MD 5 GREAT MILLS IMPROVEMENT PROJECT

BENEFIT-COST ANALYSIS SUPPLEMENTARY DOCUMENTATION

MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

EXECUTIVE SUMMARY

A benefit-cost analysis (BCA) was conducted for the MD 5 Great Mills Improvement Project for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the BUILD 2019 program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in December 2018. The period of analysis corresponds to 35 years and includes 5 years of construction and 30 years of benefits after operations begin in 2024.

The Project serves as a principal connector for regional traffic to Great Mills Road, a vital transportation link for local STEM employment centers supporting activities on several military installations in the region. These installations alone employ 21,500 active-duty personnel, civilians, and contractors, many of whom rely on MD 5 for access to destinations around D.C. and Maryland and in the event of a State or national emergency.

With traffic in the project area predicted to increase by 27% by 2040, traffic condition in the Great Mills area will be significantly impacted, especially along the MD 5 between MD 471 and MD 246. The Project aims to reduce roadway crashes, reduce road congestion, and improve pedestrian connectivity with the expansion of a lane in each direction, the installation of bicycle lanes and sidewalks, the replacement of a derelict bridge, and the installation of a right turn prohibition from Old Great Mills Road onto MD 5.

COSTS

The capital cost for this Project is expected to be $29 million in undiscounted 2019 dollars through 2023. At a 7 percent real discount rate, these costs are $21.8 million in 2017 dollars. Operations and maintenance (O&M) costs are projected to average $55,500 per year in the long term. As the Project is part of a structure with existing O&M costs that will remain unchanged with the project improvements over the entire 30-year analysis period, they will result in a zero net change in costs between the Build and No-Build scenarios. Finally, net rehabilitation and replacement (R&R) cost reductions are expected to total $0.08 in undiscounted 2019 dollars over this same period, or $0.06 million in discounted 2017 dollars when discounted at 7 percent.

The Project is expected to be financed by Federal, State, Local and Private funds according to the allocation shown in Table ES-1.

TABLE ES-1: Project Costs by Funding Source, in Undiscounted Millions of 2017 Dollars

Funding Source	Capital Costs	Total Project Cost	Percent by Source
BUILD Grant Request	$14.95	$14.95	52%
Maryland DOT State Highway Administration	$14.05	$14.05	48%
Total	**$29.00**	**$29.00**	**100%**

Source: Maryland DOT State Highway Administration (SHA)

BENEFITS

In 2017 dollars, the Project is expected to generate $30.4 in discounted benefits using a 7 percent discount rate. The Project creates these benefits primarily reducing roadway congestion on MD 5, resulting in faster travel times and fewer roadway crashes. This leads to an overall project Net Present Value of $8.6 million and a Benefit Cost Ratio (BCR) of 1.39[1]. The overall project benefit matrix can be seen in Table ES-2.

Table ES-2: Project Impacts and Benefits Summary, Monetary Values in Millions of 2017 Dollars

Project Impact Categories	Change to Baseline	Type of Impact	Population Affected by Impact	Economic Benefit	Summary of Results (at 7% discount rate)	Page Reference in BCA
Economic Competitiveness	▼	Cost & Time Savings	Auto Users	Reduced travel time for persons	$27.4	10
Safety	▼	# of Crashes	Road Users	Reduced crashes	$1.7	12
Agency Cost Reductions	▼	Net O&M and R&R Costs	MDOT	Reduced maintenance costs	($0.1)	14
Residual Value		Asset Value	WA County	Project asset remaining value	$1.3	14

Source: WSP USA

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 MD 5 Great Mills Improvement Project, Cumulative 2024-53

Category	Unit	Quantity	Direction
Vehicle-Miles Traveled	VMT	-	=
Vehicle-Hours Traveled	VHT	6,601,157	▼
Fuel Consumed	gallons	-	=
Fatalities	#	-	=
Injury Accidents	#	51	▼
Property Damage Only (PDO)	#	63	▼
CO_2 Emissions	tons	-	=
NO_X Emissions	tons	-	=
PM^{10}	tons	-	=
SO_X	tons	-	=
VOC	tons	-	=

Source: WSP USA

[1] Per USDOT guidance, operations and maintenance costs are included in the numerator along with other project benefits when calculating the benefit-cost ratio.

