Energy Discipline Report

Washington State
Department of Transportation

U.S. Department of Transportation
Federal Highway
Administration

SR 520: I-5 to Medina Bridge Replacement and HOV Project Supplemental Draft EIS

Energy Discipline Report

Prepared for

Washington State Department of Transportation
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December 2009

Contents

Acronyms and Abbreviations ..... **v**
Introduction **1**
Why are energy and greenhouse gas emissions considered in an environmental impact statement? 1
What are the key points of this report? 1
What is the I-5 to Medina: Bridge Replacement and HOV Project? 3
What are the project alternatives? 4
Affected Environment **15**
How was the energy information collected? 15
What are the existing energy characteristics of the study area? 15
Potential Effects of the Project **19**
What methods were used to evaluate the potential energy effects? 19
How would construction of the project affect energy use? 22
How would operation of the project affect energy use? 27
Mitigation **29**
What has been done to avoid or minimize negative effects on energy use? 29
What would be done to mitigate negative effects that could not be avoided or minimized? 29
What negative effects would remain after mitigation? 30
Greenhouse Gas Emissions **31**
What WSDOT efforts are underway to reduce greenhouse gas emissions in Washington State? 32
How were greenhouse gas emissions calculated for project construction? 34
How were greenhouse gas emissions calculated for project operation? 36
What effect would project construction have on greenhouse gas emissions? 37
What effect would project operation have on greenhouse gas emissions? 38
What are potential measures to minimize emissions? 41
Did the project consider future conditions related to climate change? 42
References **44**

Attachments

1 Calculations for Estimated Energy Consumption

2 Model Inputs for Greenhouse Gas Emissions Modeling

List of Exhibits

1 Project Vicinity Map

2 No Build Alternative Cross Section

3 6-Lane Alternative Cross Section

4 Options A, K, and L: Montlake and University of Washington Areas

5 6-Lane Alternative at the Evergreen Point Bridge (Common to All Options)

6 Possible Towing Route and Pontoon Outfitting Locations

7 Geographic Areas along SR 520 and Project Phasing

8 Average Automobile and Pickup Fuel Consumption Rate

9 Energy and Fuel Consumption under Existing Conditions (2006)

10 Primary Facility Type by I-5 to Medina Project Section

11 Annual VMT (millions) by Alternative

12 Energy Consumption Rate Calculations for Passenger Vehicles

13 Energy Consumption Rates by Travel Mode

14 Total Energy Consumption during Construction of the 6-Lane Alternative

15 Estimated Diesel Fuel Consumption and Energy Use during Transport of Pontoons

16 Summary of Construction Energy Effects

17 Total Energy Consumption (in MBtu) during Construction of the 6-Lane Alternative under the Phased Implementation Scenario

18 Annual Fuel Consumption during Operation (2030)

19 Gross GHG Emissions by Sector in U.S. and Washington State (2005)

20 Estimated Onsite Energy Use for Construction

21 Carbon Dioxide Equivalent Emission Factors

22 6-Lane Alternative Construction GHG Emission Option Comparisons

23 Weekday Peak-Period Operational GHG Emissions (2030)

24 Weekday Peak-Period Operational GHG Emission Comparisons (2030)

Acronyms and Abbreviations

B5	5 percent biodiesel
B10	10 percent biodiesel
B20	20 percent biodiesel
Btu	British thermal unit(s)
CALTRANS	California Department of Transportation
CEVP	Cost Estimate Validation Process®
CFR	Code of Federal Regulations
CH_4	methane (also known as "marsh gas")
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
DOE	U.S. Department of Energy
Draft EIS	*SR 520 Bridge Replacement and HOV Project Draft Environmental Impact Statement* (WSDOT 2006)
Ecology	Washington State Department of Ecology
EIA	Energy Information Administration
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
g/gal	grams per gallon
GHG	greenhouse gas
HCT	high-capacity transit
HOV	high-occupancy vehicle
I-5	Interstate 5
I-5 to Medina project	I-5 to Medina: Bridge Replacement and HOV Project
IRT	Incident Response Team

kg/gal	kilograms per gallon
laughing gas	nitrous oxide (N_2O)
marsh gas	methane (CH_4)
MBtu	million British thermal unit(s)
Medina to SR 202 project	Medina to SR 202: Eastside Transit and HOV Project
MOVES	Motor Vehicle Emissions Simulator
mpg	miles per gallon
mph	miles per hour
MT CO_2e	metric tons of carbon dioxide equivalents
MT	metric tons
N_2O	nitrous oxide (also known as "laughing gas")
NA	not applicable
NEPA	National Environmental Policy Act
Pub.L.	Public Law
RCW	Revised Code of Washington
SDEIS	I-5 to Medina: Bridge Replacement and HOV Project Supplemental Draft Environmental Impact Statement
SEPA	State Environmental Policy Act
SPUI	single-point urban interchange
SR	State Route
SR 520 Program	SR 520 Bridge Replacement and HOV Program
SUV	sport utility vehicle
VMT	vehicle miles traveled
WSDOT	Washington State Department of Transportation

Introduction

Why are energy and greenhouse gas emissions considered in an environmental impact statement?

When energy is used to build something or is used to operate a vehicle, it cannot be recovered. Building the new State Route (SR) 520 corridor from Interstate 5 (I-5) to Medina, transporting the pontoons from their moorage locations to the construction site, and operating vehicles in the SR 520 corridor would consume large amounts of energy that would be expensive and no longer available for other purposes. The National Environmental Policy Act (NEPA) requires agencies to consider these environmental effects when making decisions about a proposed project. For these reasons, the Supplemental Draft Environmental Impact Statement (SDEIS) being prepared for the I-5 to Medina: Bridge Replacement and High-Occupancy Vehicle (HOV) Project (I-5 to Medina project) must discuss energy consumption.

Washington State has adopted greenhouse gas (GHG) reduction goals (RCW 70.235.020). As part of the state's plan to reduce GHG emissions, the state has also adopted vehicle miles traveled (VMT) benchmarks (RCW 147.01.440) as one strategy to reduce transportation sector GHG emissions. Guidance on how to address GHG emissions in environmental documents prepared to meet the State Environmental Policy Act (SEPA) requirements is currently being developed. In the meantime, the Washington State Department of Transportation (WSDOT) is evaluating GHG emissions according to its *Interim Approach to Project-Level GHG and Climate Change Evaluations for Transportation Projects* (WSDOT 2009a). The GHG analysis is included in this report following the discussion of Energy.

What are the key points of this report?

Following are the key points of this energy discipline report:

- Project construction activities and the operation of vehicles on SR 520 would consume large amounts of energy resources, particularly petroleum. Because GHGs released during construction and operation come primarily from the fuel burned, GHGs would

be emitted by these activities and would be roughly proportional to these activities

- Of the 6-Lane Alternative design options, Option K would have the highest level of construction energy consumption and GHG emissions—roughly twice as much as Option A and two-thirds more than Option L. The larger energy expenditure and GHG emissions quantity of Option K is because this option would require more construction activity than the other two options.
- The total construction energy consumption and GHG emissions to replace vulnerable structures and to construct future phases would likely be higher than building the 6-Lane Alternative over one construction cycle because of the energy consumed during the additional mobilization required for building the I 5 to Medina project in phases.
- Operation of Options A, K, and L would consume less energy than the No Build Alternative in 2030 because each of the 6-Lane Alternative options would result in a reduction in VMT. The reduction in VMT is based on traffic modeling that assumed that tolls would be charged for the 6-Lane Alternative options. Tolling might encourage some travelers to seek alternative routes across Lake Washington. Other travelers would likely change transportation modes and benefit from the addition of HOV lanes.
- Operational GHG emissions for the three 6-Lane Alternative options are expected to be similar, and all three would produce lower operational GHG emissions than the No Build Alternative because all three 6-Lane Alternative options would improve the traffic flow in similar ways compared to the No Build Alternative. The 6-Lane Alternative options include tolling, which would reduce the miles traveled on the roadway.
- Operational energy consumption and GHG emissions under the scenario that would replace only vulnerable structures cannot be estimated at this time because traffic data were not developed for the Phased Implementation scenario.

Vehicle Miles Traveled

Vehicle miles traveled (VMT) is the number of miles vehicles travel each year. For transportation projects with set boundaries, VMT can refer to the aggregate number of miles that all the vehicles travel using the specified roadways. Per person (or per capita) VMT in Washington has been stable at 9,000 miles per person since the 1980s, meaning the statewide VMT has grown at roughly the same pace as population. Methods of reducing VMT typically target transferring trips from single occupant vehicles to multiple person vehicles like carpools, vanpools, and transit. VMT can also be lowered by reducing the distance of travel through changes in land use.

What is the I-5 to Medina: Bridge Replacement and HOV Project?

The Interstate 5 (I-5) to Medina: Bridge Replacement and High-Occupancy Vehicle (HOV) Project is part of the State Route (SR) 520 Bridge Replacement and HOV Program (SR 520 Program) (detailed in the text box below) and encompasses parts of three main geographic areas—Seattle, Lake Washington, and the Eastside. The project area includes the following:

- Seattle communities: Portage Bay/Roanoke, North Capitol Hill, Montlake, University District, Laurelhurst, and Madison Park
- Eastside communities: Medina, Hunts Point, Clyde Hill, and Yarrow Point
- The Lake Washington ecosystem and associated wetlands
- Usual and accustomed fishing areas of tribal nations that have historically used the area's aquatic resources and have treaty rights

The SR 520 Bridge Replacement and HOV Project Draft Environmental Impact Statement (EIS), published in August 2006, evaluated a 4-Lane Alternative, a 6-Lane Alternative, and a No Build Alternative. Since the Draft EIS was published, circumstances surrounding the SR 520 corridor have changed in several ways. These changes have resulted in decisions to forward advance planning for potential catastrophic failure of the Evergreen Point Bridge, respond to increased demand for transit

What is the SR 520 Program?

The SR 520 Bridge Replacement and HOV Program will enhance safety by replacing the aging floating bridge and keep the region moving with vital transit and roadway improvements throughout the corridor. The 12.8-mile program area begins at I-5 in Seattle and extends to SR 202 in Redmond.

In 2006, WSDOT prepared a Draft EIS—published formally as the SR 520 Bridge Replacement and HOV Project—that addressed corridor construction from the I-5 interchange in Seattle to just west of I-405 in Bellevue. Growing transit demand on the Eastside and structure vulnerability in Seattle and Lake Washington, however, led WSDOT to identify new projects, each with a separate purpose and need, that would provide benefit even if the others were not built. These four independent projects were identified after the Draft EIS was published in 2006, and these now fall under the umbrella of the entire SR 520 Bridge Replacement and HOV Program:

- I-5 to Medina: Bridge Replacement and HOV Project replaces the SR 520 roadway, floating bridge approaches, and floating bridge between I-5 and the eastern shore of Lake Washington. This project spans 5.2 miles of the SR 520 corridor.
- Medina to SR 202: Eastside Transit and HOV Project completes and improves the transit and HOV system from Evergreen Point Road to the SR 202 interchange in Redmond. This project spans 8.6 miles of the SR 520 corridor.
- Pontoon Construction Project involves constructing the pontoons needed to restore the Evergreen Point Bridge in the event of a catastrophic failure and storing those pontoons until needed.
- Lake Washington Congestion Management Project, through a grant from the U.S. Department of Transportation, improves traffic using tolling, technology and traffic management, transit, and telecommuting.

service on the Eastside, and evaluate a new set of community-based designs for the Montlake area in Seattle.

To respond to these changes, the Washington State Department of Transportation (WSDOT) and the Federal Highway Administration (FHWA) initiated new projects to be evaluated in separate environmental documents. Improvements to the western portion of the SR 520 corridor—known as the I-5 to Medina: Bridge Replacement and HOV Project (the *I-5 to Medina project*)—are being evaluated in a Supplemental Draft EIS (SDEIS); this discipline report is a part of that SDEIS. Project limits for this project extend from I-5 in Seattle to 92nd Avenue NE in Yarrow Point, where it transitions into the Medina to SR 202: Eastside Transit and HOV Project (the *Medina to SR 202 project*). Exhibit 1 shows the project vicinity.

Exhibit 1. Project Vicinity Map

What are the project alternatives?

As noted above, the Draft EIS evaluated a 4-Lane Alternative, a 6-Lane Alternative (including three design options in Seattle), and a No Build Alternative. In 2006, following Draft EIS publication, Governor Gregoire identified the 6-Lane Alternative as the state's preference for the SR 520 corridor, but urged that the affected communities in Seattle develop a common vision for the western portion of the corridor. Accordingly, a mediation group convened at the direction of the state legislature to evaluate the corridor alignment for SR 520 through Seattle. The mediation group identified three 6-lane design options for SR 520 between I-5 and the floating span of the Evergreen Point Bridge; these options were documented in a Project Impact Plan (Parametrix 2008). The SDEIS evaluates the following:

- No Build Alternative
- 6-Lane Alternative
  - Option A
  - Option K
  - Option L

These alternatives and options are summarized below. The 4-Lane Alternative and the Draft EIS 6-lane design options have been eliminated from further consideration. More information on how the project has evolved since the Draft EIS was published in 2006, as well as

more detailed information on the design options, is provided in the Description of Alternatives Discipline Report (WSDOT 2009b).

