

Seattle Department of Transportation

# EAST MARGINAL WAY CORRIDOR IMPROVEMENT PROJECT

Appendix A: BCA Technical Memorandum



Prepared for  
US Department of Transportation  
FY 2020 BUILD Grant Application

Submitted by



**Seattle**  
Department of  
Transportation

# EXECUTIVE SUMMARY

A benefit-cost analysis (BCA) was conducted for the East Marginal Way Corridor Improvement project for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the Better Utilizing Investments to Leverage Development (BUILD) 2020 program. The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs<sup>1</sup>. The period of analysis corresponds to thirty-four years and includes four years of pre-completion and construction and thirty years of benefits, after full completion of all the identified projects is assumed to begin in May 2024.

The East Marginal Way Corridor Improvement Project (BUILD Project) will support a more economically competitive Northwest by improving safety and mobility on East Marginal Way S. This critical corridor connects a residential population of nearly 750,000 in Seattle to almost 60,000 jobs in Seattle's Duwamish Manufacturing Industrial Center (MIC). East Marginal Way S serves freight movement between seven marine container terminals and two intermodal rail yards, carrying nearly 10,000 average daily traffic, while also handling nearly 1,000 bicycle commuters. The roadway has deteriorated beyond its useful life and is in dire need of state of good repair road rehabilitation, Intelligent Transportation System (ITS) upgrades, and life-saving safety improvements that will remove conflicts and provide for separate and predictable travel for people walking, biking, and driving in cars and freight trucks to access jobs and essential services.

## COVID-19 AND WEST SEATTLE BRIDGE

The East Marginal Way Corridor Improvement Project has been significantly impacted by two major global and regional events:

- The COVID-19 pandemic impacting much of the world has reduced transit trips in the Seattle area by 75 percent for King County Metro, the regions largest transit provider, and freight traffic by 50 percent in the South Seattle Area on I-5, as of mid-April, 2020<sup>2</sup>. When and if volumes return to previous levels is unknown at this time as there could be longer term impacts to commute trip generation. More people may continue to work from home if they are able, and changes in travel behavior as decreased commute vehicle trips will in theory provide more capacity for mode shift, specifically from transit. This could be further impacted by potential reluctance to use public transit in fear of contracting any future viruses.
- On March 24, 2020, the West Seattle Bridge was suddenly closed to vehicular traffic due to cracking, and its reopening is not expected until approximately 2022. Even if the bridge can be repaired in the near-term, it will not open until 2022. The bridge handled approximately 84,000 vehicle and 17,000 transit trips per day prior to the COVID-19 pandemic. One of the key alternative routes to the West Seattle Bridge is the lower bridge on Spokane St, which feeds directly into East Marginal Way S. Spokane St is also the location of the West Seattle Bridge bike trail, which is part of a regional bicycle route extending to communities south of Seattle. Since the closure of the bridge, bike trips

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<sup>1</sup> U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. January 2020. [https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020\\_0.pdf](https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf)

<sup>2</sup> Washington State Department of Transportation, Transportation System Performance, May 6, 2020. [https://public.tableau.com/profile/washington.state.dept.transportation.tssa#1/vizhome/WSDOT\\_COVID-19\\_Transit/FrontPage\\_Transit](https://public.tableau.com/profile/washington.state.dept.transportation.tssa#1/vizhome/WSDOT_COVID-19_Transit/FrontPage_Transit)

have appeared to rebound to close to 80% of pre-COVID levels compared to 23% for general vehicle trips. On weekends, bike trips have increased 110% compared with the same period in 2019.

The BUILD project is a partnership between local, state, and regional agencies and the Port of Seattle. East Marginal Way S is a strategically located, highly traveled, multimodal corridor with even more pronounced regional significance from short- and long-term traffic impacts resulting from the COVID-19 pandemic and the recent emergency closure of the West Seattle Bridge (see text box below).

To better realize the East Marginal Way S corridor's potential as a safe, reliable connector between jobs and housing, farms and foreign markets, and marine terminals and manufacturing, the Seattle Department of Transportation (SDOT) requests \$20 million in Fiscal Year (FY) 2020 BUILD funds to complete the BUILD Project. The proposed improvements would immediately address the following existing constraints:

- Reconstructing the East Marginal Way S roadway and upgrading the route to Heavy Haul Network standards along a 1.1-mile segment from a point south of S Massachusetts St to S Spokane St to enhance efficient freight flow and reduce operations and maintenance (O&M) costs for shippers and others in the supply chain
- Removing conflicts between motorists and non-motorists, and constructing a 2-way protected bike lane along a 1.4-mile segment between S Atlantic St and S Spokane St to eliminate fatalities, increase visibility, and protect the approximately 1,000 daily bicycle riders that use this corridor
- Constructing adaptive traffic signals working dynamically together using Split Cycle Offset Optimization Technique (SCOOT) technology to enhance safety and improve traffic flow at several of the City's busiest freight intersections
- Relocating the railroad tracks at S Hanford St to provide more space between truck traffic and the bicycle facility
- Rebuilding the sidewalk on the west side of East Marginal Way S adjacent to the roadway reconstruction to provide a safe, accessible route for people walking
- Installing adequate lighting and appropriate landscaping along the corridor to improve safety and the environment
- Adding a Dynamic Message Sign (DMS) just north of S Alaska St to provide a means of informing motorists about traffic conditions and direct them to the BUILD Project corridor on East Marginal Way S

The East Marginal Way S project has the potential to transform a critical roadway that links regional and national industries with the global market and provide a safe link to thousands of vehicles and cyclists accessing jobs and recreational activities in the region.

## CAPITAL COSTS

The overall capital cost of the Project is expected to be \$43.3 million in undiscounted 2019 dollars through 2025. The effective costs used in this BCA of \$43.3 million include \$1 million for prior planning and project development, \$4.1 for preliminary engineering and environmental work, and \$38.2 million for construction including construction closeout. The total construction period is anticipated to be four years and go through 2025 when including close out activities. Project expenses are anticipated to be incurred over the timeline shown in Table ES-1.

**TABLE ES-1: Project Capital Costs by Year, in Undiscounted 2019 Dollars (Millions)**

		2019 \$\$							
PROJECT ESTIMATE	Calendar Years	Prior Years	2020	2021	2022	2023	2024	2025	Total
		Planning	\$ 1,025,000						
	Design	\$ 315,000	\$ 2,582,500	\$ 877,000	\$ 313,500				\$ 4,088,000
	Construction			\$ 1,581,500	\$ 11,011,000	\$ 15,825,000	\$ 8,106,500	\$ 1,711,000	\$ 38,235,000
	<b>Total</b>	<b>\$ 1,340,000</b>	<b>\$ 2,582,500</b>	<b>\$ 2,458,500</b>	<b>\$ 11,324,500</b>	<b>\$ 15,825,000</b>	<b>\$ 8,106,500</b>	<b>\$ 1,711,000</b>	<b>\$ 43,348,000</b>

*\* Construction costs inclusive of: road replacement from south of S Massachusetts St to S Spokane St, upgraded traffic signals at S Hanford St, new traffic signal at S Horton St, protected bicycle lanes, SCOOT traffic management system, drainage, landscaping, lighting, sidewalk, relocation of Union Pacific rail tracks, installation of Dynamic Message Sign at S Alaska St, removal of existing facilities, construction management, engineering design, and construction contingency of 15 percent.*

Source: WSP Estimates 2020

All cost values were recently developed and estimated in 2019 dollars, and deflated to 2018 dollars, consistent with BUILD BCA valuation requirements. A deflation factor of 0.9849 was applied to express 2019 values to 2018 dollars.

## BENEFITS

In undiscounted 2018 dollars, the East Marginal Way S project creates benefits of \$486.4 million, or \$126.8 million when discounted at 7 percent and \$259.5 million when discounted at 3 percent. These benefits are primarily achieved through reduction in vehicle maintenance, safety improvements, and benefits such as health associated with increased access to active transportation. Despite the potential for diversion to, and potentially from, more circuitous routes without the improvements, as a conservative approach there was no reduction in vehicle miles traveled or travel time savings assumed as a result of improving East Marginal Way S as a direct access route. Travel time savings for freight and passenger vehicles are associated to improvements in signal timing and flow of traffic as a result of signal and ITS improvements, including the SCOOT system. Cyclists are projected to experience a potential increase in travel times due to the additional intersection signalization at Horton.

Benefits from cost savings include a reduction in operating and maintenance costs attributed to the new roadway facility that will replace the existing deteriorating facility. The reduction in roadway operating costs are slightly offset by new costs for maintenance of the protected bicycle lane and additional signal and ITS components. The new roadway asset is also expected to have a residual value, after consideration of depreciation, consistent with its anticipated useful life of 50 years and assumes fully funded annual maintenance. The overall project benefit matrix can be seen in Table ES-2 with total cost savings for the 30-year benefit analysis period.