In addition to the monetized benefits presented in Table ES-2, the Project would create the following qualitative benefits:

ECONOMIC COMPETITIVENESS

- The benefits for reducing the number and severity of flooding events, while not quantified in this analysis, would result in additional time travel savings and avoided vehicle-miles traveled by eliminating the need to divert traffic on long detours to complete their journey.
- As the region continues to grow, the expansion of employment sites and commercial operations will require reliable infrastructure to fulfill their economic development objectives. Reducing regional roadway congestion supports the development of local communities and the mission of the military installations affected by the roadway delays.

STATE OF GOOD REPAIR

- The project improvements are predicted to help reduce the severity and frequency of flooding event affecting the roadway, reducing the damage to the pavement and the bridge.

ENVIRONMENTAL SUSTAINABILITY

- The analysis does not directly quantify environmental benefits as a result of the project improvements, but the potential reduction in diverted traffic trips due to reductions in flooding events and daily roadway congestion would significantly reduce emissions and direct damages to the environment.

QUALITY OF LIFE

- While the Great Mills project provides critical connections between military installations and growing businesses in the area, the corridor also connects important community landmarks, ranging from housing to public services to recreation spots. Improvements to the intersection and bridge within the project limits will help residents gain access to these community facilities and recreational amenities.

While these benefits are not easily quantifiable, they do provide real advantages and improvements that will be experienced by individuals and businesses in the region.

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1 INTRODUCTION

A benefit-cost analysis (BCA) was conducted for the MD 5 Great Mills Improvement Project for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the BUILD 2019 program. The following section describes the BCA framework, evaluation metrics, and report contents.

1.1 BCA FRAMEWORK

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of an investment alternative. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. 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 disbenefits 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 life-cycle. 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 2019 Benefit-Cost Analysis Guidance for Discretionary Grant Programs.[2] This methodology includes the following analytical assumptions:

- Assessing benefits with respect to each of the five primary selection criteria defined by the U.S. DOT.
- Defining existing and future conditions under a No Build base case as well as under the Build;
- Assessing the independent utility of each project if the overall application contains multiple separate projects linked together in a common objective;
- Estimating benefits and costs during project construction and operation, including 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 2017 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;
- Discounting future benefits and costs with a real discount rate of 7 percent consistent with U.S. DOT guidance.

[2] U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. Dec 2018.

1.2 REPORT CONTENTS

The Report illustrates the methodology, assumptions and inputs used in the benefit-cost analysis and an evaluation of its results.

Section 2 provides an explanation of the benefit-cost analysis methodology and a description of the project.

Section 3 provides a detailed explanation and calculation of the project costs.

Section 4 provides a detailed explanation and calculation of the benefit categories.

Section 5 provides the detailed results of the benefit-cost analysis.

2 PROJECT OVERVIEW

2.1 DESCRIPTION

The Great Mills project provides a much-needed safety and traffic flow solution to a critical intersection in rural Maryland to improve the connection between key U.S. military and private sector employment centers and facilitate growth in the region. The project encompasses transportation improvements to MD 5 (Point Lookout Road) between MD 246 (Great Mills Road) and MD 471 (Indian Bridge Road) in Great Mills, St. Mary's County. St. Mary's County has grown by 7.15% - the fifth highest in the State of Maryland - well above the U.S. national average of 5.96 percent. The county has the fastest-growing workforce in the State, with the highest share of high-tech jobs in the country, mostly attributed to growth at the NAS PAX and WOLF, and to population moving from the Washington, DC area. This growth has resulted in increased traffic volumes in and surrounding the Great Mills project area.

New commercial and residential developments planned near and within the Great Mills project area are expected to generate higher traffic volumes and congestion, especially during peak travel periods. High traffic volumes resulting from existing development already contribute to operational failure. The additional traffic generated by future development will worsen congestion along the corridor. The intersections of MD 5/MD 471 and MD 5/MD 246 are projected to experience failing Levels of Service (LOS) in the design year of 2040.