What is the No Build Alternative?

Under the No Build Alternative, SR 520 would continue to operate between I-5 and Medina as it does today: as a 4-lane highway with nonstandard shoulders and without a bicycle/pedestrian path. (Exhibit 2 depicts a cross section of the No Build Alternative.) No new facilities would be added to SR 520 between I-5 and Medina, and none would be removed, including the unused R.H. Thomson Expressway ramps near the Washington Park Arboretum. WSDOT would continue to manage traffic using its existing transportation demand management and intelligent transportation system strategies.

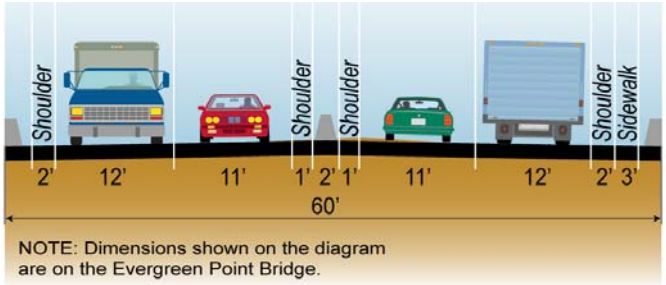


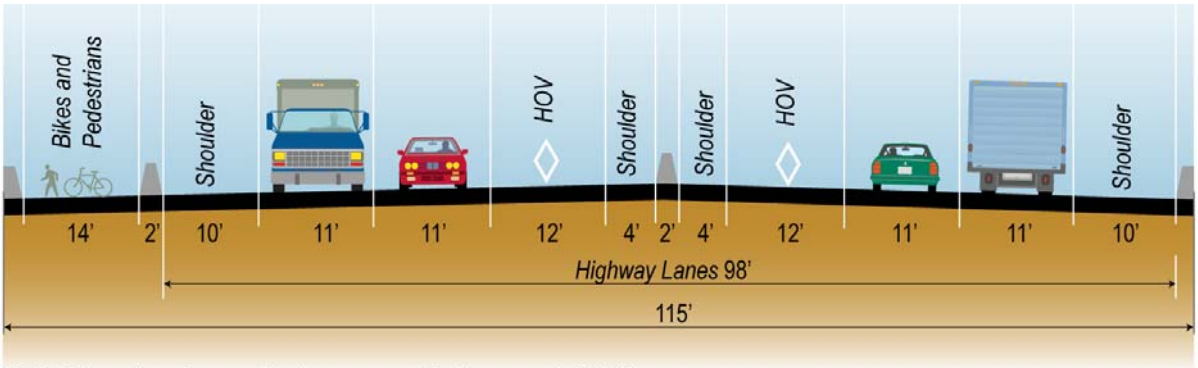
Exhibit 2. No Build Alternative Cross Section

The No Build Alternative assumes that the Portage Bay and Evergreen Point bridges would remain standing and functional through 2030 and that no catastrophic events, such as earthquakes or extreme storms, would cause major damage to the bridges. The No Build Alternative also assumes completion of the Medina to SR 202 project as well as other regionally planned and programmed transportation projects. The No Build Alternative provides a baseline against which project analysts can measure and compare the effects of each 6-Lane Alternative build option.

What is the 6-Lane Alternative?

The 6-Lane Alternative would complete the regional HOV connection (3+ HOV occupancy) across SR 520. This alternative would include six lanes (two 11-foot-wide outer general-purpose lanes and one 12-foot-wide inside HOV lane in each direction), with 4-foot-wide inside and 10-foot-wide outside shoulders (Exhibit 3). The proposed width of the roadway would be approximately 18 feet narrower than the one described in the Draft EIS, reflecting public comment from local communities and the City of Seattle.

SR 520 would be rebuilt from I-5 to Evergreen Point Road in Medina and restriped and reconfigured from Evergreen Point Road to 92nd Avenue NE in Yarrow Point. A 14-foot-wide bicycle/pedestrian path



NOTE: Dimensions shown on the diagram are on the Evergreen Point Bridge.

Exhibit 3. 6-Lane Alternative Cross Section

would be built along the north side of SR 520 through the Montlake area and across the Evergreen Point Bridge, connecting to the regional path on the Eastside. A bridge maintenance facility and dock would be built underneath the east approach to the Evergreen Point Bridge.

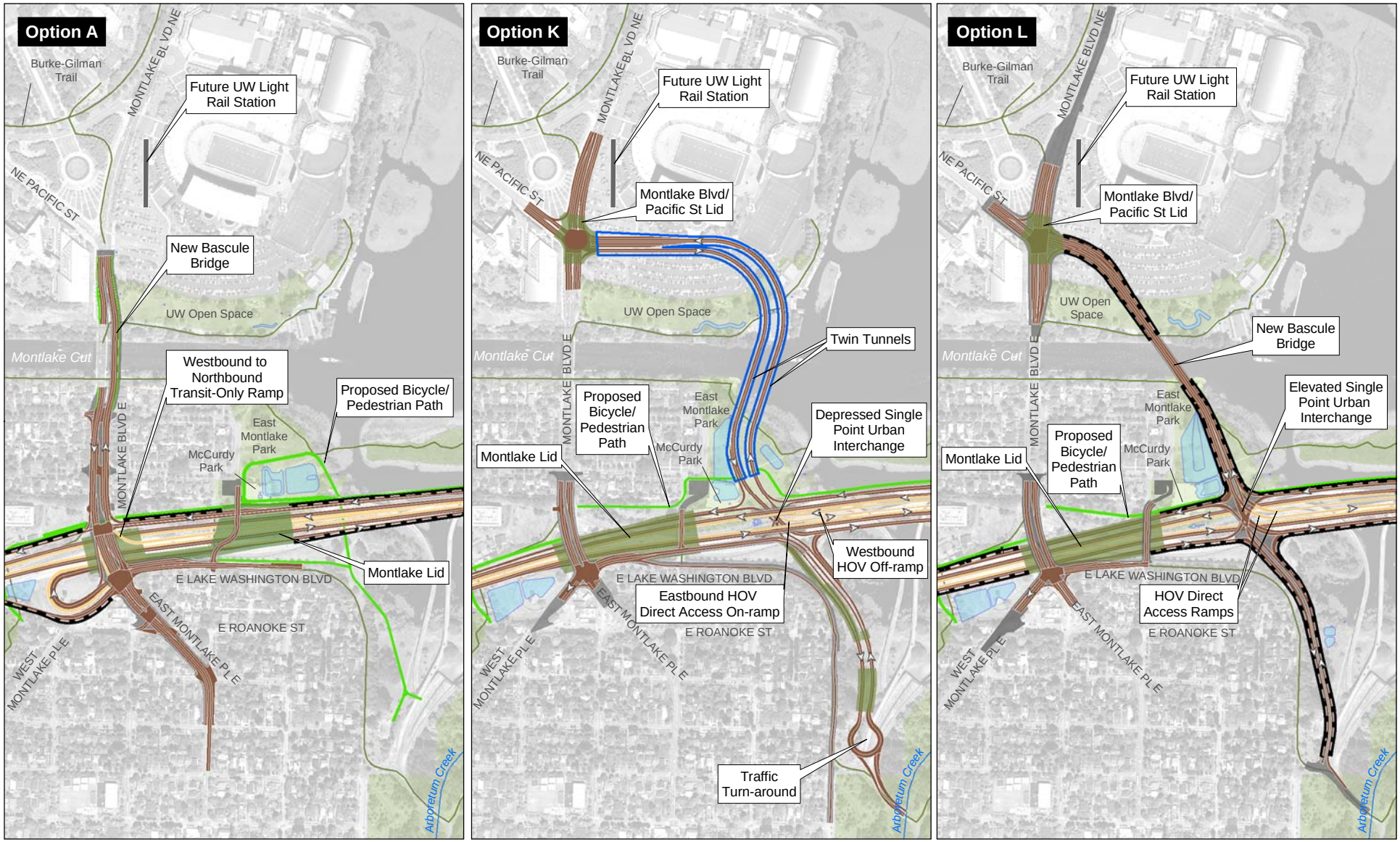
The sections below describe the 6-Lane Alternative and design options in each of the three geographical areas the project would encompass.

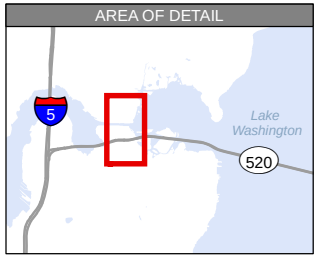
Seattle

Elements Common to the 6-Lane Alternative Options

SR 520 would connect to I-5 in a configuration similar to the way it connects today. Improvements to the I-5/SR 520 interchange would include a new reversible HOV ramp connecting the new SR 520 HOV lanes to existing I-5 reversible express lanes. WSDOT would replace the Portage Bay Bridge and the Evergreen Point Bridge (including the west approach and floating span), as well as the existing local street bridges across SR 520. New stormwater facilities would be constructed for the project to provide stormwater retention and treatment. The project would include landscaped lids across SR 520 at I-5, 10th Avenue East and Delmar Drive East, and in the Montlake area to help reconnect the communities on either side of the roadway. The project would also remove the Montlake freeway transit station.

The most substantial differences among the three options are the interchange configurations in the Montlake and University of Washington areas. Exhibit 4 depicts these key differences in interchange configurations, and the following text describes elements unique to each option.





- Potential Sound Wall
- Existing Regional Bicycle/Pedestrian Path
- Tunnel
- Lid or Landscape Feature
- Proposed Bicycle/Pedestrian Path
- Stormwater Facility
- General Purpose Lane
- HOV, Direct Access, and/or Transit-Only Lane
- Future UW Light Rail Station
- Park

N

0 250 500 1,000 Feet

Source: King County (2006) Aerial Photo, King County (2005) GIS Data (Streams), City of Seattle (1994) GIS Data (Bike/Ped Trail), Seattle Bicycle Map (2008) GIS Data (Bike/Ped Trail) CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91), vertical datum for layers is NAVD88.

Exhibit 4. **Options A, K, and L: Montlake and University of Washington Areas**

I-5 to Medina: Bridge Replacement and HOV Project

Option A

Option A would replace the Portage Bay Bridge with a new bridge that would include six lanes (four general-purpose lanes, two HOV lanes) plus a westbound auxiliary lane. WSDOT would replace the existing interchange at Montlake Boulevard East with a new, similarly configured interchange that would include a transit-only off-ramp from westbound SR 520 to northbound Montlake Boulevard. The Lake Washington Boulevard ramps and the median freeway transit stop near Montlake Boulevard East would be removed, and a new bascule bridge (i.e., drawbridge) would be added to Montlake Boulevard NE, parallel to the existing Montlake Bridge. SR 520 would maintain a low profile through the Washington Park Arboretum and flatten out east of Foster Island, before rising to the west transition span of the Evergreen Point Bridge. Citizen recommendations made during the mediation process defined this option to include sound walls and/or quieter pavement, subject to neighborhood approval and WSDOT's reasonability and feasibility determinations.

Suboptions for Option A would include adding an eastbound SR 520 on-ramp and a westbound SR 520 off-ramp to Lake Washington Boulevard, creating an intersection similar to the one that exists today but relocated northwest of its current location. The suboption would also include adding an eastbound direct access on-ramp for transit and HOV from Montlake Boulevard East, and providing a constant slope profile from 24th Avenue East to the west transition span.

Is it a highrise or a transition span?

A transition span is a bridge span that connects the fixed approach bridge to the floating portion of the bridge. The Evergreen Point Bridge has two transition spans, one at the west end of the floating bridge transitioning traffic on and off of the west approach, and one on the east end of the floating bridge transitioning traffic on and off of the east approach. These spans are often referred to as the "west highrise" (shown) and the "east highrise" during the daily traffic report, and the west highrise even has a traffic camera mounted on it.

Today's highrises have two characteristics—large overhead steel trusses and navigation channels below the spans where boat traffic can pass underneath the Evergreen Point Bridge. The new design for the floating bridge would not include overhead steel trusses on the transition spans, which would change the visual character of the highrise. For the SDEIS, highrise and transition span are often used interchangeably to refer to the area along the bridge where the east and west approach bridges transition to the floating bridge.

Option K

Option K would also replace the Portage Bay Bridge, but the new bridge would include four general-purpose lanes and two HOV lanes with no westbound auxiliary lane. In the Montlake area, Option K would remove the existing Montlake Boulevard East interchange and

the Lake Washington Boulevard ramps and replace their functions with a depressed, single-point urban interchange (SPUI) at the Montlake shoreline. Two HOV direct-access ramps would serve the new interchange, and a tunnel under the Montlake Cut would move traffic from the new interchange north to the intersection of Montlake Boulevard NE and NE Pacific Street. SR 520 would maintain a low profile through Union Bay, make landfall at Foster Island, and remain flat before rising to the west transition span of the Evergreen Point Bridge. A land bridge would be constructed over SR 520 at Foster Island. Citizen recommendations made during the mediation process defined this option to include only quieter pavement for noise abatement, rather than the sound walls that were included in the 2006 Draft EIS. However, because quieter pavement has not been demonstrated to meet all FHWA and WSDOT avoidance and minimization requirements in tests performed in Washington State, it cannot be considered as noise mitigation under WSDOT and FHWA criteria. As a result, sound walls could be included in Option K. The decision to build sound walls depends on neighborhood interest, the findings of the Noise Discipline Report (WSDOT 2009c), and WSDOT's reasonability and feasibility determinations.