**Table ES-2: Project Impacts and Benefits Summary, Monetary Values in Millions of 2018 Dollars**

Current Status/Baseline & Problem to be Addressed	Project Improvement	Population Affected by Impact	Economic Benefit	Summary of Results	
				7% Discount Rate	3% Discount Rate
Deteriorating roadway, safety, and mobility.	Improved roadway and SCOOT enhancements	Auto and truck drivers with reduced wait time and faster speeds	Travel time savings	\$0.7 million savings	\$1.9 million savings
	Addition of new signal	Cyclists have increased wait times with new signal	Travel time increases	(\$0.2 million) increase in costs	(\$0.5 million) increase in costs
	Improved roadway	Passenger cars and freight vehicles will experience less damage from the roadway	Reduction in vehicle maintenance costs	\$27.1 million in savings	\$53.9 million in savings
	Protected bicycle lane and intersection improvements	General population	Reduced tailpipe emissions from vehicles	\$1.6 million in reductions	\$3.2 million in reductions
		All existing and future users of the facility	Reduced crashes	\$7.6 million in savings	\$14.3 million in savings
		New bicyclists	Improved Health Leading to Lower healthcare costs	\$13.4 million in savings	\$27.4 million in savings
		New commuter bicyclists	Improved mobility	\$76.2 million in savings	\$155.9 million in savings
		New recreational bicyclists	Value of time benefit to access recreational activity	\$391,000 in savings	\$799,000 in savings
	Improved roadway, protected bicycle lane and ITS/signal enhancements	Seattle Department of Transportation, Maintenance Operations	Reduced operating and maintenance costs with the new roadway	\$132,000 in savings	\$246,000 in savings
		Seattle Department of Transportation	Residual value of the new assets at the end of the thirty-year benefit analysis period	\$1.5 million in remaining value	\$5.6 million in remaining value

Source: WSP, 2020

The overall Project impacts can be seen in Table ES-3, which shows the magnitude of change and direction of the various impact categories.

**Table ES-3: Project Impacts for Project, Cumulative 2020-53**

Category	Unit	Quantity	Direction
Person-Hours Traveled	PHT	122,906	▼
Vehicle Miles Traveled (vehicle maintenance)	VMT	194,173,804	n/a
Fatalities	#	2	▼
Injury Accidents	#	24	▼
Property Damage Only (PDO)	#	35	▼
Emissions	Tons	552	▼
Annual health benefits	new cyclists	10,976 (avg. new bicyclists per year)	▲
Commuter Mobility Benefits - Bicyclists	hours	584,663 (avg. new bicyclists hours per year)	▲
Recreational Benefits – Bicyclists	new cyclists	4,090 (avg. new recreational bicyclists per year)	▲

Source: WSP, 2020

Table ES-4 below shows the overall results of the BCA. At a 7 percent discount rate, the East Marginal Way Corridor Improvement Project yields a benefit-cost ratio of 3.78 over a 34-year analysis period and using an alternative 3 percent discount rate a benefit-cost ratio of 6.76.

**Table ES-4: Benefit Cost Analysis Summary Results**

Scenario	Net Present Value (2018 \$ millions discounted to 2019)	Benefit Cost Ratio
<b>Base Case - 7 percent discount rate</b>	<b>\$93,287,236</b>	<b>3.78</b>
<b>Alternative - 3 percent discount rate</b>	<b>\$221,093,652</b>	<b>6.76</b>

Source: WSP, 2020

Sensitivity tests were conducted utilizing a range of valuations for benefit categories and impacts for low and high unit values and reductions in network benefits. While the results displayed are the baseline and most likely numbers, further statistical analysis was conducted to meet the U.S. DOT’s recommendations of a thorough sensitivity analysis, and in all cases the B/C ratio remains above 1.0.

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# 1 INTRODUCTION

A benefit-cost analysis (BCA) was conducted for the East Marginal Way Corridor Improvement Project for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the Better Utilizing Investments to Leverage Development (BUILD) 2020 program. The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs<sup>3</sup>. The period of analysis corresponds to thirty-four years and includes four years of pre-completion and construction and thirty years of benefits, after full completion of all the identified projects is assumed to begin in May 2024.

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## 1.1 BCA FRAMEWORK

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of an investment opportunity. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of U.S. DOT's BCA is to assess whether the expected benefits of a project justify the costs to inform prioritization of project applications received from across the country. A BCA framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits), as well as dis-benefits where costs can be identified (e.g., project capital costs), and welfare reductions where some groups are expected to be made worse off as a result of the proposed project.

The BCA framework involves defining a Base Case or “No Build” Case, which is compared to the “Build” Case, where the grant request is awarded, and the project is built as proposed. The BCA assesses the incremental difference between the Base Case and the Build Case, which represents the net change in welfare. BCAs are forward-looking exercises which seek to assess the incremental change in welfare over a project lifecycle. The importance of future welfare changes is determined through discounting, which is meant to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the 2020 Discretionary Grant Benefit-Cost Analysis Guidance<sup>4</sup>. This methodology includes the following analytical assumptions:

- Defining existing and future conditions under a No Build base case as well as under the Build Case;
- Estimating benefits and costs during project construction and operation, including up to 30 years of operations beyond the Project completion when benefits accrue;
- Using U.S. DOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits;
- Presenting dollar values in real 2018 dollars. In instances where cost estimates and benefits valuations are expressed in historical dollar years, using an appropriate Consumer Price Index (CPI) to adjust the values;

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<sup>3</sup> U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. January 2020. [https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020\\_0.pdf](https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf)

<sup>4</sup> *ibid*

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- Discounting future benefits and costs with real discount rates of 7 percent consistent with U.S. DOT guidance.
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## 1.2 PRISM

This benefit cost analysis was done using PRISM™, a benefit cost analysis tool developed by WSP that uses a methodology consistent with the most recent guidelines developed by USDOT. The tool results and analysis are provided in an Excel file supporting the findings for the base case analysis with a 7 percent discount rate in the BCA Report.

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## 1.3 EVALUATION PERIOD

The East Marginal Way Corridor Improvement Project evaluation period includes the relevant engineering and design costs through 2022, construction of the project between 2021 and late April 2024, with allowances for project close out through 2025, and 30 years of operations beyond the assumed construction completion at the end of April 2024.

The construction period continues through late 2024 with operations assumed to begin the first day of May 2024. The analysis period, therefore, begins with the first expenditures, including prior expenditures, recorded in 2020 and continues through construction and 30-years of operations, or through 2053.

All benefits and costs are assumed to occur at the end of each year.

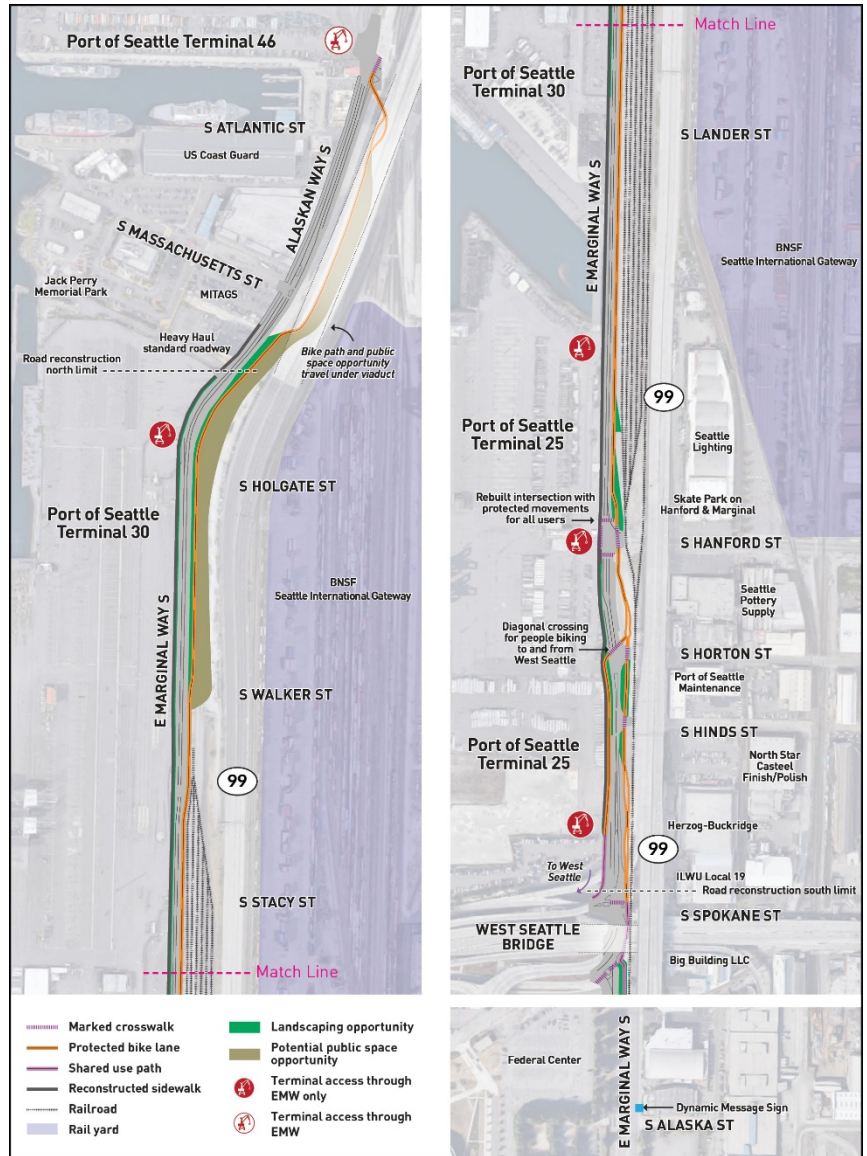
# 2 PROJECT OVERVIEW

## 2.1 DESCRIPTION

The East Marginal Way Corridor Improvement Project (BUILD Project) will support a more economically competitive Northwest by improving safety and mobility on East Marginal Way S. This critical corridor connects a residential population of nearly 750,000 in Seattle to almost 60,000 jobs in Seattle’s Duwamish Manufacturing Industrial Center (MIC). East Marginal Way S serves freight movement between seven marine container terminals and two intermodal rail yards, carrying nearly 10,000 average daily traffic, while also handling nearly 1,000 bicycle commuters. The roadway has deteriorated beyond its useful life and is in dire need of state of good repair road rehabilitation, Intelligent Transportation System (ITS) upgrades, and life-saving safety improvements that will remove conflicts and provide for separate and predictable travel for people walking, biking, and driving in cars and freight trucks to access jobs and essential services.