The improvements in the project scope include:

- the widening of MD 5 (Point Lookout Road) from an undivided two-lane roadway to an undivided four-lane closed section roadway,
- 11-foot wide outside travel lanes with 5-foot bicycle lanes
- 5-foot wide sidewalk along both sides of MD 5,
- a new bridge over the St. Mary's River at the same grade as the existing bridge, and
- the Old Great Mills Road intersection with MD 5 will be modified to prohibit right turns from Old Great Mills Road on to MD 5.

2.1.1 *EVALUATION PERIOD*

For the project, the evaluation period includes the relevant (post-design) construction period during which capital expenditures are undertaken, plus 30 years of operations beyond the project completion within which to evaluate ongoing benefits and costs.

For the purposes of this study, it has been assumed that construction of the project will begin in 2019, with construction completed by the end of 2023 and operations beginning in 2024. As such, the 30-year evaluation period concludes in 2053.

2.1.2 *DISCOUNT RATES*

For purposes of present value discounting, all benefits and costs are conservatively assumed to occur at the end of each year. Benefits accruing from the improvements are assumed to begin in the calendar year immediately following the final construction year.

For project costs and benefits, monetary values in this analysis are expressed in constant, year-end 2017 dollars. In instances where certain cost estimates or benefit valuations were expressed in dollar values from other (historical) years, the U.S. Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers (CPI-U) was used to adjust them to 2017 prices.[3]

The real discount rates used for this analysis was 7.0 percent, consistent with U.S. DOT guidance for Discretionary Grant Programs[4] and OMB Circular A-4.[5]

2.2 BASE CASE AND BUILD CASE

The analysis of the project segment considered how the balance of costs and benefits resulting from the construction of the project improvements would result in long-term benefits to its users and general society. In the "Build" Case, the project includes the widening of a four-lane road and bridge with bike lanes and pedestrian sidewalks in each direction over the St. Mary's River near the intersection of MD 5 and Great Mills Road. The construction will include improved roadway turning geometry at intersections of with MD 246 and MD 471. Due to the project's limited disturbance to existing roadways, construction-related closures and early year disbenefits are not assumed to occur.

The "No Build" Case examines the societal costs of increasing traffic on the existing adjacent arterial roads without any planned safety or capacity improvements, resulting in increasing crashes and traffic delays on MD5 and increased damage to the existing bridge over St. Mary's River requiring major repair and rehabilitation.

2.2.1 *A CONSERVATIVE APPROACH*

The BCA implements a conservative approach. Each assumption or valuation was chosen to reflect this conservative approach, and at times guidelines from other documents were modified to reflect increased conservatism. Some of these conservative assumptions include:

- Travel time savings from the reduction of congestion significantly reflect peak-hour traffic, which is calculated to be approximately 20% of total daily trips; and,
- The analysis does not capture travel time savings, reduced vehicle-miles traveled or any other benefit beyond the immediate project area on MD 5, although the region's major arterial roads connect through the project area, certainly resulting in knock-on benefits for regional traffic; and,
- The projected reduction in safety incidents of 20% used in the analysis is primarily related to improvements affecting vehicle traffic; and,
- The projected reduction in flood incidents affecting the roadway because of the project improvements will certainly provide benefits for road users and preserve the condition of the infrastructure, yet the effects of these events are not captured in this analysis. While the available information on the severity and frequency of flooding events is incomplete, their constant presence demonstrates the benefits of the project to be understated.

[3] U.S. Bureau of Labor Statistics. Consumer Price Index, All Urban Consumers, U.S. City Average, Series CUSR0000SA0. 1982-1984=100
[4] US DOT. BUILD 2018 NOFO: Benefit-Cost Analysis Guidance for Discretionary Grant Programs, Updated April 27, 2018; https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance
[5] White House Office of Management and Budget, Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992). (http://www.whitehouse.gov/omb/circulars_a094).