A suboption for Option K would include constructing an eastbound off-ramp to Montlake Boulevard East configured for right turns only.

Option L

Under Option L, the Montlake Boulevard East interchange and the Lake Washington Boulevard ramps would be replaced with a new, elevated SPUI at the Montlake shoreline. A bascule bridge (drawbridge) would span the east end of the Montlake Cut, from the new interchange to the intersection of Montlake Boulevard NE and NE Pacific Street. This option would also include a ramp connection to Lake Washington Boulevard and two HOV direct-access ramps providing service to and from the new interchange. SR 520 would maintain a low, constant slope profile from 24th Avenue East to just west of the west transition span of the floating bridge. Noise mitigation identified for this option would include sound walls as defined in the Draft EIS.

Suboptions for Option L would include adding a left-turn movement from Lake Washington Boulevard for direct access to SR 520 and adding capacity on northbound Montlake Boulevard NE to NE 45th Street.

Lake Washington

Floating Bridge

The floating span would be located approximately 190 feet north of the existing bridge at the west end and 160 feet north at the east end (Exhibit 5). Rows of three 10-foot-tall concrete columns would support the roadway above the pontoons, and the new spans would be approximately 22 feet higher than the existing bridge. A 14-foot-wide bicycle/pedestrian path would be located on the north side of the bridge.

The design for the new 6-lane floating bridge includes 21 longitudinal pontoons, two cross pontoons, and 54 supplemental stability pontoons. A single row of 75-foot-wide by 360-foot-long longitudinal pontoons would support the new floating bridge. One 240-foot-long by 75-foot-wide cross-pontoon at each end of the bridge would be set perpendicularly to the longitudinal pontoons. The longitudinal pontoons would be bolstered by the smaller supplemental stability pontoons on each side for stability and buoyancy. The longitudinal pontoons would not be sized to carry future high-capacity transit (HCT), but would be equipped with connections for additional supplemental stability pontoons to support HCT in the future. As with the existing floating bridge, the floating pontoons for the new bridge would be anchored to the lake bottom to hold the bridge in place.

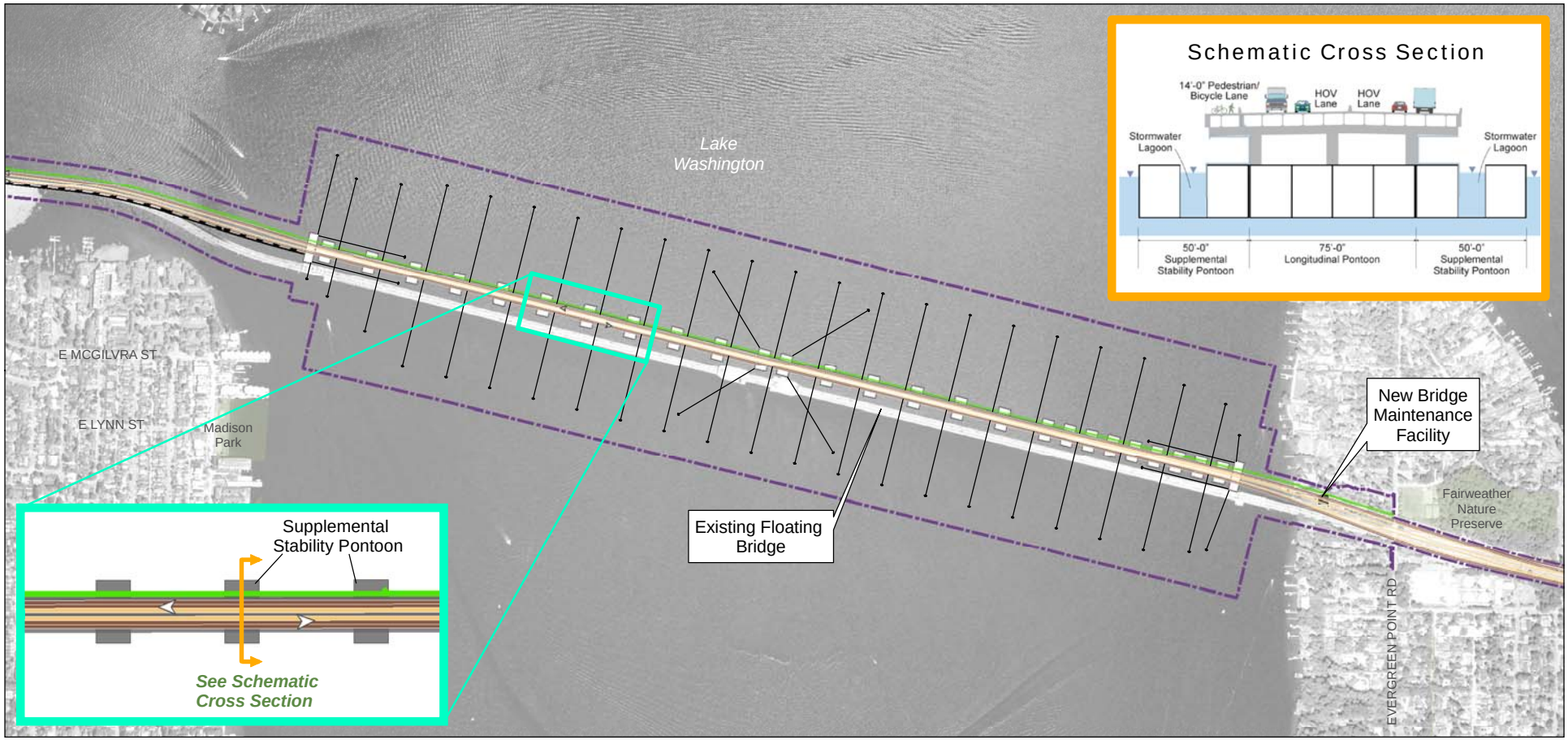
Near the east approach bridge, the roadway would be widened to accommodate transit ramps to the Evergreen Point Road transit stop. Exhibit 5 shows the alignment of the floating bridge, the west and east approaches, and the connection to the east shore of Lake Washington.

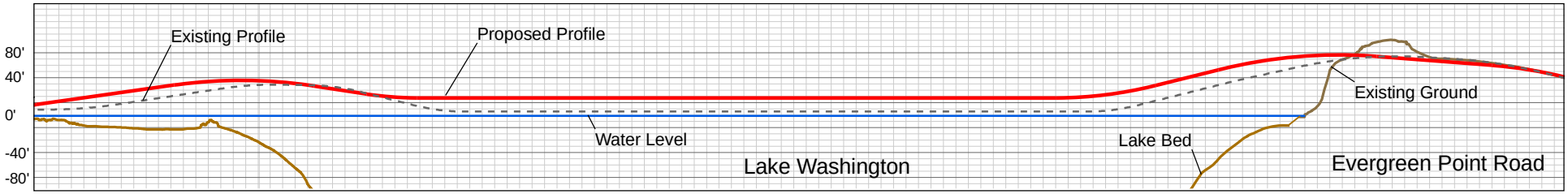
Bridge Maintenance Facility

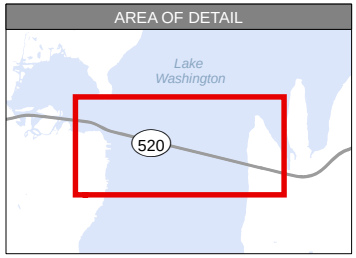
Routine access, maintenance, monitoring, inspections, and emergency response for the floating bridge would be based out of a new bridge maintenance facility located underneath SR 520 between the east shore of Lake Washington and Evergreen Point Road in Medina. This bridge maintenance facility would include a working dock, an approximately 7,200-square-foot maintenance building, and a parking area.

Eastside Transition Area

The I-5 to Medina project and the Medina to SR 202 project overlap between Evergreen Point Road and 92nd Avenue NE in Yarrow Point. Work planned as part of the I-5 to Medina project between Evergreen Point Road and 92nd Avenue NE would include moving the Evergreen







- Anchor and Cable
- Pontoons
- Limits of Construction
- Proposed Bicycle/Pedestrian Path
- General Purpose Lanes
- HOV, Direct Access, and/or Transit-Only Lane
- Park

Source: King County (2006) Aerial Photo, CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91), vertical datum for layers is NAVD88.

N

0 250 500 1,000 Feet

Exhibit 5. **6-Lane Alternative at the Evergreen Point Bridge (Common to All Options)**

I-5 to Medina: Bridge Replacement and HOV Project

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Point Road transit stop west to the lid (part of the Medina to SR 202 project) at Evergreen Point Road, adding new lane and ramp striping from the Evergreen Point lid to 92nd Avenue NE, and moving and realigning traffic barriers as a result of the new lane striping. The restriping would transition the I-5 to Medina project improvements into the improvements to be completed as part of the Medina to SR 202 project.

Pontoon Construction and Transport

If the floating portion of the Evergreen Point Bridge does not fail before its planned replacement, WSDOT would use the pontoons constructed and stored as part of the Pontoon Construction Project in the I-5 to Medina project. Up to 11 longitudinal pontoons built and stored in Grays Harbor as part of the Pontoon Construction Project would be towed from a moorage location in Grays Harbor to Puget Sound for outfitting (see the sidebar to the right for an explanation of pontoon *outfitting*). All outfitted pontoons, as well as the remaining pontoons stored at Grays Harbor would be towed to Lake Washington for incorporation into the floating bridge. Towing would occur as weather permits during the months of March through October. Exhibit 6 illustrates the general towing route from Grays Harbor to Lake Washington, and identifies potential outfitting locations.

What is Outfitting?

Pontoon outfitting is a process by which the columns and elevated roadway of the bridge are built directly on the surface of the pontoon.

Exhibit 6. Possible Towing Route and Pontoon Outfitting Locations

The I-5 to Medina project would build an additional 44 pontoons needed to complete the new 6-lane floating bridge. The additional pontoons would be constructed at the existing Concrete Technology Corporation facility in Tacoma, and/or at a new facility in Grays Harbor that is also being developed as part of the Pontoon Construction Project. The new supplemental stability pontoons would be towed from the construction location to Lake Washington for incorporation into the floating bridge. For additional information about pontoon construction, please see the Construction Techniques Discipline Report (WSDOT 2009d).

Would the project be built all at once or in phases?

Revenue sources for the I-5 to Medina project would include allocations from various state and federal sources and from future tolling, but there remains a gap between the estimated cost of the project and the revenue available to build it. Because of these funding limitations, there is a strong possibility that WSDOT would construct the project in phases over time.

If the project is phased, WSDOT would first complete one or more of those project components that are vulnerable to earthquakes and windstorms; these components include the following:

- The floating portion of the Evergreen Point Bridge, which is vulnerable to windstorms. This is the highest priority in the corridor because of the frequency of severe storms and the high associated risk of catastrophic failure.
- The Portage Bay Bridge, which is vulnerable to earthquakes. This is a slightly lower priority than the floating bridge because the frequency of severe earthquakes is significantly less than that of severe storms.
- The west approach of the Evergreen Point Bridge, which is vulnerable to earthquakes (see prior comments for the Portage Bay Bridge).

Exhibit 7 shows the vulnerable portions of the project that would be prioritized, as well as the portions that would be constructed later. The vulnerable structures are collectively referred to in the SDEIS as the Phased Implementation scenario. It is important to note that, while the new bridge(s) might be the only part of the project in place for a certain

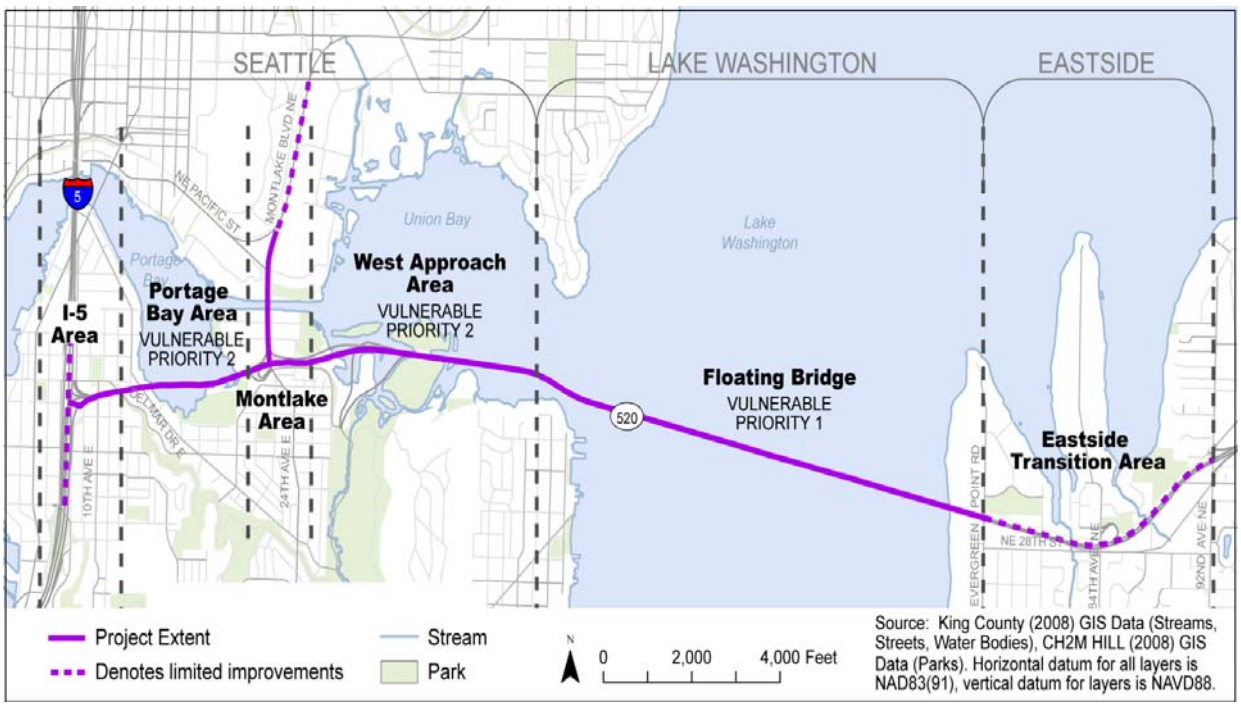


Exhibit 7. Geographic Areas along SR 520 and Project Phasing

period of time, WSDOT's intent is to build a complete project that meets all aspects of the purpose and need.