The BUILD project is a partnership between local, state, and regional agencies and the Port of Seattle. East Marginal Way S is a strategically located, highly traveled, multimodal corridor with even more pronounced regional significance from short- and long-term traffic impacts resulting from the COVID-19 pandemic and the recent emergency closure of the West Seattle Bridge.

Exhibit 1: East Marginal Way S Project Map



Source: Seattle Department of Transportation, 2020

To better realize the East Marginal Way S corridor’s potential as a safe, reliable connector between jobs and housing, farms and foreign markets, and marine terminals and manufacturing, the Seattle Department of Transportation (SDOT) requests \$20 million in Fiscal Year (FY) 2020 BUILD funds to complete the

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BUILD Project. The proposed improvements would immediately address the following existing constraints:

- Reconstructing the East Marginal Way S roadway and upgrading the route to Heavy Haul Network standards along a 1.1-mile segment from a point south of S Massachusetts St to S Spokane St to enhance efficient freight flow and reduce operations and maintenance (O&M) costs for shippers and others in the supply chain
- Removing conflicts between motorists and non-motorists, and constructing a 2-way protected bike lane along a 1.4-mile segment between S Atlantic St and S Spokane St to eliminate fatalities, increase visibility, and protect the approximately 1,000 daily bicycle riders that use this corridor
- Constructing adaptive traffic signals working dynamically together using Split Cycle Offset Optimization Technique (SCOOT) technology to enhance safety and improve traffic flow at several of the City's busiest freight intersections
- Relocating the railroad tracks at S Hanford St to provide more space between truck traffic and the bicycle facility
- Rebuilding the sidewalk on the west side of East Marginal Way S adjacent to the roadway reconstruction to provide a safe, accessible route for people walking
- Installing adequate lighting and appropriate landscaping along the corridor to improve safety and the environment
- Adding a Dynamic Message Sign (DMS) just north of S Alaska St to provide a means of informing motorists about traffic conditions and direct them to the BUILD Project corridor on East Marginal Way S

The East Marginal Way S project has the potential to transform a critical roadway that links regional and national industries with the global market and provide a safe link to thousands of vehicles and cyclists accessing jobs and recreational activities in the region.

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## 2.2 GENERAL ASSUMPTIONS

The East Marginal Way Corridor Improvement Project presents the unique opportunity to address the critical needs of both the freight and cycling community in replacing a badly deteriorating roadway with serious safety concerns. As such the analysis focuses on benefits for current users in reduced vehicle maintenance costs and improved safety, and new users, specifically bicyclists, who will use the facility as a result of the infrastructure improvements. In addition, the new signalization and implementation of a SCOOT traffic managements system will improve the flow of vehicles, specifically freight vehicles, during peak operating periods. The incremental routine maintenance costs attributed to the project improvements are projected to be lower than the projected annual maintenance requirements for the city to keep the facility operational.

The East Marginal Way Corridor Improvement Project has also been significantly impacted by both major global and regional events that influence the current vehicle traffic and bicycle trip data used to

inform the underlying forecast projections and creates a less certain outlook for future trends. Events that will impact both current and future assumptions include:

- The COVID-19 pandemic impacting much of the world has reduced transit trips in the Seattle area by 75 percent for King County Metro, the regions largest transit provider, and freight traffic by 50 percent in the South Seattle Area on I-5, as of mid-April, 2020<sup>5</sup>. When and if volumes return to previous levels is unknown at this time as there could be longer term impacts to commute trip generation. More people may continue to work from home if they are able, and changes in travel behavior as decreased commute vehicle trips will in theory provide more capacity for mode shift, specifically from transit. This could be further impacted by potential reluctance to use public transit in fear of contracting any future viruses.

*As the impact of COVID-19 is largely unknown at the time this application was prepared, and changes will likely favor further growth in bicycle and vehicle trips which will improve the overall BCR, we assumed a conservative approach and used existing pre COVID-19 volumes as the basis for our analysis.*

- On March 24, 2020, the West Seattle Bridge was suddenly closed to vehicular traffic due to cracking, and its reopening is not expected until approximately 2022. Even if the bridge can be repaired in the near-term, it will not open until 2022. The bridge handled approximately 84,000 vehicle and 17,000 transit trips per day prior to the COVID-19 pandemic. One of the key alternative routes to the West Seattle Bridge is the lower bridge on Spokane St, which feeds directly into East Marginal Way S. Spokane St is also the location of the West Seattle Bridge bike trail, which is part of a regional bicycle route extending to communities south of Seattle. Since the closure of the bridge, bike trips have appeared to rebound to close to 80% of pre-COVID levels compared to 23% for general vehicle trips. On weekends, bike trips have increased 110% compared with the same period in 2019<sup>6</sup>.

*To account for the combined impact of COVID-19 and the closure of the West Seattle Bridge, the baseline bike trips have been adjusted to reflect a 29 percent increase in baseline trips. The increase is based on a combination of the current resiliency in trips compared to transit and vehicles, approximately 50 percent higher than baseline before COVID-19 and the West Seattle Bridge closure, and general compound average growth in bicycle trips of 2.96 percent between 2014-2019. This is a conservative assumption in the sense that part of the increase in bike trips that may have previously been associated to the East Marginal Way build scenario is now captured in the no-build baseline, reducing the incremental benefits. However, it is less conservative in the context of higher potential for crashes with the increased volume of bike trips on East Marginal Way S, combined with heavy vehicle and transit use due to diversions to SW Spokane St. and East Marginal Way S from the closed West Seattle Bridge. The increase in heavy truck and transit trips on East Marginal Way S has not been considered, as a conservative approach.*

The underlying primary approach and assumptions include:

- Current trip generation, travel times, and miles traveled were derived from loop data collected in 2019-2020 with bicycle counts derived from a permanent bicycle counter on Spokane Street which feeds trips directly into East Marginal Way S and through downtown Seattle, and verified through

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<sup>5</sup> Washington State Department of Transportation, Transportation System Performance, May 6, 2020. [https://public.tableau.com/profile/washington.state.dept.transportation.tssa#!/vizhome/WSDOT\\_COVID-19\\_Transit/FrontPage\\_Transit](https://public.tableau.com/profile/washington.state.dept.transportation.tssa#!/vizhome/WSDOT_COVID-19_Transit/FrontPage_Transit)

<sup>6</sup> Seattle bike counter for SW Spokane St. Bike counter (W. Seattle Bridge) as a proxy for E. Marginal Way bike trips. <https://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-counters/spokane-bike-counters>

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quarterly video counts conducted at East Marginal Way S and S Hanford St. As indicated above an adjustment factor of 29 percent has been applied to bike trips to account for the combined impact of COVID-19 and the closure of the West Seattle Bridge.

- Forecasted vehicle trips are based on model output from the Puget Sound Regional Council, the regional Metropolitan Planning Organization, adjusted for recently announced developments by the Port of Seattle, including the transition of parts of Pier 46 at the North end of the project boundaries into a cruise ship terminal.
- Forecasted bicycle trips are based on historical annual growth from the Spokane Street bicycle counter with the adjustment for COVID-19 and the closure of the West Seattle Bridge, and incremental trip experience on other recently installed bicycle infrastructure in Seattle.
- Commuter and recreational bicycle use benefits were estimated using NCHRP guidance as stated in report 522.
- Existing safety data is derived from 10 years of data on East Marginal Way S with safety reduction benefits based on anticipated improvements from experience on other similar facilities in Seattle.

Other benefits included in the analysis have been adjusted to incorporate primarily conservative approaches and are described in more detail in the corresponding sections below.

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## 2.3 BASE CASE AND BUILD CASE

The following section summarized the methodology used to develop the underlying assumptions used as inputs in the benefit calculations.

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### 2.3.1 MODEL OVERVIEW

The PSRC travel demand model was used as the basis for the no-build analysis. As described by PSRC: “For every household in the region, the model estimates how many trips are made each day, where they go, what time of day they travel, which modes they use, and which routes they follow. The relationships that are estimated for the 2010 base year are combined with future population, employment, and transportation infrastructure growth assumptions to produce future travel forecasts. The future travel forecasts are then analyzed to inform regional transportation studies and plans. The model uses Inro’s Emme software and is built entirely in the Emme macro language<sup>7</sup>.” The model considers some of the underlying port growth plan assumptions but was refined to consider recent developments in the no-build case. As a conservative assumption no additional vehicle trips are assumed in the build case, despite the improved operations of the facility and likely diversion back to East Marginal Way S from current alternative preferred routes due to the condition of the roadway on East Marginal Way S.