3 PROJECT COSTS

3.1 CAPITAL COSTS

Initial project investment costs include right-of-way acquisition, engineering and design and construction. Total capital costs of $29.0 million (2019$) were included in the project budget and included costs beginning in 2019 and ending in 2023, as shown in Table 1. Using an adjustment factor for inflation of 1.045, the total capital costs are equivalent to $27.8 million in 2017 dollars. The improved facility is expected to be open and operational at the beginning of 2024.

Table 1: Project Schedule and Costs, Millions of 2017 Dollars

Variable	Unit	Value
Construction Start	year	2019
Construction End	year	2024
Construction Duration	years	5
Project Opening	year	2024
Capital Cost – Construction, Professional Services, and Right-of-way	2017$ M, Undiscounted	$27.76
Net Operating and Maintenance (O&M) Costs	2017$ M / year, Undiscounted	$0
Net Repair and Replacement (R&R) Costs	2017$ M / year, Undiscounted	($0.07)

Source: WSP USA

3.2 OPERATIONS AND MAINTENANCE COSTS

The annual costs of operating and maintaining the project are included in the analysis. In the “Build” Case, the operations and maintenance costs for the project include the regular maintenance and repairs to the replacement bridge and roadway. Since the project involves the replacement and enhancement of existing infrastructure, operating and maintenance costs for the bridge and roadway are calculated to have similar costs, yet maintenance activities will be on a deferred schedule.

The project improvements will not change the frequency or costs of annual operations and maintenance to maintain the quality of the asset, resulting in zero net change in costs for Maryland DOT. The annual operations and maintenance costs for the “Build” and the “No Build” Case for the project segment are shown in Table 2.

3.3 REPAIR AND REHABILITATION (R&R) COSTS

The pavement of the road and bridge lanes will need to be replaced or rehabilitated during the evaluation period. Rehabilitation of the roadway will occur every 25 years and repair of the bridge will occur every 20 years, according to the standard practices of the Maryland DOT SHA Operations department. The project improvements will defer the patching and repaving for the roadway from 2041 to 2049 and major restoration of the bridge from 2024 to 2043. An undiscounted value of $0.07 million in 2017 dollars was applied for net rehabilitation costs to maintain the quality of this investment, as shown in Table 2.

Table 2: Schedule of Operations and Maintenance and Repair/Rehabilitation/Replacement Costs (in 2017 Dollars)

Year	Build		No Build	
	O&M	R&R	O&M	R&R
2024	$55,519	$71,792	$55,519	$0
…	…	…	…	…
2041	$55,519	$0	$55,519	$ 120,610
…	…	…	…	…
2043	$55,519	$71,792	$55,519	$0
…	…	…	…	…
2044	$55,519	$0	$55,519	$71,792
…	…	…	…	…
2049	$55,519	$120,610	$55,519	$0

Source: Maryland DOT SHA

4 PROJECT BENEFITS

The benefits of the project improvements can be described as user benefits, including travel time savings and reduction in vehicle operating costs, and social benefits, including emissions reductions and the reduction in damage to property and injuries as the result of fewer collisions. The analysis covers the following benefit categories:

- Travel Time Savings
- Safety Benefits
- Vehicle Operating Cost Savings
- Reduced Roadway Damage
- Reduced Emissions
- Noise Reduction
- Improved Bicycle Commuter Mobility
- Recreational Benefits
- Health Benefits
- Agency Net O&M and R&R Costs
- Residual Value of the Project

The analysis uses standardized factors provided by governmental and industry sources to efficiently determine the monetized value of user and social benefits resulting from the project improvements. These benefits include the reduction of existing costs or the prevention of future costs related to the operation and use of the existing road facility. Table 3 shows how the benefit categories align with the merit criteria of the BUILD Grants program.