The Phased Implementation scenario would provide new structures to replace the vulnerable bridges in the SR 520 corridor, as well as limited transitional sections to connect the new bridges to existing facilities. This scenario would include stormwater facilities, noise mitigation, and the regional bicycle/pedestrian path, but lids would be deferred until a subsequent phase. WSDOT would develop and implement all mitigation needed to satisfy regulatory requirements.

To address the potential for phased project implementation, the SDEIS evaluates the Phased Implementation scenario separately as a subset of the "full build" analysis. The evaluation focuses on how the effects of phased implementation would differ from those of full build and on how constructing the project in phases might have different effects from constructing it all at one time. Impact calculations for the physical effects of phased implementation (for example, acres of wetlands and parks affected) are presented alongside those for full build where applicable.

Affected Environment

How was the energy information collected?

Information used to estimate current and forecasted energy use in the study area is cited in the narrative and listed in the References section.

What are the existing energy characteristics of the study area?

SR 520 Corridor

The study area for the energy analysis is the same as the study area for the traffic operations analysis described in the Transportation Discipline Report (WSDOT 2009e). The study area includes the entire SR 520 corridor from I-5 to SR 202 because the traffic model captured all vehicle trips across Lake Washington via SR 520.

According to the Washington State Department of Commerce, Washington's per capita average energy consumption was approximately 200 million British thermal units (MBtu) in 2005 after averaging close to 250 MBtu from 1970 through 1999. The drop in per capita energy consumption was due to decreased energy use in some energy-intensive industries (i.e., aluminum) and to higher energy prices (Washington State Department of Commerce 2008). Washington's economy is also becoming less energy intensive because of improved technology, efficiency increases, and a shift from natural resource manufacturing to less energy-intensive industries such as software and biotech. Washington's per capita average energy consumption in 2005 was below the national average of 232 MBtu.

Because most of the energy consumed during 6-Lane Alternative construction and operation would result from transporting site materials, construction products, and other items to and from the site, the analysts have included a discussion of fuel consumption. Because detailed fuel consumption data are not available at the local level, the analysts included a discussion about statewide fuel consumption.

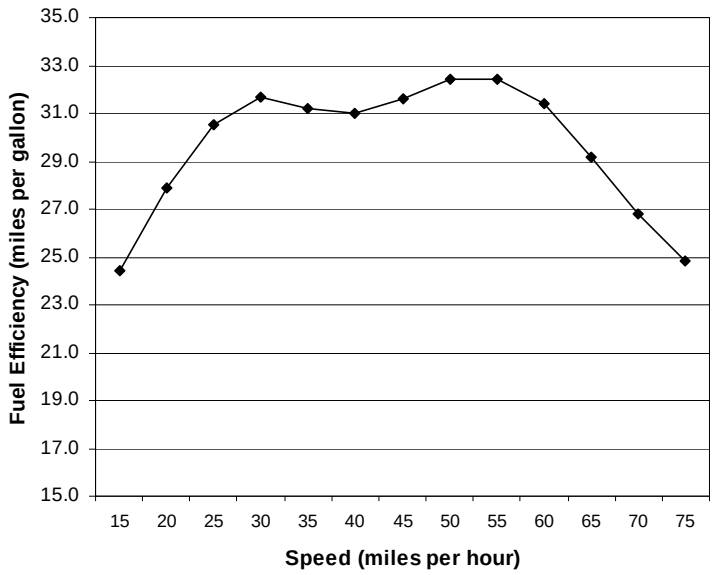
In 2007, the transportation sector in the state of Washington consumed approximately 338.0 trillion British thermal units (Btu) of gasoline and approximately 143.2 trillion Btu of distillate fuel (EIA 2009b and 2009c). Distillate fuel encompasses diesel fuel and fuel oils, including those for on-highway diesel engines for trucks and cars as well as off-highway diesel engines for railroad locomotives.

In recent years, the fuel efficiency of new vehicles has declined because of the popularity of larger engine vehicles such as pickups, vans, and sport utility vehicles (SUVs). The passage of the national Energy Independence and Security Act of 2007 (Pub.L. 110-140), which revised fuel efficiency standards, is expected to lead to higher new vehicle fuel efficiency in the future. The Energy Independence and Security Act of 2007 mandates that, by 2020, the fuel economy of all new cars, trucks, and SUVs will be 35 miles per gallon (mpg). On May 19, 2009, President Barack Obama announced a national autos fuel efficiency program that will require an average fuel economy standard of 35.5 mpg by 2016 (The White House 2009).

The SR 520 corridor is heavily used and frequently congested with traffic because it is one of only two crossings that serve residents, commuters, and other travelers across Lake Washington. The corridor is home to some large organizations, such as Microsoft and the University of Washington, whose employees travel SR 520 to get to and from their places of work. Currently, congestion occurs for more than 2 hours in both the morning and evening commutes. The congestion level indicates that the available roadway capacity is fully used and traffic is being forced to operate at lower speeds and with limited maneuverability. The Transportation Discipline Report (WSDOT 2009e) gives a more detailed explanation of current traffic congestion.

Excessive idling and stop-and-go traffic conditions substantially reduce fuel economy compared with free-flow conditions. Because of the current conditions in the study area, at many times throughout the day, the study area is congested and vehicles operate at inefficient speeds. Exhibit 8 presents the average fuel efficiency in mpg for cars and pickups traveling at speeds between 15 and 75 miles per hour (mph).

The data in Exhibit 8, which are based on the results of an FHWA test of vehicles (DOE 2008), are presented for illustrative purposes to demonstrate the effect vehicle speed has on fuel efficiency. As shown, fuel efficiency is greatest when passenger vehicles are traveling between 30 and 55 mph.



Source: DOE (2008).

Exhibit 8. Average Automobile and Pickup Fuel Consumption Rate

Because of traffic congestion, the existing average freeway travel speed of all vehicles driving in the study area is 29 mph. According to the Transportation Discipline Report (WSDOT 2009e), vehicles drive approximately 1.7 million miles daily along the SR 520 corridor. To convert the daily number to an annual number, a conversion factor of 340 days per year was applied to the daily VMT number, resulting in an annualized estimate of 562 million VMT (WSDOT 2009e).

Exhibit 9 presents the energy consumption under existing conditions (2006). Vehicles in the study area consume approximately 3.8 million MBtu of energy each year. Converting MBtu to gallons of fuel results in approximately 30.3 million gallons of fuel consumed annually under existing conditions.

Pontoon Production Sites and Transport Routes

WSDOT recognized the urgent need to prepare for catastrophic failure of the Evergreen Point Bridge, and initiated the Pontoon Construction Project in January 2008 under an independent NEPA process. Construction of 21 longitudinal pontoons, two cross pontoons, and 10 supplemental stability pontoons (33 pontoons total) necessary to replace the existing capacity (4-lanes) of the bridge in the event of a catastrophic failure is being evaluated in the EIS for the Pontoon

Exhibit 9. Energy and Fuel Consumption under Existing Conditions (2006)

		Existing Conditions		
Vehicle Type	**Consumption Factor (Btu/mile)**	**Annual VMT (millions)**	**MBtu**	**Gallons of Fuel (millions)**
Passenger Vehicle[a]	6,005	541	3,249,000	26.2
Heavy-duty Truck	23,238	17	392,000	2.8
Transit Bus	39,408	4	177,000	1.3
Total		**562**	**3,818,000**	**30.3**

[a] Passenger vehicles include cars, light trucks, and motorcycles.

Notes:

1 gallon of gasoline = 124,000 Btu

1 gallon of diesel = 139,000 Btu

Source: WSDOT (2009e); EIA (2007); DOE (2008).

Construction Project. The energy consumed to produce the 33 pontoons is discussed in the Energy Technical Memorandum, appended to the Pontoon Construction Project Draft EIS (WSDOT 2009f).

If the floating portion of the Evergreen Point Bridge does not fail before its planned replacement, WSDOT would use the pontoons constructed and stored as part of the Pontoon Construction Project for the I-5 to Medina: Bridge Replacement and HOV Project. The design for the new 6-lane floating bridge would require 21 longitudinal pontoons, two cross pontoons, and 54 supplemental stability pontoons (77 pontoons total). The I-5 to Medina project would require an additional 44 supplemental stability pontoons beyond those constructed for the Pontoon Construction Project. The additional pontoons would be needed to provide buoyancy and stability for the new 6-lane floating bridge.

The 44 supplemental stability pontoons would be constructed in a casting basin. WSDOT would utilize a new casting basin located in Grays Harbor, and potentially a casting basin at Concrete Technology Corporation (CTC) in Tacoma, to build the additional supplemental stability pontoons. Energy consumed during construction of the 44 supplemental stability pontoons, and energy needed to transport all of the pontoons to the floating bridge construction site in Lake Washington is estimated in this report.

Potential Effects of the Project

What methods were used to evaluate the potential energy effects?

This section describes the methodology applied to the construction and operational energy analyses conducted for the I-5 to Medina project. The methodology for the GHG analysis is discussed in the Greenhouse Gas Emissions section at the end of this report.

Construction Analysis

During construction of the 6-Lane Alternative, energy would be consumed by site preparation and construction activities, including equipment operation, and by construction lighting. Energy would also be consumed during the production and transportation of project materials. The amount of energy used during 6-Lane Alternative construction would be roughly proportional to the cost of the project.

The analysts used cost estimates developed during WSDOT's Cost Estimate Validation Process® (CEVP) to calculate energy consumption during the construction period. The cost estimates are in 2014 dollars and represent the midpoint of expenditure for the 6-Lane Alternative.

The California Department of Transportation (CALTRANS) established energy consumption factors for different transportation facilities in *Energy and Transportation Systems* (1983), and these factors are widely used in energy analyses today. For this I-5 to Medina project, the analysts estimated energy consumption during construction by applying a construction energy consumption factor to total 6-Lane Alternative construction costs. Costs associated with right-of-way purchase and construction engineering were excluded from the energy consumption estimate.

CALTRANS developed separate energy consumption factors for various freeway types and components, such as urban freeways, bridges, interchanges, and rural freeways. For this analysis, each I-5 to Medina project section was assigned an energy consumption factor based on the primary facility being constructed. For example, the primary structure being constructed in the I-5 area section of the project

is an interchange. Therefore, the energy consumption factor for an interchange was applied to the construction costs for this section of the project. Exhibit 10 lists the facility type assigned to each I-5 to Medina project section.

Exhibit 10. Primary Facility Type by I-5 to Medina Project Section

Project Section	Primary Facility Type	Energy Consumption Factor (Btu/Dollars)
I-5 Area	Interchange	70,100
Portage Bay Area	Bridge	28,100
Montlake Area (Montlake Interchange and Montlake Cut)	Interchange	70,100
West Approach Area	Bridge	28,100
Floating Bridge Area	Bridge	28,100
Eastside Transition Area	Urban Freeway	27,500

Source: CALTRANS (1983).

The consumption factors were reported in Btu per dollars of construction spending. Because the CALTRANS report was developed using 1977 construction dollars, the estimated construction costs for each option had to be deflated to account for inflation. The California Construction Cost Index was used to adjust the construction costs from 2014 dollars (year of expenditure) to 1977 dollars.

Energy would be consumed during transport of pontoons from Grays Harbor and Puget Sound construction and outfitting sites to Lake Washington. The analysts assumed the energy consumed during the transport of the pontoons was not included in the CALTRANS consumption factors. Therefore, the consumption of fuel during the transportation of the pontoons to the construction site was calculated separately. To estimate the diesel fuel that would be consumed during pontoon transport, the energy analysts applied the following assumptions:

- The diesel fuel consumption rate would be 150 gallons per hour of operation
- The average towing speed would be 3 mph
- One tug would tow each pontoon from the moorage location to the I-5 to Medina project construction location on Lake Washington

- An additional tug would be required to navigate the pontoons through the Lake Washington Locks
- The approximate towing distances would be 254 miles from Grays Harbor to Lake Washington and 35 miles from the Puget Sound moorage location to Lake Washington

Operational Analysis

The analysis of energy effects is based on projected 2030 SR 520 corridor traffic volumes and total VMT (WSDOT 2009e). Exhibit 11 presents the annual VMT for existing conditions (2006), the No Build Alternative in 2030, and each of the 6-Lane Alternative options in 2030.