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<sup>7</sup> PSRC, Trip Based Modeling Methodology, 2020: <https://www.psrc.org/trip-based-travel-model-4k>

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### 2.3.2 EXTRAPOLATION OF FORECAST VALUES

The no-build trip forecast is based on current vehicle counts on East Marginal Way S prior to evaluation of the impact from both replacement of the aging SR 99 Alaskan Way Viaduct through downtown Seattle, with a tunnel that has limited access to downtown Seattle for commuter trips, as well as the tolling of the tunnel in early November, 2019. With two months of reported data the combined impact of transitioning to the tunnel and tolling of the tunnel has resulted in an average increase in average weekday traffic on East Marginal Way S of 4.2 percent, with some weeks experiencing volume increases in excess of 12 percent. With a baseline average daily traffic volume of 9,275 vehicles per day, applying a 4.2 percent increase to account for the impacts from transitioning to the SR 99 Alaskan Way Tunnel results in a baseline 2019 vehicle volume of 9,666 per day. Furthermore, the following considerations were made in the vehicle trip forecast:

- Underlying modeling analysis provided by the Puget Sound Regional Council forecast indicates a 1.12% annual growth rate for passenger vehicles, and a 2.81% annual growth rate for trucks between 2019 and 2035.
- Improvements at Terminal 5 (T-5) are embedded in the baseline forecasts based on the Port of Seattle's current plans. As a verified timeline is not currently available for when various operations will come online, it was assumed that by the start of operations on East Marginal Way S in 2024, T-5 will be fully operational and accounted for in the underlying growth rate.
- Improvements at Terminal 46 and Terminal 30 are treated as one facility in the Port's Container Terminal Access Study. The forecasts assumed 1,920 trucks/day for T-30 and 1,990 trucks/day for T-46.
  - Transition of parts of Terminal 46 to a Cruise Ship terminal, with the assumption of one cruise ship a day, on average, would generate approximately 2,150 passenger vehicles and 200 trucks.
- Other major investments that could impact the future use of the East Marginal Way Corridor for both vehicles and bicycles were not incorporated as not enough information is available at this time to inform forecast values
  - ProLogis recently opened a three-story 590,000 square foot fulfillment center on East Marginal Way S in 2018 that is currently fully leased by Amazon. As operations are still ramping up the impact on vehicle volumes, specifically heavy freight and delivery vehicles, is unknown at this time. Excluding the impact of the ProLogis site is a conservative approach for purposes of a BCA.
  - Sound Transit's Ballard to West Seattle Link Light Rail line is anticipated to start operations in 2035 with planning only recently commencing on the project. The line is currently projected to cross over to West Seattle on a facility parallel to the West Seattle Bridge that will also cross East Marginal Way S. While the facility will have limited impact on freight vehicle volumes there is a possibility of reduced passenger vehicle trips and bicycle trips. As the impacts, either higher or lower, are difficult to estimate without the final alignment being established, they are excluded from the analysis.
  - The Port of Seattle issued a Request for Proposals for redevelopment of Terminal 106 in summer 2019. This terminal is located just south of the project limits. Depending on the ultimate use of this facility, it could impact traffic volumes on East Marginal Way S, however this potential impact has been excluded from the analysis as the use is unknown at this time.

Travel time and travel distance on East Marginal Way S are generally aligned with the distance of the facility and posted speed limits as the facility has limited access points. As such the average trip length is



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assumed to be the full length of the proposed facility at 1.3 miles with travel times based on current average speeds of 27 to 29 mph and level of service A, or free flow, in the northbound direction during peak periods and level of service B, or reasonable free flow with some restricted movement, in the southbound direction during peak periods. Backups occasionally happen during peak periods and during major events at the two major sports venues located on the North End of the facility, which include concerts, major conference/corporate events, and professional sports events, primarily the Seattle Mariners, Seattle Seahawks, and Seattle Sounders.

The level of service in the no-build case is anticipated to decline slightly in the 2035 model year but does not have a significant enough impact on traffic volumes and times to include in the underlying extrapolation assumptions. As a conservative approach for purposes of the BCA deteriorating level of service and increasing travel times has been excluded in the no-build case.

The resulting values for vehicle miles traveled (VMT) and vehicle hours traveled (VHT) are provided in Table 1 and are based on the growth rates used for the no-build scenario.

**Table 1: Annual Extrapolation of Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT)**

Year	Vehicle Miles Traveled			Vehicle Hours Traveled		
	Passenger Car	Freight	Total	Passenger Car	Freight	Total
2024	1,949,127	3,054,834	5,003,961	68,691	107,658	176,349
2025	2,003,898	3,089,048	5,092,946	70,701	108,988	179,689
2026	2,060,207	3,123,645	5,183,853	72,771	110,333	183,104
2027	2,118,099	3,158,630	5,276,729	74,900	111,696	186,596
2028	2,177,618	3,194,007	5,371,625	77,092	113,075	190,167
2029	2,238,809	3,229,780	5,468,589	79,349	114,471	193,820
2030	2,301,720	3,265,953	5,567,673	81,671	115,884	197,555
2031	2,366,398	3,302,532	5,668,930	84,061	117,315	201,376
2032	2,432,894	3,339,520	5,772,414	86,521	118,764	205,285
2033	2,501,258	3,376,923	5,878,181	89,053	120,230	209,283
2034	2,571,543	3,414,744	5,986,288	91,660	121,715	213,374
2035	2,643,804	3,452,989	6,096,793	94,342	123,217	217,560
2036	2,718,095	3,491,663	6,209,757	97,103	124,739	221,842
2037	2,794,473	3,530,770	6,325,243	99,945	126,279	226,224
2038	2,872,998	3,570,314	6,443,312	102,870	127,838	230,708
2039	2,953,729	3,610,302	6,564,031	105,881	129,417	235,297
2040	3,036,729	3,650,737	6,687,466	108,980	131,015	239,994
2041	3,122,061	3,691,625	6,813,686	112,169	132,632	244,801
2042	3,209,791	3,732,972	6,942,762	115,452	134,270	249,722
2043	3,299,986	3,774,781	7,074,767	118,831	135,928	254,758
2044	3,392,715	3,817,058	7,209,774	122,308	137,606	259,914
2045	3,488,051	3,859,809	7,347,860	125,888	139,305	265,193
2046	3,586,065	3,903,039	7,489,104	129,572	141,025	270,597
2047	3,686,833	3,946,753	7,633,587	133,364	142,766	276,131
2048	3,790,433	3,990,957	7,781,390	137,267	144,529	281,797
2049	3,896,945	4,035,656	7,932,600	141,285	146,314	287,598
2050	4,006,449	4,080,855	8,087,304	145,420	148,120	293,540
2051	4,119,030	4,126,561	8,245,590	149,676	149,949	299,625
2052	4,234,775	4,172,778	8,407,553	154,056	151,801	305,857
2053	4,353,772	4,219,513	8,573,285	158,565	153,675	312,240

Source: WSP based on baseline model results and extrapolation, 2020

For purposes of the Build case it was assumed that there would be an increase in travel times during construction and as a result of the infrastructure improvements over the long term due to the additional signal at S Horton St for safety improvements, where one does not exist today. However, the additional delay time from the new signal is anticipated to be more than offset through improved pavement conditions and timing of the signals as the result of installation of a SCOOT dynamic traffic system. Initial Synchro traffic modeling results have shown potential 30 seconds or more of travel time savings during peak operational periods. On average the analysis assumes the overall savings will be 15 seconds per vehicle as a result of the SCOOT dynamic traffic system, which when adjusted for the increase in 10 seconds per vehicle due to the additional signal and higher bicycle volumes, and therefore more frequent bicycle signals, the net result is a 5 second saving in travel times. Further travel time savings are anticipated as a result of the improved conditions of the roadway surface but as a conservative measure were not factored into the benefit-cost analysis.

During the four primary years of staging and construction between 2021 and 2024 all vehicle trips are anticipated to experience an average delay of 20 seconds. There are plans for mitigation of construction

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impacts through maintaining traffic in both directions during all periods of work, and reserving major directional closures for low traffic periods, in coordination with the Port of Seattle and their tenants.

Bicycle trips were calculated primarily based on existing data on facility use and anticipated growth in use as the result of the improvement informed by other similar investments in critical corridors in Seattle. A key reason for this growth in bicycle ridership through the BUILD Project is the fact that East Marginal Way S currently serves as a critical bicycle connection between significant regional destinations and fills a gap in the regional trail system, including the following:

- Between Downtown Seattle and West Seattle – East Marginal Way S carried just under 320,000 bicycle trips in 2019 connecting Downtown to West Seattle without protected bike facilities<sup>8</sup>. The combined impact from COVID-19 and closure of the West Seattle Bridge is anticipated to increase baseline bike volumes by 29 percent, a conservative approach from the approximate 50 percent adjustment currently experienced based on bicycle volumes compared to other modes.
- Between bicycle trails and facilities in the region that are currently being developed as part of the City of Seattle Bicycle Master Plan and active transportation investments outlined in the Move Seattle Plan and the Levy to Move Seattle. A major investment in Downtown Seattle will be the Portside Trail that will run along Alaskan Way as part of the City’s redevelopment of the central waterfront following the tunnel replacement of the SR 99 Viaduct. The East Marginal Way S protected bicycle lanes will largely serve as an extension of the facility from S Atlantic St to the West Seattle Bridge. The Portside Trail, anticipated to be completed in 2024, will produce a 10 percent increase in bicycle trips. The completion of the East Marginal Way S protected bicycle lanes through the BUILD Project is anticipated to increase bicycle volumes by 58 percent in the near term. The 58 percent is conservative when compared to the doubling of bicycle volumes on Westlake Ave as a result of investments in protected bicycle lanes and the over 300 percent increase in volumes on Second Ave as a result of investments and extension of the Second Ave protected bicycle lanes<sup>9</sup>.
- Between the extensive Seattle and regional bike network – At the northern limit of the BUILD Project corridor, the protected bike path will connect directly to the Portside Trail and to Downtown Seattle through the expanding Center City bike network. At the southern limit of the BUILD Project corridor, the protected bike facility will connect to a trail under the West Seattle Bridge and continue south to West Seattle and communities south of Seattle. The Project unlocks connections to the regional bike network within a 5.6-mile<sup>10</sup> and 10-mile diameter. In particular, the BUILD Project will create new access for communities in neighboring cities, such as Tukwila, Renton, SeaTac, Burien, and Normandy Park to the south, and Mercer Island and Bellevue across the regional trail along I-90 to the east.