Table 3: Project Benefits by Long-Term Outcome Category

Long-Term Outcome	Benefit (Disbenefit) Category	Description	Monetized	Qualitative
Economic Competitiveness	Travel Time Savings	Reduced travel time for persons	√	
	Vehicle Operating Costs	Reduced vehicle operating and maintenance costs		√
	Fuel Savings	Reduced vehicle fuel consumption		√
Safety	Reduced Incidents	Avoided pedestrian, bicycles and vehicle crashes	√	
State of Good Repair	Reduced Roadway Damage	Reduced damage to roads from reduced vehicle-miles traveled		√
Environmental Sustainability	Reduced Emissions	Lower emissions (reduced health risks)		√
Quality of Life / Livability	Recreational Benefits	Benefits for bicyclists and pedestrians		√
	Health Benefits	Benefits for bicyclists and pedestrians		√

4.1 DEMAND PROJECTIONS

Traffic demand projections illustrate the growth in roadway use in response to the availability of capacity and user demand and the social costs and benefits associated with the use of the facility. Projections of future traffic patterns indicates whether project improvements will improve safety and decrease congestion and trip length with additional capacity and infrastructure features.

The analysis incorporates growth projections developed by Maryland DOT SHA using travel forecasting and analysis to project traffic patterns within the project segment on MD 5 from 2016 to 2040. The travel demand analysis resulted in a projected annual traffic growth rate of 1.08% for the project segment, which is reflected in the traffic projections in this study. As Great Mills is designated as a community within the Lexington Park metro area and the project segment performs as a key corridor for regional travel, the induced demand due to the project improvements in the local area are assumed to be captured in the traffic growth projections.

Table 4: Demand Projection Assumptions and Sources

Variable	Unit	Value	Source
Average Daily Peak Period Trips - MD 471 to MD 246 on MD 5 – 2016	trips	21,800	Maryland DOT SHA Travel Demand Forecasting
Average Daily Peak Period Trips - MD 471 to MD 246 on MD 5 – 2025	trips	23,850	Maryland DOT SHA Travel Demand Forecasting
Average Daily Peak Period Trips - MD 471 to MD 246 on MD 5 – 2040	trips	27,600	Maryland DOT SHA Travel Demand Forecasting
Average Daily Peak Period Trips – Compound Annual Growth Rate	%	1.08%	Maryland DOT SHA Travel Demand Forecasting
% Peak Period Trips of Total Daily Traffic	%	19.2%	Maryland DOT SHA Travel Demand Forecasting
Average Daily Peak Period VMTs - MD 471 to MD 246 on MD 5 – 2016	VMTs	10,900	Maryland DOT SHA Travel Demand Forecasting
Average Daily Peak Period VMTs - MD 471 to MD 246 on MD 5 – 2025	VMTs	11,750	Maryland DOT SHA Travel Demand Forecasting
Average Daily Peak Period VMTs - MD 471 to MD 246 on MD 5 – 2040	VMTs	13,800	Maryland DOT SHA Travel Demand Forecasting
Average Speed - MD 471 to MD 246 on MD 5 – 2016	mph	29	Maryland DOT SHA Travel Demand Forecasting
Average Speed - MD 471 to MD 246 on MD 5 – 2040 – Build	mph	31	Maryland DOT SHA Travel Demand Forecasting
Average Speed - MD 471 to MD 246 on MD 5 – 2040 – No Build	mph	14	Maryland DOT SHA Travel Demand Forecasting
Annualization Factor	days/year	250	WSP
Average Traffic Mix – Auto/Truck	%	99%/1%	St. Mary's County Transportation Plan, 2006

The resulting demand projections are presented in the following table.

Table 5: No Build and Build Demand Projections

Variable	Project Opening Year		Final Year of Analysis	
	No Build	Build	No Build	Build
Peak Period ADTs – MD 471 to MD 246 on MD 5	23,249	23,249	31,728	31,728
Peak Period VMTs – MD 471 to MD 246 on MD 5	11,624	11,624	15,864	15,864
Average Speed (mph) – MD 471 to MD 246 on MD 5	24 mph	29 mph	11 mph	32 mph
Peak Period VHTs – MD 471 to MD 246 on MD 5	61	46	307	57
Annual VHTs – MD 471 to MD 246 on MD 5	79,497	59,905	399,648	74,505

Source: Maryland DOT SHA, WSP USA

4.2 ECONOMIC COMPETITIVENESS

This project would contribute to increasing the economic competitiveness of the Nation through improvements in the mobility of people and goods in the study area. Two types of societal benefits are measured in the assessment of economic competitiveness: travel time savings and vehicle operating savings. The analysis quantifies benefits related to travel time savings associated with the project improvements, yet largely describes vehicle operating savings in qualitative terms.