Exhibit 11. Annual VMT (millions) by Alternative

Vehicle Type	Existing Conditions (2006)	No Build Alternative (2030)	Option A (2030)	Option K or Option L (2030)
Passenger Vehicle[a]	541	776	710	727
Heavy-duty Truck	17	24	22	23
Transit Bus	4	6	6	6
Total	**562**	**806**	**738**	**756**

[a] Passenger vehicles include cars, light trucks, and motorcycles.

Source: WSDOT (2009e).

Exhibit 12 presents calculations for the estimated energy consumption factors for passenger vehicles. The weighted average Btu per mile for passenger vehicles includes the calculations for cars, light trucks, and motorcycles based on energy consumption rates and vehicle miles.

Exhibit 12. Energy Consumption Rate Calculations for Passenger Vehicles

	Consumption Factor (Btu/mile)	Vehicle Miles (millions)	Energy Consumption (MBtu)	Weighted Average Btu/mile
Cars	5,514	1,672,461	9,221,951,013	
Light trucks	6,785	1,111,944	7,544,542,123	
Motorcycles	2,226	12,119	26,976,894	
Total		**2,796,524**	**16,793,470,030**	**6,005**

Note:

Numbers may not add up due to rounding.

Source: DOE (2008), Tables 2.13 and 3.6.

The analysts estimated operational effects by calculating the total energy consumed under each option of the 6-Lane Alternative. Energy consumption was estimated by multiplying the annual VMT presented in Exhibit 11 by the energy consumption rates by travel mode listed in Exhibit 13. Annual VMT was calculated by multiplying a factor of 340 days per year by daily VMT for the study area. The analysts obtained energy consumption rates (expressed in Btu per mile) for passenger vehicles, buses, and heavy-duty trucks from the U.S. Department of Energy's (DOE's) *Transportation Energy Data Book, Edition 27* (2008). Gallons of fuel consumed under each option were also estimated. To convert Btu to gallons of gasoline, the total Btu values for passenger vehicles were divided by 124,000 (EIA 2007). To convert Btu to gallons of diesel, the total Btu values for heavy-duty trucks and transit buses were divided by 139,000 (EIA 2007).

Exhibit 13. Energy Consumption Rates by Travel Mode

Vehicle Type	Btu/mile	Miles/Gallon of Fuel
Passenger Vehicle[a]	6,005	20.6
Heavy-duty Truck	23,238	6.0
Transit Bus	39,408	3.5

[a] Passenger vehicles include cars, light trucks, and motorcycles.

Notes:

124,000 Btu = 1 gallon of gasoline

139,000 Btu = 1 gallon of diesel

Source: DOE (2008).

How would construction of the project affect energy use?

No Build Alternative

The No Build Alternative would not result in construction effects related to energy use because the 6-Lane Alternative would not be built. The No Build Alternative assumes that existing infrastructure would remain exactly the same as it is today.

6-Lane Alternative

Project Construction

Exhibit 14 presents the total construction energy consumption for each of the 6-Lane Alternative options. Exhibit 1-1 in Attachment 1 provides detailed calculations of energy consumed during construction for each 6-Lane Alternative option. These amounts would be spread out over the entire construction period (2012–2017). Option K would consume the most energy because of the larger amount of construction activity required for the depressed interchange and tunnel, which is reflected in the higher construction cost.

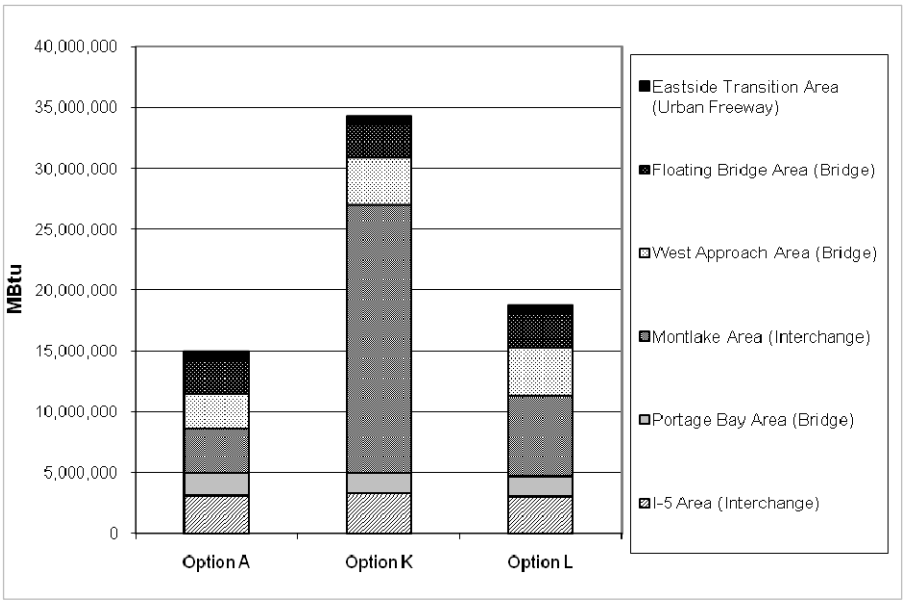


Exhibit 14. Total Energy Consumption during Construction of the 6-Lane Alternative

Construction of the 6-Lane Alternative might also cause additional traffic delays as construction activities would modify existing on- or off-ramps, shift traffic to new or temporary lanes, or create distractions for the drivers. Additional traffic delays could result in increased congestion and reduced speeds, which would cause vehicles to use fuel less efficiently. Construction-related congestion will cause additional energy use. The magnitude of this energy use cannot be estimated at this time because traffic data were not developed for construction.

Pontoon Production and Transport

A total of 54 supplemental stability pontoons, 21 longitudinal pontoons, and 2 cross pontoons will be needed for the 6-Lane Alternative floating bridge. As mentioned previously, all longitudinal and cross pontoons,

as well as 10 supplemental stability pontoons, would be constructed as part of the Pontoon Construction Project. Some of the pontoons could be constructed at a proposed facility in Grays Harbor while others could be produced in Tacoma, Washington, at the existing CTC site.

The estimated energy consumed during the construction of the 44 supplemental stability pontoons that are part of the I-5 to Medina project is included in the "Floating Bridge Area" MBtu presented in Exhibit 14. The 44 supplemental stability pontoons represent approximately 1.5 million MBtu (54 percent) of the total energy needed to construct the floating bridge area of the I-5 to Medina project.

Exhibit 15 shows the estimated diesel fuel consumption and the energy use required to transport the pontoons from their construction and moorage locations in Grays Harbor and Puget Sound to the project site. For this analysis, it was assumed that 56 pontoons would be towed by one tug from Grays Harbor to Lake Washington and 21 pontoons would be towed by one tug from their location in Puget Sound to the floating bridge construction site. An additional tug would be required to navigate the pontoons through the Lake Washington Locks. The energy and fuel consumption involved in transporting pontoons would be the same for each option of the 6-Lane Alternative.

Exhibit 15. Estimated Diesel Fuel Consumption and Energy Use during Transport of Pontoons

Route	Number of Trips	Est. Miles per Trip	Est. Total Miles	Est. Avg. mph	Est. Operating Hours	Diesel Fuel Consumption[a] (gallons)	MBtu[b]
Grays Harbor to SR 520	56	254	14,224	3	4741	711,150	99,000
Puget Sound to SR 520	21	35	735	3	245	36,750	5,000
Additional Tug for Locks	77	10	770	2	385	57,750	8,000
Total	**154**		**15,729**		**5,371**	**805,650**	**112,000**

[a] Fuel consumption of 150 gallons per hour based on delivery tow estimate for SR 520 pontoon tow (WSDOT 2005).

[b] Conversion rate: One gallon of diesel = 139,000 Btu.

Summary of Construction Effects

Exhibit 16 summarizes the construction energy consumption. Of all the design options, Option K would have the highest level of construction energy consumption—roughly twice as much as Option A and two-thirds more than Option L. The larger energy expenditure of Option K is because this option would require more construction activity than the other two options.

Exhibit 16. Summary of Construction Energy Effects

Option	Energy Expended (MBtu)		
	Construction Activities	Pontoon Transport	Total Construction
Option A	15,006,000[a]	112,000[b]	15,118,000
Option K	34,299,000[a]	112,000[b]	34,411,000
Option L	18,781,000[a]	112,000[b]	18,893,000

[a] A 60-percent risk cost was used to estimate construction energy consumption.

[b] Conversion rate: one gallon of diesel = 139,000 Btu.

Phased Implementation Scenario

Building the 6-Lane Alternative in phases would spread the energy consumption over a longer period of time because some components of the project would be deferred. Exhibit 17 presents energy consumption for replacement of vulnerable structures and for future construction phases for each 6-Lane Alternative option.

Estimates to replace vulnerable structures do not include the I-5 area interchange or Montlake area (Montlake interchange and Montlake Cut) sections of the I-5 to Medina project, which would be completed in later phases. However, the total construction energy to replace vulnerable structures and to construct future phases would likely be higher than building the 6-Lane Alternative over one construction cycle because of the energy consumed during the additional mobilization required for building the I-5 to Medina project in phases.

Exhibit 17. Total Energy Consumption (in MBtu[a]) during Construction of the 6-Lane Alternative under the Phased Implementation Scenario

Option	I-5 Area	Portage Bay Area	Montlake Area (Montlake Interchange and Montlake Cut)	West Approach Area	Floating Bridge Area	Eastside Transition Area	Total Effect
Primary Facility	**Interchange**	**Bridge**	**Interchange**	**Bridge**	**Bridge[b]**	**Urban Freeway**	
Option A							
Vulnerable priorities	–	1,871,000	–	2,880,000	2,890,000	698,000	8,339,000
Future Phases	3,176,000	–	3,603,000	–	0	–	6,779,000
Option K							
Vulnerable priorities	–	1,633,000	–	3,793,000	2,890,000	698,000	9,014,000
Future Phases	3,346,000	–	22,051,000	–	0	–	25,397,000
Option L							
Vulnerable priorities	–	1,639,000	–	3,950,000	2,890,000	698,000	9,177,000
Future Phases	3,135,000	–	6,581,000	–	0	–	9,716,000

[a] A 60 percent risk cost was used to estimate construction energy consumption.

[b] Includes energy to tow pontoons from temporary moorage locations to construction site.

How would operation of the project affect energy use?

No Build Alternative

The No Build Alternative assumes that existing infrastructure would remain exactly the same as it is today. However, under the No Build Alternative, the annual VMT for the study area is forecasted to increase and average speeds are expected to decrease when compared to existing conditions (2006). In 2030, the annual VMT under the No Build Alternative will be approximately 806 million miles (Exhibits 11 and 18). This annual VMT is expected to be higher than for any of the 6-Lane Alternative options because no tolls would be in effect. Vehicles operating in the study area would consume about 5.5 million MBtu of energy, which is equivalent to 43.4 million gallons of fuel per year (Exhibit 18**).**

Exhibit 18. Annual Fuel Consumption during Operation (2030)

Alternative/ Option	Annual VMT (millions)	MBtu	Gallons of Fuel[a] (millions)	% Change from No Build Alternative
Existing Conditions (2006)	562	3,818,000	30.3	–
2030 No Build Alternative	806	5,474,000	43.4	NA
2030 Option A	738	5,012,000	39.8	-8%
2030 Option K or L[b]	756	5,134,000	40.7	-6%

[a] Fuel includes both diesel and gasoline.

[b] Options K and L are based on the same traffic data.

Notes:

NA = not applicable

Source: WSDOT (2009e), DOE (2008).

6-Lane Alternative

Project Operation

Exhibit 18 presents estimates of annual fuel consumption during operation for the alternatives and options. Exhibit 1-2 in Attachment 1 provides detailed calculations of energy consumption during operations for the No Build Alternative and each 6-Lane Alternative option. Each of the 6-Lane Alternative options is expected to consume between 5 and 10 percent less energy than the No Build Alternative,

with Option A using slightly less energy than Options K and L. The reduction in energy use under the 6-Lane Alternative options is attributable to three factors:

- A reduction in VMT because of tolling for single occupancy vehicles in the SR 520 corridor, which might cause commuters to shift transportation modes or find alternative routes across Lake Washington
- The addition of HOV lanes, which would improve traffic flow for buses and carpools
- More people using transit and carpooling rather than driving alone, resulting from improved mobility in the general-purpose lanes

Option A would result in fewer trips across the lake than Options K and L because of on- and off-ramp limitations near the Montlake interchange with the removal of Lake Washington Boulevard ramps.

This analysis does not take into account the improved vehicle speed that is anticipated under the 6-Lane Alternative nor does it account for changes in fuel efficiency standards for future vehicles. The analysis focuses on the changes in VMT and uses year 2007 vehicle energy consumption factors to estimate both existing (2006) and 2030 energy consumption during operations. Incorporating expected improvements in vehicle speed under each of the 6-Lane Alternative options would likely lead to a greater decrease in the fuel consumed by the 6-Lane Alternative options when compared to the No Build Alternative than what is presented in Exhibit 18.