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<sup>8</sup> Seattle bike counter for SW Spokane St. Bike counter (W. Seattle Bridge) as a proxy for E. Marginal Way bike trips. <https://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-counters/spokane-bike-counters>

<sup>9</sup> Westlake Protected Bicycle Lane Program, 2016. <https://www.seattle.gov/transportation/projects-and-programs/programs/bicycle-program/protected-bicycle-lanes/westlake-protected-bicycle-lane>  
Dongho Chang, Seattle Department of Transportation, 2020. [https://twitter.com/dongho\\_chang/status/1118625428892078080?lang=en](https://twitter.com/dongho_chang/status/1118625428892078080?lang=en)

<sup>10</sup> The average bicycle commute trip length for people who bike from home to work in Downtown Seattle is 5.6 miles, as measured in the [2019 Seattle Center City Commute Mode Split Survey](#)

With 16 percent of Seattle households currently not possessing a motor vehicle for their personal use, the BUILD Project will provide a safer and more attractive option for riding a bike to work along the East Marginal Way S corridor. In this way, it will provide a healthy and affordable economic lifeline to the City’s carfree residents. Providing bicycle infrastructure to all ages and abilities in parts of the City with lower car ownership will provide better transportation choice for all residents.

The increase in commuter trips is anticipated to be mostly trips diverted from transit, 85 percent, or as drivers and passengers in vehicles, 15 percent. Overall increases in trips are monetized in the BCA for purposes of health and accessibility benefits but decreases in emissions, noise, and vehicle and roadway maintenance are not quantified in the benefit cost ratio, a conservative approach. Mode shift impacts were excluded as detailed trip analysis evaluation was not conducted for non-motorized trips as part of the benefit cost analysis.

The resulting values for bicycle trips and bicycle miles traveled for the no-build and build scenarios are provided in Table 2.

**Table 2: Annual Extrapolation of Bicycle Trips**

Year	Bicycle Trips			Bicycle Miles		
	No-Build	Build	Variance	No-Build	Build	Variance
2024	462,771	802,403	339,632	601,602	1,043,124	441,522
2025	472,446	835,089	362,643	614,180	1,085,616	471,436
2026	482,121	867,775	385,654	626,757	1,128,107	501,350
2027	491,796	900,460	408,665	639,334	1,170,598	531,264
2028	501,470	933,146	431,675	651,912	1,213,089	561,178
2029	511,145	965,831	454,686	664,489	1,255,581	591,092
2030	520,820	998,517	477,697	677,066	1,298,072	621,006
2031	530,495	1,031,202	500,707	689,644	1,340,563	650,919
2032	540,170	1,063,888	523,718	702,221	1,383,054	680,833
2033	549,845	1,096,573	546,729	714,798	1,425,545	710,747
2034	559,520	1,129,259	569,739	727,376	1,468,037	740,661
2035	569,194	1,161,945	592,750	739,953	1,510,528	770,575
2036	578,869	1,194,630	615,761	752,530	1,553,019	800,489
2037	588,544	1,227,316	638,771	765,107	1,595,510	830,403
2038	598,219	1,260,001	661,782	777,685	1,638,002	860,317
2039	607,894	1,292,687	684,793	790,262	1,680,493	890,231
2040	617,569	1,325,372	707,803	802,839	1,722,984	920,145
2041	627,244	1,358,058	730,814	815,417	1,765,475	950,058
2042	636,919	1,390,743	753,825	827,994	1,807,966	979,972
2043	646,593	1,423,429	776,836	840,571	1,850,458	1,009,886
2044	656,268	1,456,114	799,846	853,149	1,892,949	1,039,800
2045	665,943	1,488,800	822,857	865,726	1,935,440	1,069,714
2046	675,618	1,521,486	845,868	878,303	1,977,931	1,099,628
2047	685,293	1,554,171	868,878	890,881	2,020,422	1,129,542
2048	694,968	1,586,857	891,889	903,458	2,062,914	1,159,456
2049	704,643	1,619,542	914,900	916,035	2,105,405	1,189,370
2050	714,317	1,652,228	937,910	928,613	2,147,896	1,219,283
2051	723,992	1,684,913	960,921	941,190	2,190,387	1,249,197
2052	733,667	1,717,599	983,932	953,767	2,232,879	1,279,111
2053	743,342	1,750,284	1,006,942	966,345	2,275,370	1,309,025

Source: WSP based on bicycle counts and extrapolation, 2020

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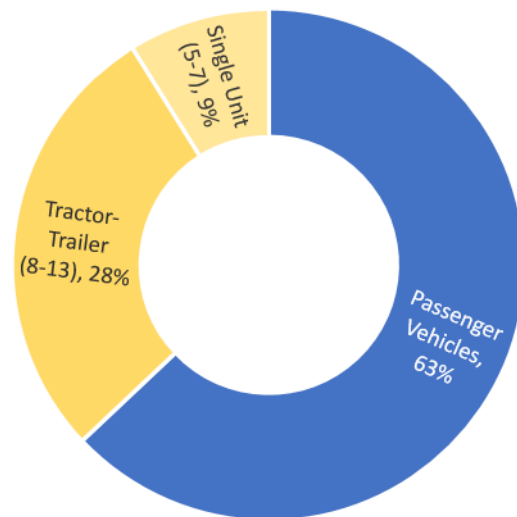
## 2.3.3 VEHICLE ADJUSTMENTS

Underlying daily values have been extrapolated for each of the forecast years in the benefit analysis, annualization factors are applied to calculate total annual values and vehicle class are established to determine the correct value of time to apply to travel time changes as directed in DOT guidance.

Upon calculating daily vehicle miles travelled (VMT) and passenger hours travelled (PHT) values by mode annual expansion factors were applied to derive annual values. For VMT an expansion factor of 365 days was applied as the underlying average daily values account for both weekday and weekend days. For PHT a similar expansion factor of 365 days was applied with no adjustment made for passenger vehicle occupancy since this data, specific to the East Marginal Way Corridor, is not available. Travel time savings resulting from the improvement is on the conservative side since it precludes the possibility of multiple vehicle occupants.

Vehicle shares between passenger cars and trucks is based on modeled results for the facility and includes incremental adjustments for announced Port of Seattle improvements along the facility. Passenger vehicles currently make up approximately 64 percent of all vehicle trips on East Marginal Way S, with the share anticipated to decline to 55 percent with projected higher growth in freight trips anticipated through the forecast horizon. The share of freight trips includes both Port of Seattle and non-Port movements with the former representing approximately 40 percent of freight trips today and 39 percent by 2035. The slight decline in Port of Seattle trips as a share of total freight trips is the result of increased volumes of delivery trucks using East Marginal Way S as a primary connection between downtown Seattle and the warehouses and distribution centers in South Seattle.

Exhibit 2: Observed Vehicle Share 2015



Source: Transpo Group, 2020

Cruise ship operations are anticipated to commence on Terminal 46 prior to the completion of the East Marginal Way Corridor Improvement Project in 2024 and generate approximately 2,150 passenger vehicle movements and 200 freight vehicle movements per sailing.

## 2.3.4 BICYCLE ADJUSTMENTS

Daily no-build baseline bicycle trips are calculated based on reported count data and adjustments to account for the near-term impact of COVID-19 and the West Seattle Bridge closure which resulted in an upward revision of 30 percent. Furthermore, projected growth in bicycle trips is applied using historical compound average growth rates. The increase in bicycle trips as a result of installation of protected bicycle lanes is based on similar experiences on comparable facilities in Seattle. Bicycle trip data is further adjusted to estimate trips by purpose for commute and recreational purposes. Trips were divided

by two, assuming that single trips are part of a round trip taken by a single user. The percentage allocations of trips are based on current counts during peak school and work commute times on weekdays from 6-10AM and 3-7PM. For bicycle trips the resulting split is 63 percent commuter and 37 percent recreational. Total hours of travel time for bicycle commuters, used to derive commuter mobility benefits, is based on just under 21 minutes per trip and 250 bicycle commute trips per year. Resulting forecast values are provided in Table 3.

**Table 3: Cumulative New Bicycle Users**

Year	Cumulative New Bicyclists			Total Hours of Travel Time for New Bicycle Commuters
	Commuter	Recreational	Total New Riders	
2024	1,383	2,328	3,712	197,726
2025	2,216	3,729	5,945	316,684
2026	2,356	3,966	6,322	336,778
2027	2,497	4,203	6,699	356,872
2028	2,637	4,439	7,077	376,967
2029	2,778	4,676	7,454	397,061
2030	2,919	4,913	7,831	417,156
2031	3,059	5,149	8,208	437,250
2032	3,200	5,386	8,586	457,345
2033	3,340	5,622	8,963	477,439
2034	3,481	5,859	9,340	497,534
2035	3,621	6,096	9,717	517,628
2036	3,762	6,332	10,094	537,722
2037	3,903	6,569	10,472	557,817
2038	4,043	6,806	10,849	577,911
2039	4,184	7,042	11,226	598,006
2040	4,324	7,279	11,603	618,100
2041	4,465	7,516	11,981	638,195
2042	4,606	7,752	12,358	658,289
2043	4,746	7,989	12,735	678,383
2044	4,887	8,225	13,112	698,478
2045	5,027	8,462	13,489	718,572
2046	5,168	8,699	13,867	738,667
2047	5,309	8,935	14,244	758,761
2048	5,449	9,172	14,621	778,856
2049	5,590	9,409	14,998	798,950
2050	5,730	9,645	15,376	819,044
2051	5,871	9,882	15,753	839,139
2052	6,011	10,119	16,130	859,233
2053	6,152	10,355	16,507	879,328

Source: WSP calculations based on current bicycle counts and time of day of travel

Additional bicycle factors were calculated based on the above user information and are described in more detail in the specific corresponding benefit categories.