With the reduction of roadway congestion resulting from the project improvements, travel time savings are a significant direct benefit for users of the road facility. The user benefits represent a reduction of future costs related to the personal and commercial use of the roadway. The reduction in time delays allows personnel to reach employment centers and freight trucks to deliver equipment and materials to technical facilities and military installations in a cost- and time-efficient manner, impacting economic industries throughout the region. As a central component in improving traffic movements throughout St. Mary's County, the project improvements facilitate the development of commercial properties and employment sites in the Lexington Area, while improving connectivity to regional pedestrian and bicyclist infrastructure.

4.2.1 *TRAVEL TIME SAVINGS*

Travel time savings includes in-vehicle travel time savings for auto drivers and passengers and truck drivers. 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. The MD 5 Great Mills Improvement Project will provide additional capacity on a vital connector in the region, alleviating peak-hour congestion on adjacent arterials with reduced travel time and higher travel speeds for commuters, freight traffic and recreational users throughout the region. The reduction in travel time for the project is calculated to be $27.4 million in discounted 2017 dollars.

Table 6: Travel Time Savings Estimation of Benefits, Millions of 2017 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Travel Time Savings - Auto	$0.57	$0.38	$146.74	$27.07
Travel Time Savings - Truck	$0.01	$0.00	$1.57	$0.29

Source: WSP USA

The assumptions used in the estimation of travel time savings benefits are presented in the following table.

Table 7: Travel Time Savings Assumptions and Sources

Variable	Unit	Value	Source
Value of Travel Time Savings - Personal, Local	2017$ per person hour	$14.80	US DOT Guidance, December 2018
Value of Travel Time Savings - Business, Local	2017$ per person hour	$26.50	US DOT Guidance, December 2018
Value of Travel Time Savings - All Purposes, Local	2017$ per person hour	$16.10	US DOT Guidance, December 2018
Value of Travel Time Savings - Personal, Intercity	2017$ per person hour	$20.70	US DOT Guidance, December 2018
Value of Travel Time Savings - Business, Intercity	2017$ per person hour	$26.50	US DOT Guidance, December 2018
Value of Travel Time Savings - All Purposes, Intercity	2017$ per person hour	$21.94	US DOT Guidance, December 2018
Value of Travel Time - Real Growth Rate	Annual Rate	1.20%	US DOT Guidance, 2014

4.2.2 *VEHICLE OPERATING COST SAVINGS*

Vehicle operating cost savings includes the cost of fuel, as well as maintenance and repair, replacement of tires, and the depreciation of the vehicle over time. The project improvements do not measurably reduce the direct distance through the project area, yet the reductions in road congestion and faster travel times could incidentally reduce fuel consumption and general wear-and-tear by minimizing idling in stop-go traffic. Additionally, as the

project improvements aim to reduce the frequency and severity of flooding events on MD 5, it would avoid the need for drivers to take lengthy detours around the flooded area to complete their journey, thereby reducing total vehicle-miles traveled.

4.3 SAFETY

The safety benefits assessed in this analysis include a reduction in fatalities and injuries, as well as a reduction in other property damage crash costs resulting directly from the project.

Due to being a mix of residential neighborhoods and commercial developments, the traffic of the area around Great Mills includes personal vehicles, freight trucks, on-road bicyclists and pedestrians. The constriction of daily commuter traffic down to two lanes on MD 5 and Great Mills Road leads to frequent crashes resulting from inattention, abrupt stops and impatient driving. From 2009 to 2018, 154 crashes occurred within a half-mile of the project segment around the intersections of MD 5 with MD 246 and MD 471, including 69 serious injuries. The expansion of the roadway and changes of roadway geometry on MD 5, in addition to the improved facilities for bicycles and pedestrians, are projected to reduce crashes by an average of about 20%, or an average of three incidents annually. The prevention of these crash incidents is calculated to be $1.73 million in discounted 2017 dollars.

