gas emissions against alternatives (build vs. no-build) is discussed.

7.2. Potential Adverse Impacts

Any increase in the consumption and greenhouse gas emissions against alternatives (build vs. no-build) is discussed.

7.3. Potential Mitigation

Potential mitigation measures are qualitatively discussed.

8. Limitations and Constraints

This section uses relevant Environmental Impact Statement (EIS) template language from Appendix B of the WSDOT Guidance – Project-level Greenhouse Gas Evaluations under NEPA and SEPA to discuss that the production and disposal of materials used in the project will release greenhouse gases. However, at this time, there is no accurate and standardized methodology for calculating the embodied and lifecycle emissions for transportation projects.