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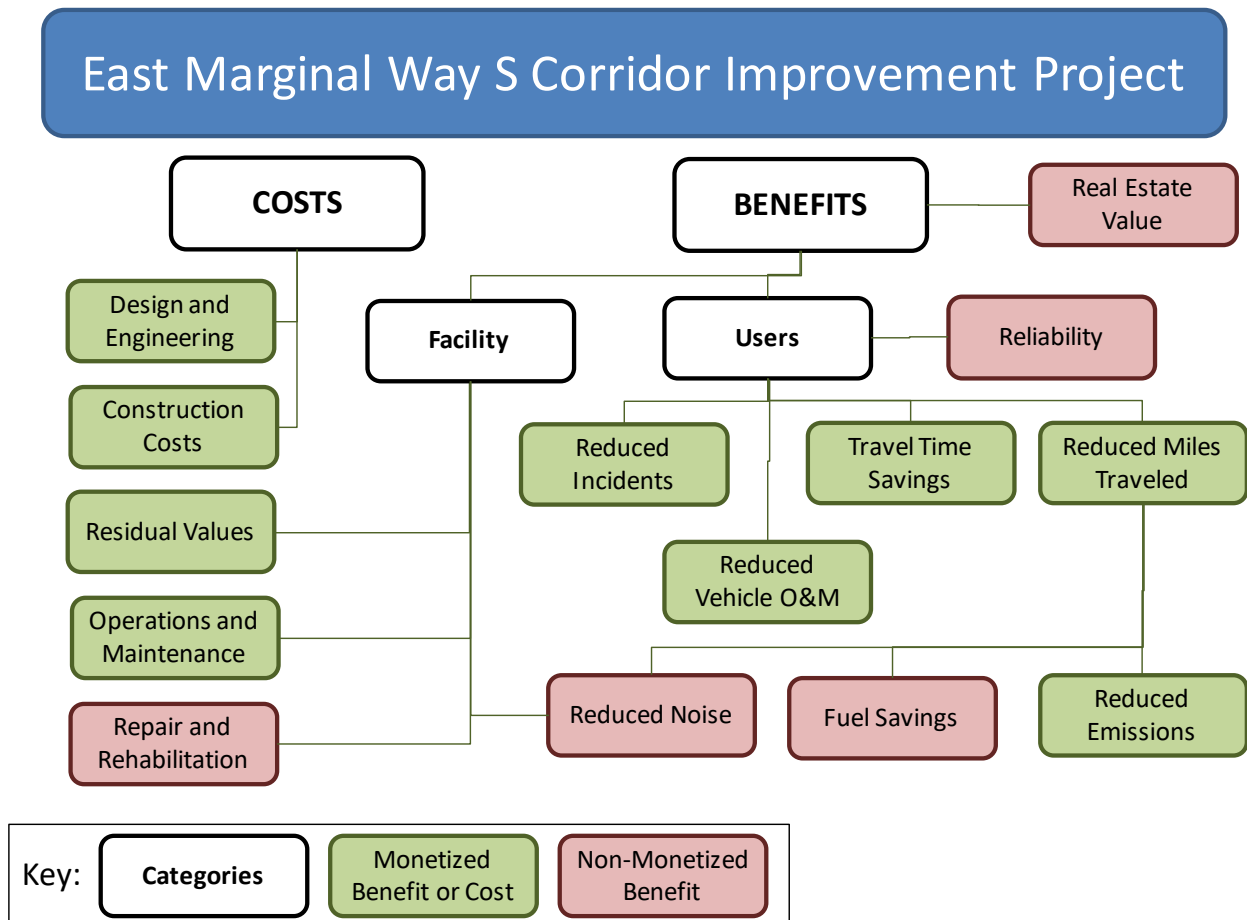
## 2.4 ANALYSIS TOOL

The benefit cost analysis was supported using a Microsoft Excel-based benefit cost analysis tool with methodology consistent with the most recent guidelines developed by USDOT. The tool determined benefits according to quantifiable benefits and in addition to the base build case, are adjusted to develop a high and low scenario for evaluating a range of expected benefit-cost ratios.

## 2.5 OVERVIEW OF BENEFITS AND COSTS

The following identifies and groups the benefits that are included in the BCA for the East Marginal Way Corridor Improvement Project. Most of these benefits occur as a result of reducing vehicle operating costs, improving safety for all users, and attracting new bicycle commuters and recreational users. The costs considered are typical for most projects: design, construction, and operations and maintenance (O&M). Table 4 provides an overview of these costs and benefits, which are further discussed in the following sections.

**Table 4: Project Benefits and Costs**



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## 2.6 PROJECT COSTS

In the benefit-cost analysis, the term “cost” refers to the additional resource costs or expenditures required to implement the investments associated with the East Marginal Way Corridor Improvement Project.

The BCA uses project costs that have been estimated for the East Marginal Way Corridor Improvement Project on an annual basis. Capital costs were initially expressed in real 2019 dollars which were deflated to 2018 dollars based on guidance provided by USDOT, using a factor of 0.98494. Residual value of the capital investments and the supporting variance in routine operations and maintenance costs are included in the benefits for purposes of the benefit-cost ratio calculation<sup>11</sup>.

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### 2.6.1 CAPITAL COSTS

Initial project investment costs include engineering and design, construction, other capital investments, and contingency factors. These costs include expenditures prior to 2020 through 2024. Further construction closeout costs are assumed going into 2025. The facility is expected to be operational in 2024 with an anticipated opening date of May 1, 2024.

**Table 5: Project Schedule and Costs, 2018 Dollars**

Project Estimate 2018 \$									
Stages	Calendar Years	Prior Years	2020	2021	2022	2023	2024	2025	Total
Planning		\$ 1,009,564							\$ 1,009,564
Design		\$ 310,256	\$ 2,543,608	\$ 863,793	\$ 308,779				\$ 4,026,435
Construction				\$ 1,557,683	\$ 10,845,176	\$ 15,586,678	\$ 7,984,417	\$ 1,685,233	\$ 37,659,187
Total		\$ 1,319,820	\$ 2,543,608	\$ 2,421,475	\$ 11,153,955	\$ 15,586,678	\$ 7,984,417	\$ 1,685,233	\$ 42,695,186

Source: WSP, 2020

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### 2.6.2 RESIDUAL VALUE

The remaining Capital Value of this project consists primarily of Heavy Haul road construction costs which are expected to retain their value through ongoing operations and maintenance on the facility. The total undiscounted residual value of the capital investments is estimated at \$15.80 million assuming a 50-year asset life and straight-line depreciation, with a further 20-years of anticipated asset life remaining at the end of the 30-year benefit period ending in 2053.

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### 2.6.3 OPERATIONS AND MAINTENANCE COSTS

The annual costs of operating and maintaining assets on East Marginal Way S are included in the analysis. Operations and maintenance activities apply to the road surface, curbs and sidewalks, protected bicycle lanes, and ITS infrastructure in the project scope. Incremental costs associated with the protected bicycle lanes and ITS infrastructure are anticipated to be more than offset by decreasing maintenance costs attributed to the currently deteriorating roadway. In addition to historic maintenance expenditures,

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<sup>11</sup> U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. January 2020. [https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020\\_0.pdf](https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf)



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other similar heavy haul corridors were considered when developing the no-build and build maintenance cost estimates.

A comparable street in Seattle in terms of current pavement conditions and heavy vehicle use is North 105th Street and Northgate Way between Interstate 5 and Greenwood Ave N. Conditions on 105th reflect the serious and failed state of the roadway on East Marginal Way S.

From early 2010 until the North 105th Street reconstruction was completed in early 2014, a span of four years, Seattle Department of Transportation spent about \$121,000 in spot repairs to keep the street serviceable. In addition, the Department of Transportation paid out about \$8,000 in pothole or street condition related claims. The project area associated with the failed street measured 5.2 lane-miles or approximately \$6,184 per lane-mile per year. Adjusted to current dollars using a construction inflation rate of 5 percent results in a cost of approximately \$9,136 per lane-mile per year.

The paving portion of the East Marginal Way Project measures about 7.7 lane-miles, and using 105th as a model, the cost to maintain East Marginal Way S from S Spokane St to Alaskan Way S will be about \$69,291 in 2018 dollars per year for spot pavement repairs and claims.

The build scenario in which the Heavy Haul corridor and protected bicycle lanes are completed along with signals and other ITS improvements will reduce the baseline assumed operating and maintenance costs but will be partially offset by higher costs specific to the protected bicycle lanes and ITS components. The base annual roadway maintenance costs are anticipated to decline from \$70,250 per year in 2019 dollars to \$14,070 per year, consistent with maintenance expenditures on other similar facilities. Two steel traffic signals are anticipated, which will increase costs by \$7,992 per year based on eight years of historic expenditure data for similar assets. Historical annual maintenance on bicycle facilities range from \$4,680 to \$98,494 per year, with the latter costs associated with incremental landscaping maintenance costs. For purposes of East Marginal Way S and the proposed investments, an annual cost of \$33,000 was assumed in 2018 dollars. The total maintenance costs in the build scenario are approximately \$54,850 per year compared to an estimated annual maintenance cost under the No-Build scenario of \$69,291 per year, to address the further deterioration in the current roadway surface.

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## 2.6.4 REPAIR AND REHABILITATION (R&R) COSTS

Periodic repair and rehabilitation costs were not evaluated separately from annual operating and maintenance costs, with no major periodic costs assumed on the new heavy-haul surface, although more extensive repairs are included in the historical annual values which are based on averages including periodic expenditures used to derive the current and future costs for E Marginal Way S. The roadway is assumed to be completely replaced after 50 years of operations.