Table 8: Safety Estimation of Benefits, Millions of 2017 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Fatality Reduction	$0.00	$0.00	$0.00	$0.00
Injury Reduction	$0.11	$0.08	$5.89	$1.65
Property Damage Reduction	$0.01	$0.01	$0.27	$0.08
Total Safety Benefits	**$0.12**	**$0.08**	**$6.16**	**$1.73**

Source: WSP USA

The analysis assumes accident rates modified with a crash modification factor reflective of the roadway improvements for the “Build” scenario. As a result, any changes in the number of accidents will be a result of structural changes to the safety conditions on the roadway network tied to the growth of traffic. The assumptions used in the estimation of safety benefits are presented in the following table.

Table 9: Safety Benefits Assumptions and Sources

Variable	Unit	Value	Source
Cost per Fatality	2017$	$9,600,000	US DOT Guidance, December 2018
Cost per MAIS 5 Injury	2017$	$5,692,800	US DOT Guidance, December 2018
Cost per MAIS 4 Injury	2017$	$2,553,600	US DOT Guidance, December 2018
Cost per MAIS 3 Injury	2017$	$1,008,000	US DOT Guidance, December 2018
Cost per MAIS 2 Injury	2017$	$451,200	US DOT Guidance, December 2018
Cost per MAIS 1 Injury	2017$	$28,800	US DOT Guidance, December 2018
Cost per Property-Damage Only Crash	2017$	$4,300	US DOT Guidance, December 2018
Crash Modification Factor	factor	0.802	Park et al. “Assessment of safety effects for widening urban roadways in developing crash modification functions using nonlinearizing link functions”, 2015.

4.4 STATE OF GOOD REPAIR

The state of good repair condition benefits assessed in this analysis include maintenance and repair savings, deferral of replacement cost savings, reduced VMT which leads to less road and facility damage, as well as use of design and technologies to increase resilience performance during natural hazard events and long-term use. While prevented damage to roadway pavement is associated with reductions in VMTs, the replacement of the bridge will ensure the vital transportation link for the region will continue to operate at peak performance while reducing the probability of flooding events. While not quantified in this analysis, the improvements to the roadway and bridge will help reduce the probability that the flooding of the St. Mary's River will adversely affect the condition of the roadway or the bridge.

4.5 ENVIRONMENTAL SUSTAINABILITY

This project will create environmental and sustainability benefits relating to reduction in air pollution associated with decreased automobile and commercial truck travel and reduction in environmental damages. While the analysis does not directly quantify environmental benefits as a result of the project improvements, the reduction in diverted traffic trips due to reductions in flooding events and daily roadway congestion would significantly reduce emissions and direct damages to the environment. Additionally, the completion of sidewalks and lanes for bicyclists and pedestrians may induce residents to switch modes of travel for commuting or to complete short local trips by foot or an alternative to driving a car.

4.6 QUALITY OF LIFE / LIVABILITY

This project could create quality of life / livability benefits associated with encouraging pedestrian and bicyclists traffic and improving ADA access around Great Mills and Lexington Park for greater mobility. Extending and completing pedestrian infrastructure to increase connectivity within the community has been shown to induce foot and bicycle traffic for commuting and recreation. Additionally, the project improvements would build pedestrian and bicycle connections to the National Park Service-designated Southern Maryland Potomac Heritage Trail on-road bicycling route that runs on MD 5 from the county seat of Leonardtown south to Point Lookout.

4.7 AGENCY COST REDUCTIONS

Project improvements resulting in reductions in agency costs related to the operation, maintenance, repair or rehabilitation of an asset can be the result of improved management processes or the replacement of underperforming equipment. Over the analysis period, the expansion of the four-lane roadway bridge and the construction of dedicated bike and pedestrian infrastructure will result in cost reductions in routine operations & maintenance costs and periodic repair & rehabilitation totaling $0.06 million in discounted 2017 dollars.