Phased Implementation Scenario

Traffic data were not developed for the Phased Implementation scenario. Thus, operational energy consumption under the scenario that would replace only vulnerable structures cannot be estimated at this time.

Mitigation

What has been done to avoid or minimize negative effects on energy use?

Construction Mitigation

Building the 6-Lane Alternative would consume large amounts of energy that would no longer be available for other purposes. Construction practices that minimize roadway congestion and encourage efficient energy use would be implemented. Possible measures might include:

- Limiting idling equipment
- Encouraging carpooling of construction workers
- Locating staging areas near work sites

Operation Mitigation

Each 6-Lane Alternative option includes elements that would reduce VMT on the SR 520 corridor. The addition of an HOV lane would improve traffic flow for buses and carpoolers, which might encourage some travelers to change transportation modes. While tolling is in place along the corridor, it might encourage some travelers to seek alternative modes of transportation or alternative routes to cross Lake Washington.

What would be done to mitigate negative effects that could not be avoided or minimized?

There are no significant unavoidable adverse energy effects associated with the I-5 to Medina project.

What negative effects would remain after mitigation?

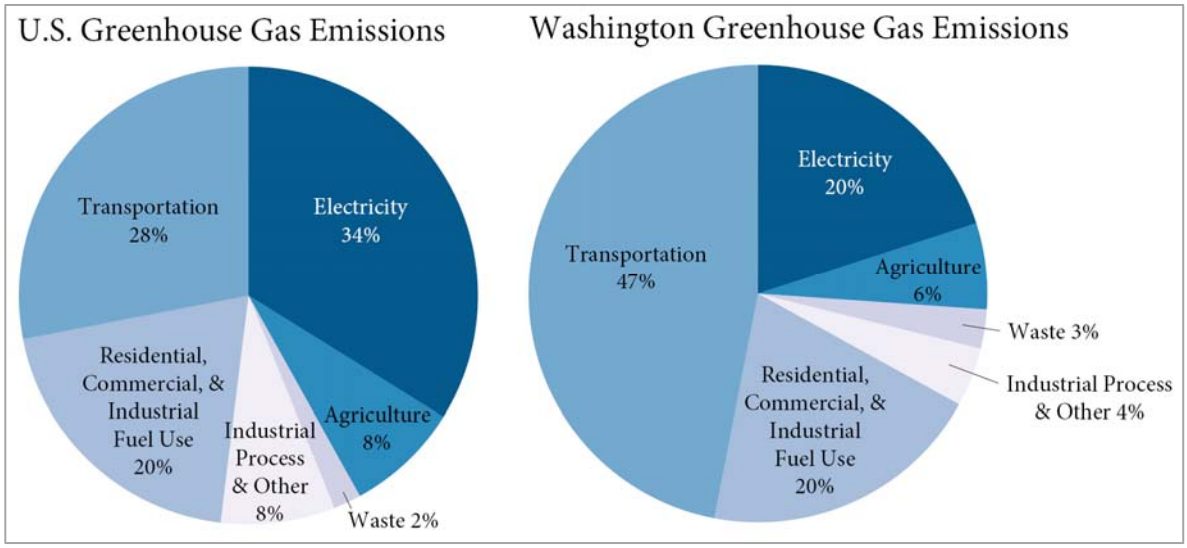
As mentioned previously, there are no significant unavoidable adverse energy effects associated with the I-5 to Medina project.

Greenhouse Gas Emissions

Vehicles emit a variety of gases during their operation; some of these are GHGs. The GHGs associated with transportation are water vapor, carbon dioxide (CO_2), methane (CH_4; also known as "marsh gas"), and nitrous oxide (N_2O; used in dentists' offices as "laughing gas"). Any process that burns fossil fuel releases CO_2 into the air. CO_2 makes up the bulk of the emissions from transportation.

National estimates show that the transportation sector (including on-road vehicles, construction activities, airplanes, and boats) accounts for almost 30 percent of total domestic CO_2 emissions. However, in Washington, transportation accounts for nearly half of GHG emissions because Washington relies heavily on hydropower for electricity generation. Most other states rely on fossil fuels such as coal, petroleum, and natural gas to generate electricity. The next largest contributors to total GHG emissions in Washington are fossil fuel combustion in the residential, commercial, and industrial sectors (at 20 percent), and electricity consumption (also 20 percent).

Exhibit 19 shows the gross GHG emissions by sector, nationally and in Washington State.



Source: Ecology (2007)

Exhibit 19. Gross GHG Emissions by Sector in U.S. and Washington State (2005)

What WSDOT efforts are underway to reduce greenhouse gas emissions in Washington State?

In 2007, Governor Gregoire and the legislature set the following GHG reduction goals for Washington State:

- 1990 GHG levels by 2020
- 25 percent reduction below 1990 levels by 2035
- 50 percent reduction below 1990 levels by 2050

Also in 2007, Governor's Executive Order 07-02 formed the Climate Advisory Team to find ways to reduce GHG emissions. The final report included 13 broad recommendations of actions.

In March 2008, Governor Gregoire signed Washington's Climate Change Framework/Green-Collar Jobs Act (House Bill 2815), which was developed with the help of a broad coalition of business, environment, education, labor, and energy leaders. This law includes, among other elements, statewide per capita VMT reduction benchmarks as part of the state's GHG emission reduction strategy. This law also established the Climate Action Team, a group similar to 2007's Climate Advisory Team. The Climate Action Team refined the Climate Advisory Team's broad recommendations into specific actions the state can take to reduce emissions.

Washington State Secretary of Transportation Paula Hammond was a member of the Climate Action Team. WSDOT staff served on subgroups focused on strategies to reduce VMT and on how to include climate change in SEPA evaluations. The final report and other information on the process are available on the Internet (Ecology 2008a).

In 2009, the Governor signed Executive Order 09-05, which includes direction to WSDOT to continue developing GHG reduction strategies for the transportation sector.

In addition to working with others in the state, WSDOT is leading the development of effective, measurable, and balanced GHG-emission-reduction strategies. Current WSDOT activities that reduce GHG emissions include the following:

- **Transportation Options.** For 30 years, WSDOT has supported carpooling, vanpooling, and public transportation through the funding, building, and maintenance of the freeway HOV system, ferries, rail, and other programs. For 17 years, WSDOT's Commute Trip Reduction program has been partnering with employers to offer alternatives to drive-alone commuting. WSDOT has the nation's oldest and largest public vanpool program.

  These programs continue to expand and, with recent high gas prices, demand for these programs has surged. These investments help to reduce the number of vehicles on the roadway during peak congestion and help reduce total VMT.

- **Incident Response Team (IRT).** WSDOT has 55 vehicles that patrol 500 miles of highway to clear blocking incidents quickly and safely. The IRT clears 98.6 percent of all incidents in less than 90 minutes, reducing the amount of time motorists spend sitting and idling in traffic.

- **Using Biodiesel in Ferries.** Each year, the state ferry system burns approximately 17 million gallons of diesel fuel in its ferries, making the agency a significant fuel consumer in Puget Sound. In March 2008, Washington State Ferries began testing the use of biodiesel in the marine environment. Using biodiesel instead of traditional petroleum-based fuels reduces emissions of particulate matter and may reduce GHGs.

WSDOT is also taking action to reduce the agency's emissions. Two key elements of the internal effort are the agency's no-idle policy and its expanded use of biodiesel.

- In 2006, WSDOT adopted a no-idle policy to reduce fuel use and vehicle emissions. WSDOT estimates that by reducing vehicle idling by 50 percent, the agency can save as much as $500,000 annually in fuel costs.

- In 2005, WSDOT started using 5 percent biodiesel (B5) in maintenance vehicles operating in the Central Puget Sound area. Currently, 25 WSDOT fueling stations have 10 percent biodiesel (B10) available, and the agency is working towards using 20 percent biodiesel (B20), as required of State agencies in RCW 43.19.648, depending on availability.

Finally, the most valuable contributions for reducing GHG emissions are from delivering well-planned transportation improvements. WSDOT and its partners are actively implementing the Transportation Partnership Act of 2005, a 16-year plan to meet Washington State's most critical transportation needs. Many of these local, regional, and statewide transportation system improvements are completed in conjunction with ongoing programs to help reduce the number of miles that vehicles need to travel each year. Together, these efforts combine to create more efficient driving conditions, offer mode choices, and help move the state toward GHG-emission-reduction goals.

How were greenhouse gas emissions calculated for project construction?

During construction, the primary source of GHG emissions would be fuel combustion. The GHG emissions would be proportional to the amount of energy used, which is the basis of GHG emission analysis. Small amounts of GHG emissions could also come from fugitive gases unintentionally released, such as coolant leaking from air conditioners. Fugitive GHG emissions were not included in the analysis.

This GHG emission analysis is based on the results of the energy analysis. Because the energy analysis directly converts I-5 to Medina project costs to energy use, project costs also drive the GHG emission estimates. The factors used in this methodology were developed by CALTRANS in the early 1980s and have not been updated. This methodology provides an estimate of the energy use and GHG emissions from 6-Lane Alternative construction and is appropriate for identifying large differences between project alternatives and options. A more precise analysis would require detailed construction schedule information; however, this information was not available at the time of the analysis.

For this analysis, it was assumed that site construction energy needs would be met with diesel fuel only (no electricity or gasoline). This assumption is conservative and will overestimate the GHG emissions if electricity is used to meet some of the construction energy requirements. Transport of all materials to and from the site was included in the energy analysis, except for pontoon transport, which was calculated separately. The energy needs are estimates intended to show approximate relative differences among the 6-Lane Alternative options. Actual use could differ based on specific equipment and

construction methods. Exhibit 20 shows the energy use anticipated for the No Build Alternative, each 6-Lane Alternative option, and pontoon transport.

Exhibit 20. Estimated Onsite Energy Use for Construction

Alternative	MBtu
No Build Alternative	No construction energy use
Option A	15,006,000
Option K	34,299,000
Option L	18,781,000
Pontoon Transport	112,000

The results of the energy analysis were converted to gallons of diesel fuel using the conversion factor of 139,000 Btu per gallon of diesel (EIA 2009a).

CO_2, N_2O, and CH_4 emissions were calculated by applying the appropriate emission factors (Exhibit 21). Because N_2O and CH_4 are more potent GHGs than CO_2, the quantities of N_2O and CH_4 were multiplied by their global warming potentials to convert to carbon dioxide equivalents (CO_2e). Global warming potentials express the ability of different compounds to warm the atmosphere compared to CO_2. CO_2e represents the warming potential of gases in terms of the amount of CO_2 that would cause the same level of warming. For example, one kilogram of N_2O has the same global warming power as 310 kilograms CO_2e.

Exhibit 21. Carbon Dioxide Equivalent Emission Factors

GHG	Emissions per Gallon Diesel[a]	Global Warming Potential
CO_2	10.15 kg/gal	1
N_2O	0.26 g/gal	310
CH_4	0.58 g/gal	21

[a] The Climate Registry (2008), page 93.

Notes:

g/gal = grams per gallon

kg/gal = kilograms per gallon

How were greenhouse gas emissions calculated for project operation?

Operational GHG emissions would come from the vehicles that use the roadway once it is complete. These emissions depend on the number of vehicles, vehicle speed, distance traveled, and vehicle fuel efficiency. Federal legislation on fuel economy is anticipated to result in higher fuel efficiencies in the future. However, this analysis assumes that the vehicles traveling in the study area would use technology and fuels similar to those in use today. These assumptions are built in to the modeling tools currently available. Knowledge of how the vehicle fleet will change in the coming years is inadequate for making alternative assumptions.

Traffic analysts provided distance, volume, and speed data in 15-minute increments for two time periods (5:30 a.m. to 10:15 a.m. and 3:00 p.m. to 7:45 p.m.) for SR 520 from the interchange with I-5 to one mile past SR 202. HOV and general-purpose lanes were reported separately, and heavy trucks were estimated to be 3 percent of overall traffic. This information was available for five scenarios:

- Existing conditions (2006)
- 2030 No Build Alternative (includes Medina to SR 202 project, but does not include tolling)
- 2030 Option A
- 2030 Option A with suboptions (suboptions added to base option)
- 2030 Options K and L

The options are grouped based on the traffic data provided. Options K and L were analyzed together because they would have similar effects.

The 2004 Demo version of the U.S. Environmental Protection Agency (EPA's) Motor Vehicle Emissions Simulator (MOVES) modeling tool was used to calculate emission factors based on vehicle type and speed. Three emission factors were modeled, as follows:

- HOV lanes (passenger cars, passenger trucks, transit buses)
- General purpose (passenger cars, passenger trucks, motorcycles, motor homes)

- Trucks (single- and combination-unit, long- and short-haul trucks; light commercial trucks; refuse trucks)

MOVES models emission factors by month and time of day because weather can affect vehicle efficiency. The purpose of this analysis was to show differences in options, not predict absolute total emissions. Therefore, one month—March—was chosen to represent the average weather in the area. Although weather does affect emission factors, a review of the emission factors showed that they were almost identical across the time periods being analyzed; thus the emission factors for 7:00 a.m. to 8:00 a.m. were used for all hours analyzed. Attachment 2 provides detailed model inputs.