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## 2.7 PROJECT BENEFITS

The following section outlines and identifies the benefits that were considered in the BCA for the East Marginal Way Corridor Improvement project. This section discusses the valuations and methodologies

for each benefit category that is monetized, and a summary of the model outputs for valuations as used in the analysis.

### 2.7.1 TRAVEL TIME SAVINGS

Travel time savings includes in-vehicle travel time savings for auto drivers and passengers as well as truck drivers. For the purposes of this analysis, travel time savings for bicyclists were excluded from this analysis as limited information is available on current diversion routes from the existing facility, but increases were assumed for bicyclists due to the installation of a new signal at S Horton St. Travel time is considered a cost to users, and its value depends on the disutility that travelers attribute to time spent traveling. A reduction in travel time translates into more time available for work, leisure, or other activities.

#### VALUE OF TIME ASSUMPTIONS

Travel time savings must be converted from hours to dollars in order for benefits to be aggregated and compared against costs. This is performed by assuming that travel time is valued as a percentage of the average wage rate, with different percentages assigned to different trip purposes (Table 6), as recommended by U.S. DOT<sup>12</sup>.

**Table 6: U.S. DOT Recommended Values of Time, 2020; (percentage split between personal and business travel)**

Category	Travel by Share
<b>Local Travel</b>	
Personal	88.2%
Business	11.8%

Source: Office of the Secretary of Transportation, 2020.

Values of time used for 2018 are as follows:

**Table 7: U.S. DOT Recommended Values of Time, 2018 \$s**

Category	Values of time (2018 U.S \$ per person-hour)
<b>Surface (except High-Speed Rail)</b>	
Personal	\$15.20
Business	\$27.10
All Purposes	\$16.60

Source: Office of the Secretary of Transportation, 2020

<sup>12</sup> U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. January 2020. [https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020\\_0.pdf](https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf)

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Because the exact division between personal and business travel is not known for trips potentially impacted by this project, the values of time for “all purposes” are used; these represent a weighted average of the personal and business values of time according to national proportions of personal and business as calculated by the U.S. DOT<sup>13</sup>.

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## 2.7.2 OPERATING COST SAVINGS

Vehicles have operating costs that include maintenance and repair, and replacement of tires which are affected by the quality of the roads that they are driven on. The wear and tear costs per VMT factors of these costs in terms of wear and tear on their vehicles are estimated using the Washington State Department of Transportation (WSDOT) Highway Development and Management System (HDM-4) user cost model<sup>14</sup>. The Seattle Department of Transportation (SDOT)’s basic benefit-cost Paving Prioritization Model assumes the base automobile user cost at \$0.28/mile in 2016 \$’s increasing by 10 cents to \$0.38/mile at pavement failure. For trucks, a user cost at \$2.58/mile in 2016 \$’s increasing by \$2.10 to \$4.68/mile at pavement failure is assumed. For purposes of the benefit cost analysis the modeled values were divided in half as a conservative approach to avoid overstating the benefits from the new road surface, and no escalation was assumed to bring the values to 2018 \$’s. A further sensitivity test maintains the full modeled values. Values are shown below in Table 8 below.

**Table 8: Incremental Operating Cost Savings Assumptions and Sources**

Cost Category	Passenger Vehicle (2018 \$ / VMT)	Freight Vehicle (2018 \$ / VMT)
Maintenance / Repair – Modeled	\$0.10	\$2.10
Maintenance / Repair – Adjusted for BCA	\$0.05	\$1.05

Source: Seattle Department of Transportation, 2020; WSP, 2020

The per VMT costs are multiplied by the total projected annual VMT by category. The VMT associated to the East Marginal Way S Corridor are based on the reductions in vehicle costs attributed to the current pavement conditions.

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## 2.8 SAFETY

### COLLISION COST SAVINGS

The BCA assumes reduced collisions will occur with the completion of the project compared to the “no build” scenario. Table 9 contains a summary of ten years of police reported crash statistics for the project area that will be improved because of the proposed project. Of the crashes, there were three that included a fatality. The total crashes from the project area amounted to 105 over the ten-year period from 2010 to 2020 year to date, or just over 10 per year. It was assumed that with the improvements crashes will

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<sup>13</sup> Ibid.

<sup>14</sup>Washington State Department of Transportation HDM-4 Model, 2004, <https://www.wsdot.wa.gov/research/reports/fullreports/588.1.pdf>

decrease by up to 20 percent, specifically intersection improvement and collisions involving cyclists as the result of improved intersections and the protected bicycle facility. One of the more comprehensive studies conducted by New York City Department of Transportation showed a reduction in both total injuries of 20 percent and a 74 percent decrease in the average risk of a serious injury following the installation of protected bicycle lanes<sup>15</sup>. Similar analysis on the impact on the number of crashes following the installation of protected bicycle lanes in Seattle is ongoing, however analysis on the Second Avenue protected bicycle lanes indicate a comparable 20 percent reduction in overall crashes.

Bicycle crash data also tends to be difficult to accurately measure as many crashes go unreported, with reported ratios of police-reported to hospital-reported injury cases ranging from 0.2 to 0.82 for bicyclists based on a literature review conducted by the U.S. Federal Highway Administration<sup>16</sup>. Furthermore, many bicyclists are involved in crashes that do not involve a vehicle and will visit a hospital facility directly without reporting the incident to police.

**Table 9: East Marginal Way S Crash History Between S Atlantic St and S Spokane Street (2010-2020 March)**

Type of Crash	Crash Location		Total Crashes
	Intersection	Other	
Property Damage Only and Unknown	36	31	69
Possible Injury	14	16	30
Suspected Serious Injury	1	5	6
Fatal	3	0	3

Data extracted from Seattle Online GIS Crash Database Tool (2020)

The cost savings that arise from a reduction in the number of crashes include direct savings (e.g., reduced personal medical expenses, lost wages, and lower individual insurance premiums), as well as significant avoided costs to society (e.g., second party medical and litigation fees and supporting costs, emergency response costs, and incident congestion costs). Monetized values for fatalities, and accidents categorized on the Maximum Abbreviated Injury Scale (MAIS) scale are reported in the U.S. DOT’s BCA Guidance released in 2020<sup>17</sup>.

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<sup>15</sup> New York City Department of Transportation, Protected Bicycle Lane Analysis, September 2014.

<https://www.streetsblog.org/wp-content/uploads/2014/09/2014-09-03-bicycle-path-data-analysis.pdf>

<sup>16</sup> Federal Highway Administration Research and Technology, Injuries to Pedestrians and Bicyclists: An Analysis Based on Hospital Emergency Department Data, 1999.

<https://www.fhwa.dot.gov/publications/research/safety/pedbike/99078/chapter1.cfm>

<sup>17</sup> U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. January 2020. [https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020\\_0.pdf](https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf)

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**Table 10: Monetized Injury and Damage Values**

Accident Type	Severity	Unit Value (2018 \$)
Fatality	Not Survivable	\$9,600,000
AIS 5	Critical	\$5,692,800
AIS 4	Severe	\$2,553,600
AIS 3	Serious	\$1,008,000
AIS 2	Moderate	\$451,200
AIS 1	Minor	\$28,800
Property Damage Only	No Injury	\$3,200

Source: U.S. DOT, 2020 update; WSP, 2020

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## 2.9 EMISSIONS

Emissions reductions for East Marginal Way will be derived from mode shift from vehicles to bicycle trips. Of the incremental bike commute trips associated to the completion of the East Marginal Way separated bike facility, 85 percent are assumed to shift from transit and the remaining 15 percent from passenger car vehicles. An occupancy factor of 1.9 passengers per vehicle<sup>18</sup> was assumed to convert bike trips to vehicle trip equivalents, a more conservative assumption as it assumed a reduced impact from fewer vehicles.

Per-mile emissions rates for automobiles were derived from the EPA Moves 2014B Model as recommended through the provided guidance. Per mile emissions factors differ depending on vehicle, fuel efficiency, average speed, and driving conditions. This BCA used emissions factors for vehicles based on averages of vehicle model years. It is important to note that a unique set of emissions factors exists at each speed. Thus, the emissions data set consists of emissions factors for each emissions type, by year, and by speed. For purposes of our analysis we assumed a constant 27 miles per hour over the life of the project benefits based on travel times with the new roadway improvements and SCOOT system.

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<sup>18</sup> Based on FHWA national guidance of 1.7 as the average of all vehicles as provided in April 2018 - [https://www.fhwa.dot.gov/tpm/guidance/avo\\_factors.pdf](https://www.fhwa.dot.gov/tpm/guidance/avo_factors.pdf) with adjustment for higher assumed vehicle occupancy in Seattle.

**Table 11: Auto Emissions Rates (grams per vehicle-mile traveled)**

Emissions Type	2025	2030	2040	2050
NO <sub>x</sub>	0.0474	0.0251	0.0115	0.0105
PM 2.5	0.0030	0.0025	0.0019	0.0019
PM 10	0.0034	0.0028	0.0022	0.0021
SO <sub>x</sub>	0.0021	0.0018	0.0015	0.0015
VOC	0.0084	0.0053	0.0031	0.0029
CO <sub>2</sub>	309.9380	262.7470	230.1360	228.0820

Source: EPA MOVES 2014B; WSP, 2020

### VALUE OF EMISSIONS COSTS

In order to monetize the emissions, the values of PM<sub>10</sub>, NO<sub>x</sub>, SO<sub>x</sub>, VOC, and CO<sub>2</sub> emissions were derived from U.S. DOT BCA guidance as of January 2020. Resulting values are shown in Table 20.