Table 10: Agency Estimation of Net O&M and R&R Costs, Millions of 2017 Dollars

Benefit	Project Opening Year - 2024		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
O&M Costs	$0.00	$0.00	$0.00	$0.00
R&R Costs	($0.07)	($0.05)	($0.07)	($0.06)
Total Agency O&M and R&R Costs	**($0.07)**	**($0.05)**	**($0.07)**	**($0.06)**

Source: WSP USA

The assumptions used in the estimation of net operations & maintenance and repair & rehabilitation costs are presented in the following table.

Table 11: Agency Costs Reduction Assumptions and Sources

Variable	Unit	Frequency	Source
Operations & Maintenance Costs	2017$	Annual	Maryland DOT SHA
Repair & Rehabilitation – Road	2017$	Every 25 Years	Maryland DOT SHA
Repair & Rehabilitation – Bridge	2017$	Every 20 Years	Maryland DOT SHA

4.8 RESIDUAL VALUE

The residual capital value (RCV) is calculated by determining the percentage of useful life remaining beyond the analysis period, and multiplying that percentage by the construction cost for that component. Since we are using a 30-year analysis period and a 50-year design life, the residual value is 40% of the initial cost using the straight-line depreciation method. The remaining capital value is viewed as cost offset or "negative cost" and is applied to the last year of analysis period as a negative value. The residual value is discounted back to $0.98 million in discounted 2017 dollars in the BCA calculations.

Table 12: Residual Value Estimation of Benefits, Millions of 2017 Dollars

Benefit	Final Analysis Year – 2053	
	Undiscounted	Discounted (7%)
MD 5 Bridge and Roadway Remaining Capital Value In Final Year	$9.32	$0.87
Remaining Land Value In Final Year	$4.45	$0.11
Total Residual Value Benefits	**$13.78**	**$0.98**

Source: WSP USA

The assumptions used in the estimation of residual value benefits are presented in the following table.

Table 13: Residual Value Assumptions and Sources

Asset Name	Expected Life Span	Capital Cost	Last Purchase Year
MD 5 Bridge and Roadway	50	$23,309,063	2023
Right of Way Land Acquisition Costs	100	$4,452,190	2021

5 SUMMARY OF RESULTS

5.1 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.
- Internal Rate of Return (IRR): The IRR is the discount rate which makes the NPV from the Project equal to zero. In other words, it is the discount rate at which the Project breaks even. Generally, the greater the IRR, the more desirable the Project.
- Payback Period: The payback period refers to the period of time required to recover the funds expended on a Project. When calculating the payback period, the time value of money (discounting) is not taken into account.

5.2 BCA RESULTS

The table below presents the evaluation results for the project. Results are presented in undiscounted 2017 dollars and 2017 dollars discounted at 7 percent, as prescribed by the U.S. DOT. All benefits and costs were estimated in constant 2017 dollars over an evaluation period extending 30 years beyond system completion in 2023.

The total benefits from the project improvements within the analysis period are calculated to be $30.4 million in discounted 2017 dollars. The total capital costs, including engineering, construction, and right-of-way and land acquisition, are calculated to be $21.8 million in discounted 2017 dollars. The difference of the discounted benefits and costs equal a net present value of $8.6 million in discounted 2017 dollars, resulting in a benefit-cost ratio (BCR) of 1.39. The internal rate of return for the project is 9% with a payback period of 19.24 years.

Table 14: Benefit Cost Analysis Results, Millions of 2017 Dollars

BCA Metric	Project Lifecycle	
	Undiscounted	Discounted (7%)
Total Benefits	$168.3	$30.4
Total Costs	$27.8	$21.8
Net Present Value (NPV)	$140.5	$8.6
Benefit Cost Ratio (BCR)	6.06	1.39
Internal Rate of Return (IRR)	9%	N/A
Payback Period (Years)	19.24	29.17

Source: WSP USA

The benefits over the project lifecycle are presented in the table below by U.S. DOT long-term outcome category.

Table 15: Benefits by Long-Term Outcome, Millions of 2017 Dollars

Type of Benefit	Undiscounted	Discounted
Travel Time Savings	$148.3	$27.4
Safety	$6.2	$1.7
Reduced Agency O&M Costs	$0.1	$0.1
Residual Value	$13.8	$0.9

Source: WSP USA