From the traffic data supplied, VMT was calculated for each 15-minute period for each roadway link. To determine GHG emissions, VMT for each link was multiplied by the relevant speed-based emission factor. Alternatives were compared by summing the emissions from all vehicle types by time period and by roadway link.

What effect would project construction have on greenhouse gas emissions?

Exhibit 22 shows the estimated construction GHG emissions for each 6-Lane Alternative option and pontoon transport. The emissions estimates include both facility construction activities and towing the pontoons to the site, as well as construction of additional pontoons not covered in the Pontoon Construction Project. Construction GHG emissions would be spread over the duration of construction.

These estimates are based on the results of the energy analysis. Because the energy analysis is based on applying an energy conversion factor to project costs, GHG emissions are directly proportional to project costs. This methodology does not rely on an in-depth analysis of construction techniques and equipment. Actual GHG emissions would depend on the type of equipment used and construction methods chosen.

Option A and Option A plus suboptions would have the lowest level of construction GHG emissions. Construction of Option L would produce approximately 25 percent more emissions than Option A, while Option K would have the highest level of construction emissions—over double the emissions of Option A.

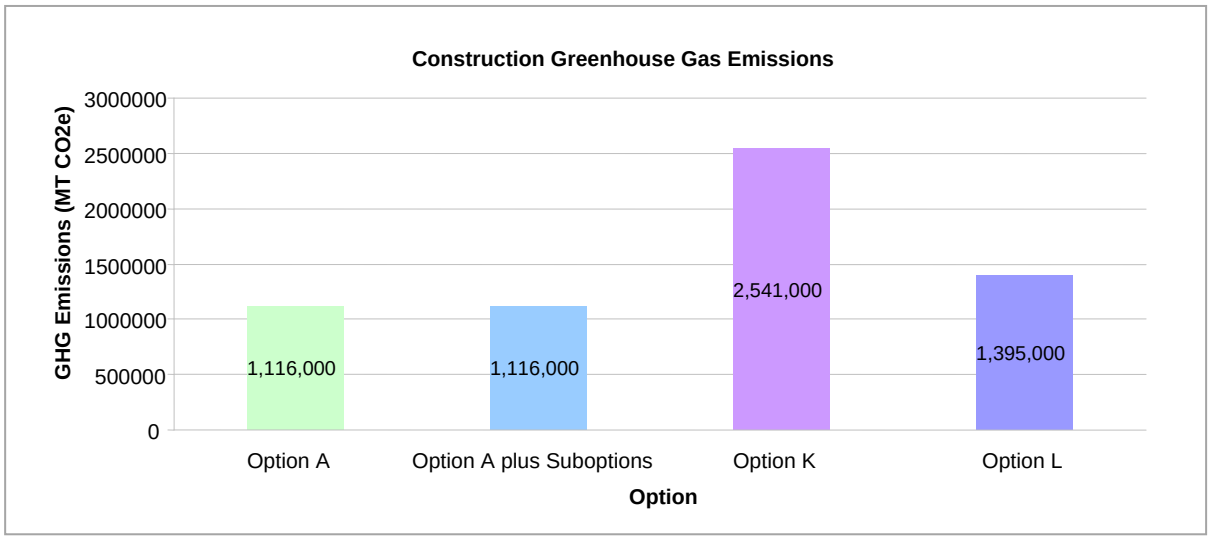


Exhibit 22. 6-Lane Alternative Construction GHG Emission Option Comparisons

Phased Implementation Scenario

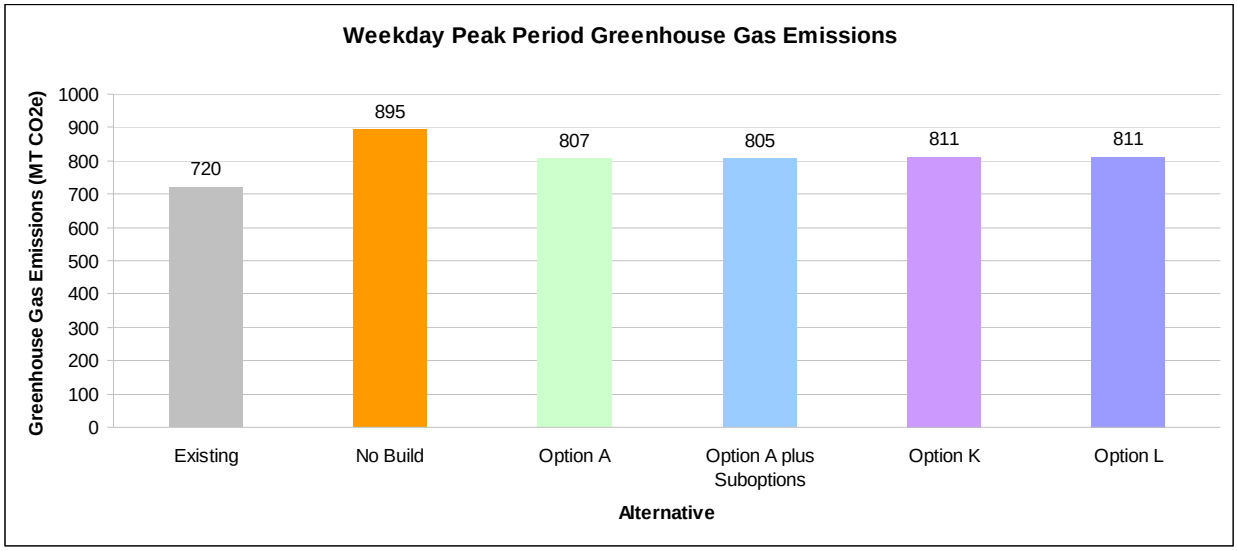
The total construction GHG emissions to replace vulnerable structures and to construct future phases would likely be higher than building the 6-Lane Alternative over one construction cycle because of the energy consumed during the additional mobilization required for building the I-5 to Medina project in phases.

What effect would project operation have on greenhouse gas emissions?

Exhibit 23 shows the total estimated CO_2e emissions produced during the peak periods of traffic on weekdays (5:30 a.m. to 10:15 a.m. and 3:00 p.m. to 7:45 p.m.). These periods were compared because they are the most congested times of day. Congestion noticeably affects fuel economy and, in turn, GHG emissions. Changes in the roadway configuration would most affect traffic during these time periods because of the high number of vehicles on the road and the greater likelihood of congested conditions.

Exhibit 24 compares the alternatives and presents percentage changes from the No Build Alternative. These values represent average days. On some days, emissions would be higher because of special events, weather, or incidents on the roadway. On other days, traffic conditions would allow traffic to flow at more efficient speeds and emissions would be lower. The 6-Lane Alternative includes tolling, which is

intended to help optimize system efficiency. The No Build Alternative does not include this feature.



Notes:

Emissions in metric tons CO_2e

Exhibit 23. Weekday Peak-Period Operational GHG Emissions (2030)

Current conditions produce about 720 metric tons (MT) of CO_2e each weekday from 5:30 a.m. to 10:15 a.m. and 3:00 p.m. to 7:45 p.m. In 2030, the No Build Alternative would produce about 895 MT CO_2e during the same time periods. All 6-Lane Alternative options would produce between 805 and 811 MT CO_2e, which is roughly 9 to 10 percent less GHG emissions than with the No Build Alternative. All of the 6-Lane Alternative options should be considered equal in their operational GHG emissions.

The 6-Lane Alternative options are expected to emit the same amount of GHGs because all 6-Lane Alternative options influence traffic in similar ways:

- VMT would be reduced because of tolling in the SR 520 corridor, which might cause commuters to shift transportation modes or find alternative routes across or around Lake Washington
- HOV lanes would be added, which would improve traffic flow for buses and carpools
- More people would use transit and carpooling rather than driving alone, which should also improve mobility in the general-purpose lanes

Exhibit 24. Weekday Peak-Period Operational GHG Emission Comparisons (2030)

Alternative	a.m. Emissions (MT CO_2e)	Compared to No Build Alt. (MT CO_2e)	Percent Difference	p.m. Emissions (MT CO_2e)	Compared to No Build Alt. (MT CO_2e)	Percent Difference	Total Emissions (MT CO_2e)	Compared to No Build Alt. (MT CO_2e)	Percent Difference
Existing (2006)	379	-34	-8%	341	-140	-29%	720	-174	-19%
No Build Alternative (2030)	413	–	–	482	–	–	895	–	–
Option A (2030)	384	-29	-7%	422	-59	-12%	807	-88	-10%
Option A plus Suboptions (2030)	386	-27	-7%	420	-62	-13%	805	-89	-10%
Option K or Option L (2030)	389	-24	-6%	422	-60	-12%	811	-84	-9%

Notes:

Numbers may not add up due to rounding.

MT CO_2e = metric tons of carbon dioxide equivalents

The operational emissions values represent only the emissions during peak periods on weekdays. Additional emissions are released during non-peak periods and on the weekends. Because traffic data were not available for these periods, the analysis does not include these emissions. This data limitation also precludes the calculation of annual GHG emissions for this I-5 to Medina project. However, because the weekday peak travel hours are the highest GHG-emitting periods, the weekday comparison is expected to reflect annual trends.

Although the analysis does not include project effects on roadways other than SR 520, the conditions on SR 520 influence and are influenced by traffic on other roadways in the region. The overall effect of the I-5 to Medina project on GHG emissions in the region could be lower or higher than the figures reported.

These values should not be compared to the construction emissions. Construction emissions can be clearly delineated in time and space. Operational emissions are much less clearly defined because they are heavily influenced by conditions outside the study area.

Phased Implementation Scenario

Operational GHG emissions under the scenario that would replace only vulnerable structures cannot be estimated at this time because traffic data were not developed for the Phased Implementation scenario.

What are potential measures to minimize emissions?

Because GHG emissions are related to fuel consumption, any steps taken to minimize fuel use would reduce GHG emissions as well. WSDOT would seek to set up active construction areas, staging areas, and material transfer sites in ways that would reduce equipment and vehicle idling. WSDOT would also work with its partners to promote ridesharing and other commute-trip reduction efforts for employees working on the 6-Lane Alternative.

Because 6-Lane Alternative operation GHG emissions depend on the number of vehicles traveling on the roadway and their fuel efficiency, steps to improve driving conditions on the roadway would reduce the GHG emissions. WSDOT and its transportation partners are working to reduce GHG emissions from the transportation sector throughout the state, including the SR 520 corridor. Examples of these activities include

providing alternatives to driving alone (such as carpooling, vanpooling, and transit); developing transportation facilities that encourage transit, HOV, bike, and pedestrian modes; supporting land use planning and development that encourage such travel modes (such as concentrating growth within urban growth areas); and optimizing system efficiency through variable speeds and tolling.

Did the project consider future conditions related to climate change?

Governor Gregoire committed the state to preparing for and adapting to the effects of climate change as part of Executive Order 0702. A focus sheet titled Preparing for Impacts (Ecology 2008b) provides a brief summary of the key climate changes that Washington is likely to experience over the next 50 years, as follows:

- Increased temperature (heat waves, poor air quality)
- Changes in volume and timing of precipitation (reduced snow pack, increased erosion, flooding)
- Ecological effects of a changing climate (spread of disease, altered plant and animal habitats, negative impacts on human health and well-being)
- Sea level rise, coastal erosion

Climate change is considered in the design of the new Evergreen Point Bridge, which crosses Lake Washington. The Hiram Chittenden Locks control the lake's surface elevation, maintaining an elevation that is, on average, 21 feet above the surface elevation of Puget Sound. This elevation difference protects the lake from major surface elevation changes associated with a rise in surface elevation of Puget Sound due to climate change. Lake surface elevation changes associated with less water entering the lake would affect the floating bridge transition spans and anchor cables.

As part of its design, the I-5 to Medina project has incorporated features that would help protect the project areas from storm damage and offer resilience to the potential effects of climate change. These features include the following:

- Designing the floating bridge transition spans for lake surface elevation changes of a rise of 0.8 foot and a fall of 3.8 feet, and being

able to adjust the anchor cables for the appropriate water surface elevation.

- Providing an enhanced design to protect the floating bridge and maintenance facility dock from damage due to wave action during large storm events.
- Preserving large trees and existing vegetation where possible to protect from erosion and potential landslides during large storm events.
- Using native vegetation and other natural materials to protect and stabilize the shoreline in locations exposed to low wave energy, minimizing erosion and colonization by non-native, invasive plant species.