**Table 12: Emissions Costs (2018 \$ / short ton)**

Emissions Type	Emissions Costs
NO <sub>x</sub>	\$8,600
PM	\$387,300
SO <sub>x</sub>	\$50,100
VOC	\$2,100
CO <sub>2</sub>	\$1

Source: US DOT Guidance 2020, WSP, 2020

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## 2.10 LIVABILITY

### PHYSICAL HEALTH BENEFITS

Health benefits apply to new cyclists who would otherwise not be able to use a facility under existing conditions. These cyclists realize benefits by increased daily physical activity, which has been shown to improve the health of users and reduce future medical costs. The NCHRP Guidelines for Analysis of Investment in Bicycle Facilities<sup>19</sup> identified ten studies which estimated the overall health benefit of increased physical activity. These benefits ranged from \$19 to \$1,175 per new cyclist per year, with a median value of \$128 (all values in 2006 \$), with detailed review available in appendix E of that document. These values were adjusted to 2018 dollars with resulting values of \$155.58. The NCHRP Guidelines state that this benefit is ascribed per daily new user; since our cyclist volumes represent one-way trips, we divided the volume by two in order to estimate the number of total users. This is slightly conservative since not all bicyclists use the same route for the return trip.

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<sup>19</sup> *Ibid*, p. 33.

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The benefit is thus defined:

$$\text{Health Benefit} = \frac{b_n}{2} \cdot H$$

Where:

$b_n$  = volume of daily new bicycle trips, divided by two to convert to individuals from trips

$H$  = distribution of value of per-capita health benefit, 2018\$

Health benefits have also been studied for pedestrians. However, our analysis has assumed that since there a low relative number of induced pedestrian trips as a result of the project improvements we do not ascribe any health benefit to pedestrians. This is considered a conservative approach as there will likely be pedestrians using the protected bike facility for recreational and potential commuting purposes.

## COMMUTER MOBILITY BENEFITS

Commuter users, are non-recreational riders, experience a benefit because research has shown that bicyclists prefer using certain facilities over others, with dedicated bicycle infrastructure showing the greatest monetized value of benefit.

The NCHRP Guidelines for Analysis of Investment in Bicycle Facilities reviewed available research and found that bicycle commuters are willing to spend 20.38 extra minutes per trip<sup>20</sup> to travel on an off-street bicycle trail for reasons including higher level of safety, more pleasant and lower stress experience, and lack of auto impacts such as road spray and exhaust fumes. These benefits can be directly applied to new commute trip bicyclists according to the following formula (modified from NCHRP Report 552):

$$\text{Commuter Mobility}_{\text{bicyclists}} = \frac{20.38}{60} \cdot b_{n,c} \cdot \bar{W} \cdot 5 \cdot VOT$$

Where:

20.38/60 = additional value of off-road bicycle facility in minutes, converted to hours

$b_{n,c}$  = volume of daily new commute bicyclists

$\bar{W}$  = weighted average of workweeks per year

5 = number of work days per week

$VOT$  = distribution of value of time, 2018\$ / hr

NCHRP Report 552 Guidelines assumed 50 commute weeks per year. The value of time applied for this benefit is the same as that previously documented and used for travel time savings; that is, the values of time for local travel across all trip purposes.

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<sup>20</sup> NCHRP Report 552 (2006). *Guidelines for Analysis of Investments in Bicycle Facilities*, Transportation Research Board, Washington, D.C. ([http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_552.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_552.pdf))

## RECREATION BENEFITS

The NCHRP Guidelines for Analysis of Investment in Bicycle Facilities also identified benefits for recreational users of bicycle facilities separate from the health benefits identified earlier. These benefits result from the time spent performing recreational activity, since this represents a revealed preference in how recreational cyclists choose to spend their time. This time is assumed to be one hour per bicyclist including preparation and clean-up time<sup>21</sup>. The value of time for this benefit is assumed to be lower than the value of time used for commuters or the population at large. The NCHRP Guidelines indicate a value of \$10 per hour in 2006 dollars, which becomes \$12.17 per hour in 2018 dollars. The benefit is computed as follows:

$$\text{Recreation Benefit} = \frac{b_{n,r}}{2} \cdot 365 \cdot VOT_r$$

Where:

$b_{n,r}$  = volume of daily new recreational bicyclists, divided by two to convert to trips

365 = number of recreation days per year, per NCHRP Report 552

$VOT_r$  = distribution of recreational value of time, 2018\$ / hr

This benefit is only computed for bicyclists. While a similar argument may be made for recreational pedestrians, the amount of time pedestrians spend in recreational activity is unknown, so it is not monetized. It should be noted that the demand forecasting process produced trips on an average day.

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<sup>21</sup> *Ibid*, p. 39.



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## 3 SUMMARY OF RESULTS

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### 3.1 EVALUATION MEASURES

The benefit-cost analysis converts potential gains (benefits) and losses (costs) from the Project into monetary units and compares them. The following common benefit-cost evaluation measures are included in this BCA:

- Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.
  - Benefit Cost Ratio (BCR): The evaluation also estimates the benefit-cost ratio; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The BCR expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of the costs.
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### 3.2 BCA RESULTS

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#### 3.2.1 RESULTS IN BRIEF

The primary benefit cost analysis assumes a 7.0 percent discount rate as prescribed by the U.S. DOT, with an alternative 3.0 percent discount rate used for comparison purposes. Baseline 2018 \$ input and unit assumptions are forecasted in constant dollars and discounted to 2019 values for a horizon of 30 years following substantial construction completion in 2024. An alternative case was also evaluated with a horizon of 20 years.

For the base case analysis using a 7 percent discount rate, the proposed East Marginal Way Corridor Improvement Project investments yield a net present value of \$93.3 million, and a benefit-cost ratio of 3.78.

For the alternative 3 percent discount rate approach, the proposed East Marginal Way Corridor Improvement Project yields a net present value of \$221.1 million, and a benefit-cost ratio of 6.76.

**Table 13: Benefit Cost Analysis Summary Results**

Scenario	Net Present Value (2018 \$ millions discounted to 2019)	Benefit Cost Ratio
Base Case - 7 percent discount rate	\$93,287,236	3.78
Alternative - 3 percent discount rate	\$221,093,652	6.76

Source: WSP, 2020

### 3.3 BENEFITS BY CATEGORY

Over the entire analysis period, the East Marginal Way Corridor Improvement Project exhibits primary increases in reduced vehicle maintenance costs, and safety and mobility benefits.

Table 12 below outlines the changes in some of the impact categories. Some categories increased, while others decreased. Overall, the benefits are concentrated in categories including property value, reduced vehicle miles traveled, and reduced accidents.

**Table 14: Project Benefit Impacts, Cumulative 2024-53**

Category	Unit	Quantity	Direction
Person-Hours Traveled	PHT	122,906	▼
Vehicle Miles Traveled (vehicle maintenance)	VMT	194,173,804	n/a
Fatalities	#	2	▼
Injury Accidents	#	24	▼
Property Damage Only (PDO)	#	35	▼
Emissions	Tons	552	▼
Annual health benefits	new cyclists	10,976 (avg. new bicyclists per year)	▲
Commuter Mobility Benefits - Bicyclists	hours	584,663 (avg. new bicyclists hours per year)	▲
Recreational Benefits – Bicyclists	new cyclists	4,090 (avg. new recreational bicyclists per year)	▲

Source: WSP, 2020

Over the 30-year analysis period, there are \$126.8 million in benefits in 7% discounted 2019 dollars or \$259.5 million in benefits in 3% discounted 2019 dollars, inclusive of residual value and incremental operating and maintenance costs. In present value dollars, of the primary benefits indicated in Table 12 above, reductions related to reduced vehicle maintenance costs constitute approximately \$99.0 million or 20 percent of total benefits in undiscounted dollars; mobility benefits of \$343.9 million or 71 percent; and safety benefits of \$24.9 million or 5 percent.

### 3.4 SENSITIVITY TESTING

To test the robustness of the estimated NPV, and B/C ratio, the economic analysis applies sensitivity analysis simulations using the ranges of valuations discussed throughout the benefit analysis section.

In addition to the base case scenario results analysis conducted for the 7 and 3 percent discount scenarios, sensitivity tests were conducted for a 20 year benefit period, lower and higher induced bicycle ridership

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of 20 and 40 percent respectively, and higher vehicle operating and maintenance cost reductions using the direct modeled cost results that were reduced by 50 percent in the base build case analysis.

The results are provided in Table 13 and indicate that even in the low scenarios the East Marginal Way Corridor Improvement project is anticipated to provide a high net present value and positive benefit cost ratio.

**Table 15: Benefit Cost Analysis Summary Results for Sensitivity Tests**

		Base Case 7 Percent Discount Rate	Sensitivity Tests			
			3 Percent Discount Rate	10 percent Higher Bike Ridership Increase	10 percent Lower Bike Ridership Increase	Higher Value of Vehicle Cost Reduction
Analysis Length (years)	20	3.02	4.65	3.41	2.63	3.66
	30	3.78	6.76	4.28	3.28	4.59

The impact of sensitivity tests for bicycle ridership didn't result in a substantial change to the benefit cost ratio with a similar variance of plus and minus 13 percent over the base 7 percent discount rate. The more significant impact is associated to using the higher value of vehicle maintenance cost reduction as extracted from the WSDOT HDM-4 model which increased the benefit cost ratio to 3.66 in the 20-year analysis evaluation period and 4.59 in the 30-year evaluation period, or a net present value of \$89.1 million and \$120.4 million respectively. It is anticipated that the East Marginal Way Corridor Improvement Project will result in a final benefit-cost ratio between 2.63 and 4.59 using a 7 percent discount rate.