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Attachment 1

Calculations for Estimated Energy Consumption

Exhibit 1-1. Construction Energy Calculation

Sections	Primary Structure	2014 Construction Dollars		Deflation Factor		1977 Construction Dollars		Energy Consumption Factor (Btu)		Conversion to MBtu		Energy Consumption (MBtu)
Option A: Construction Costs (2014$) and Energy Consumption												
I-5 Area	Interchange	$280,900,000	/	6.2	=	$45,299,877	*	70100	/	1,000,000	=	3,176,000
Portage Bay Area	Bridge	$412,800,000	/	6.2	=	$66,570,983	*	28100	/	1,000,000	=	1,871,000
Montlake Area (Montlake Interchange & Montlake Cut)	Interchange	$318,700,000	/	6.2	=	$51,395,767	*	70100	/	1,000,000	=	3,603,000
West Approach Area	Bridge	$635,600,000	/	6.2	=	$102,501,253	*	28100	/	1,000,000	=	2,880,000
Floating Bridge Area	Bridge	$613,000,000	/	6.2	=	$98,856,620	*	28100	/	1,000,000	=	2,778,000
Eastside Transition Area	Urban Freeway	$157,400,000	/	6.2	=	$25,383,413	*	27500	/	1,000,000	=	698,000
Total		**$2,418,400,000**										**15,006,000**
Option K: Construction Costs (2014$) and Energy Consumption												
I-5 Area	Interchange	$296,000,000	/	6.2	=	$47,735,008	*	70100	/	1,000,000	=	3,346,000
Portage Bay Area	Bridge	$360,400,000	/	6.2	=	$58,120,597	*	28100	/	1,000,000	=	1,633,000
Montlake Area (Montlake Interchange & Montlake Cut)	Interchange	$1,950,600,000	/	6.2	=	$314,567,249	*	70100	/	1,000,000	=	22,051,000
West Approach Area	Bridge	$837,000,000	/	6.2	=	$134,980,410	*	28100	/	1,000,000	=	3,793,000
Floating Bridge Area	Bridge	$613,000,000	/	6.2	=	$98,856,620	*	28100	/	1,000,000	=	2,778,000
Eastside Transition Area	Urban Freeway	$157,400,000	/	6.2	=	$25,383,413	*	27500	/	1,000,000	=	698,000
Total		**$4,214,400,000**										**34,299,000**

Exhibit 1-1. Construction Energy Calculation

Sections	Primary Structure	2014 Construction Dollars		Deflation Factor		1977 Construction Dollars		Energy Consumption Factor (Btu)		Conversion to MBtu		Energy Consumption (MBtu)
Option L: Construction Costs (2014$) and Energy Consumption												
I-5 Area	Interchange	$277,300,000	/	6.2	=	$44,719,316	*	70100	/	1,000,000	=	3,135,000
Portage Bay Area	Bridge	$361,600,000	/	6.2	=	$58,314,117	*	28100	/	1,000,000	=	1,639,000
Montlake Area (Montlake Interchange & Montlake Cut)	Interchange	$582,100,000	/	6.2	=	$93,873,473	*	70100	/	1,000,000	=	6,581,000
West Approach Area	Bridge	$871,700,000	/	6.2	=	$140,576,372	*	28100	/	1,000,000	=	3,950,000
Floating Bridge Area	Bridge	$613,000,000	/	6.2	=	$98,856,620	*	28100	/	1,000,000	=	2,778,000
Eastside Transition Area	Urban Freeway	$157,400,000	/	6.2	=	$25,383,413	*	27500	/	1,000,000	=	698,000
Total		**$2,863,100,000**										**18,781,000**

Exhibit 1-2. Energy Consumption during Operations Calculation

Mode	Annual VMT (millions)		Energy Consumption (Btu/mile)		Energy Consumed (MBtu)		Btu per Gallon of Fuel		Gallons of Fuel (millions)
Existing Conditions									
Passenger Vehicle[a]	541	*	6,005	=	3,248,713	/	124,000	=	26.2
Heavy-duty Truck	17	*	23,238	=	392,044	/	139,000	=	2.8
Transit Bus	4	*	39,408	=	177,292	/	139,000	=	1.3
Total	**562**			=	**3,818,048**				**30.3**
No Build Alt. 2030									
Passenger Vehicle[a]	776	*	6,005	=	4,657,405	/	124,000	=	37.6
Heavy-duty Truck	24	*	23,238	=	562,040	/	139,000	=	4.0
Transit Bus	6	*	39,408	=	254,168	/	139,000	=	1.8
Total	**806**			=	**5,473,613**				**43.4**
Option A 2030									
Passenger Vehicle[a]	710	*	6,005	=	4,264,967	/	124,000	=	34.4
Heavy-duty Truck	22	*	23,238	=	514,682	/	139,000	=	3.7
Transit Bus	6	*	39,408	=	232,752	/	139,000	=	1.7
Total	**738**			=	**5,012,400**				**39.8**
Option K or L 2030									
Passenger Vehicle[a]	727	*	6,005	=	4,368,281	/	124,000	=	35.2
Heavy-duty Truck	23	*	23,238	=	527,149	/	139,000	=	3.8
Transit Bus	6	*	39,408	=	238,390	/	139,000	=	1.7
Total	**756**			=	**5,133,821**				**40.7**

[a] Passenger vehicles include cars, light trucks, and motorcycles.

Note: Numbers may not add up due to rounding.

Source: WSDOT (2009e); DOE (2008); EIA (2007).

Attachment 2

Model Inputs for Greenhouse Gas Emissions Modeling

EPA MOVES RunSpec File Name:
C:\Documents and Settings\landsbk\My Documents\Climate Change\Projects\SR 520\SR 520 East and West\MOVES\Draft_Runs\090727_SR520_GP.mrs

Description:
SR 520 General Purpose Lanes

Domain/Scale: National
Calculation Type: Emission Rates

Time Spans:
Aggregate By: Hour
Years:
2006
2030

Months:
March
Days:
Weekdays
Hours:
Begin Hour: 07:00 - 07:59
End Hour: 07:00 - 07:59

Geographic Bounds:
LINK geography
Selection: WASHINGTON - King County

On Road Vehicle Equipment:
Compressed Natural Gas (CNG) - Motor Home
Compressed Natural Gas (CNG) - Passenger Car
Compressed Natural Gas (CNG) - Passenger Truck
Diesel Fuel - Motor Home
Diesel Fuel - Passenger Car
Diesel Fuel - Passenger Truck
Electricity - Motor Home
Electricity - Passenger Car

Electricity - Passenger Truck
Ethanol (E85) - Motor Home
Ethanol (E85) - Passenger Car
Ethanol (E85) - Passenger Truck
Gasoline - Motor Home
Gasoline - Passenger Car
Gasoline - Passenger Truck
Liquid Propane Gas (LPG) - Motor Home
Liquid Propane Gas (LPG) - Passenger Car
Liquid Propane Gas (LPG) - Passenger Truck

Road Types:
Urban Restricted Access

Pollutants And Processes:
Running Exhaust Atmospheric CO2
Running Exhaust CO2 Equivalent
Running Exhaust Methane (CH4)
Running Exhaust Nitrous Oxide (N2O)
Running Exhaust Total Energy Consumption

Strategies:

Strategies:

Manage Input Data Sets:

General Output:
Output Database Server Name: [using default]
Output Database Name: 090717_SR5202_GPlanes
Output Time Factors:
Time Units: Hours
Mass Units: Grams
Energy Units: Joules
Distance Units: Miles

Output Emissions Breakdown:
On Road/Off Road

```
    Road Type
    Output Time Step
        Hour
    Geographic Output Detail
        LINK

Advanced Performance Features:
    Do Not Execute:
    Save Data From:
    Do Not Save Generator Data
    Saved Data Database Server Name: [using default]
    Saved Data Database Name: [using default]
    Custom Default Database Server Name: [using default]
    Custom Default Database Name: [using default]
    Perform Final Aggregation (if necessary)
```

EPA MOVES RunSpec File Name:
C:\Documents and Settings\landsbk\My Documents\Climate Change\Projects\SR 520\SR 520 East and West\MOVES\Draft_Runs\090727_SR520_Trucks.mrs

Description:
SR 520 General Purpose Lanes

Domain/Scale: National
Calculation Type: Emission Rates

Time Spans:
Aggregate By: Hour
Years:
2006
2030

Months:
March
Days:
Weekdays
Hours:
Begin Hour: 07:00 - 07:59
End Hour: 07:00 - 07:59

Geographic Bounds:
LINK geography
Selection: WASHINGTON - King County

On Road Vehicle Equipment:
Compressed Natural Gas (CNG) - Light Commercial Truck
Compressed Natural Gas (CNG) - Refuse Truck
Compressed Natural Gas (CNG) - Single Unit Long-haul Truck
Compressed Natural Gas (CNG) - Single Unit Short-haul Truck
Diesel Fuel - Combination Long-haul Truck
Diesel Fuel - Combination Short-haul Truck
Diesel Fuel - Light Commercial Truck
Diesel Fuel - Refuse Truck

Diesel Fuel - Single Unit Long-haul Truck
Diesel Fuel - Single Unit Short-haul Truck
Electricity - Light Commercial Truck
Electricity - Refuse Truck
Electricity - Single Unit Short-haul Truck
Ethanol (E85) - Light Commercial Truck
Ethanol (E85) - Refuse Truck
Ethanol (E85) - Single Unit Long-haul Truck
Ethanol (E85) - Single Unit Short-haul Truck
Gasoline - Combination Long-haul Truck
Gasoline - Combination Short-haul Truck
Gasoline - Light Commercial Truck
Gasoline - Refuse Truck
Gasoline - Single Unit Long-haul Truck
Gasoline - Single Unit Short-haul Truck
Liquid Propane Gas (LPG) - Light Commercial Truck
Liquid Propane Gas (LPG) - Refuse Truck
Liquid Propane Gas (LPG) - Single Unit Long-haul Truck
Liquid Propane Gas (LPG) - Single Unit Short-haul Truck

Road Types:
Urban Restricted Access

Pollutants And Processes:
Running Exhaust Atmospheric CO2
Running Exhaust CO2 Equivalent
Running Exhaust Methane (CH4)
Running Exhaust Nitrous Oxide (N2O)
Running Exhaust Total Energy Consumption

Strategies:

Strategies:

Manage Input Data Sets:

General Output:
Output Database Server Name: [using default]

```
    Output Database Name: 090730_sr5202_trucks_hour
    Output Time Factors:
        Time Units: Hours
        Mass Units: Grams
        Energy Units: Joules
        Distance Units: Miles

Output Emissions Breakdown:
    On Road/Off Road
    Road Type
    Output Time Step
        Hour
    Geographic Output Detail
        LINK

Advanced Performance Features:
    Do Not Execute:
    Save Data From:
    Do Not Save Generator Data
    Saved Data Database Server Name: [using default]
    Saved Data Database Name: [using default]
    Custom Default Database Server Name: [using default]
    Custom Default Database Name: [using default]
    Perform Final Aggregation (if necessary)
```

EPA MOVES RunSpec File Name:
C:\Documents and Settings\landsbk\My Documents\Climate Change\Projects\SR 520\SR 520 East and West\MOVES\Draft_Runs\090727_SR520_HOV.mrs

Description:
SR 520 General Purpose Lanes

Domain/Scale: National
Calculation Type: Emission Rates

Time Spans:
Aggregate By: Hour
Years:
2006
2030

Months:
March
Days:
Weekdays
Hours:
Begin Hour: 07:00 - 07:59
End Hour: 07:00 - 07:59

Geographic Bounds:
LINK geography
Selection: WASHINGTON - King County

On Road Vehicle Equipment:
Compressed Natural Gas (CNG) - Motor Home
Compressed Natural Gas (CNG) - Passenger Car
Compressed Natural Gas (CNG) - Passenger Truck
Compressed Natural Gas (CNG) - School Bus
Compressed Natural Gas (CNG) - Transit Bus
Diesel Fuel - Intercity Bus
Diesel Fuel - Motor Home
Diesel Fuel - Passenger Car

Diesel Fuel - Passenger Truck
Diesel Fuel - School Bus
Diesel Fuel - Transit Bus
Electricity - Motor Home
Electricity - Passenger Car
Electricity - Passenger Truck
Electricity - School Bus
Electricity - Transit Bus
Ethanol (E85) - Motor Home
Ethanol (E85) - Passenger Car
Ethanol (E85) - Passenger Truck
Ethanol (E85) - School Bus
Ethanol (E85) - Transit Bus
Gasoline - Motor Home
Gasoline - Passenger Car
Gasoline - Passenger Truck
Gasoline - School Bus
Gasoline - Transit Bus
Liquid Propane Gas (LPG) - Motor Home
Liquid Propane Gas (LPG) - Passenger Car
Liquid Propane Gas (LPG) - Passenger Truck
Liquid Propane Gas (LPG) - School Bus
Liquid Propane Gas (LPG) - Transit Bus

Road Types:
Urban Restricted Access

Pollutants And Processes:
Running Exhaust Atmospheric CO2
Running Exhaust CO2 Equivalent
Running Exhaust Methane (CH4)
Running Exhaust Nitrous Oxide (N2O)
Running Exhaust Total Energy Consumption

Strategies:

Strategies:

```
Manage Input Data Sets:

General Output:
    Output Database Server Name: [using default]
    Output Database Name: 090717_sr5202_HOVlanes
    Output Time Factors:
        Time Units: Hours
        Mass Units: Grams
        Energy Units: Joules
        Distance Units: Miles

Output Emissions Breakdown:
    On Road/Off Road
    Road Type
    Output Time Step
        Hour
    Geographic Output Detail
        LINK

Advanced Performance Features:
    Do Not Execute:
    Save Data From:
    Do Not Save Generator Data
    Saved Data Database Server Name: [using default]
    Saved Data Database Name: [using default]
    Custom Default Database Server Name: [using default]
    Custom Default Database Name: [using default]
    Perform Final Aggregation (if necessary)
```