Unalaska Captains Bay Road Paving and Utility Extension Review Draft Cost-Benefit Analysis

City of Unalaska

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Executive Summary

Unalaska, Alaska, the home of Dutch Harbor, holds state, national, and international economic importance as the largest fishing port in the United States by volume caught. Much of the seafood arriving in Unalaska is transported along Captains Bay Road, a 2.6-mile-long, heavily trafficked industrial gravel road. Captains Bay Road experiences 1,000 vehicles per day on average, 75 percent of which are semi-trucks and other industrial vehicles. During peak seafood seasons, industrial traffic on Captains Bay Road operates throughout the day, supporting the seafood industry's 24-hour-per-day, 7-day-per-week operations.

Captains Bay Road is narrow and unpaved, with limited shoulders, adjacent vertical rock cliffs with occasional rockfall, no lighting, and no pedestrian safety considerations. Its poor surface conditions, combined with several sharp curves as it follows the coastline, limit speeds to 30 miles per hour (mph). Heavy industrial traffic creates ruts and potholes in the road, significantly slowing traffic. In winter, the road is slippery due to wet-ice conditions. These road conditions are dangerous, leading to frequent accidents and trucks and vehicles sliding off the road. The road is also dusty on dry, windy days. The City of Unalaska (City) grades the road twice per week to control rutting and potholes. The rough condition of the road, and the maintenance necessary to fix it, slows industrial traffic, adding to operational costs of the City and industrial users. The rough road condition causes high vehicle maintenance costs due to excessive wear and tear. The lack of pedestrian safety considerations is also a concern expressed by many in the community.

City of Unalaska/Port of Dutch Harbor:

Unalaska is the anchor for commercial fishing activity in the Bering Sea and the Aleutian Islands. According to National Oceanic and Atmospheric Administration's report *Fisheries of the United States 2019*[1], Unalaska's Port of Dutch Harbor led the nation with the greatest quantity of fish landed, a distinction held for more than 23 years; during those same years, the port was rated either first or second in value of the catch. During 2019, commercial fisherman delivered 763 million pounds of seafood at the port, valued at $190 million dollars, ranking the Port of Dutch Harbor second in the nation for value of the catch. Approximately 400 vessels fish the Aleutian Islands and Bering Sea for various ground fish, halibut, salmon, herring, and crab species. The fleet utilizes approximately 12,000 feet of city dock space, with an additional 10,000 feet of commercial dock space available within the community.

City utilities do not extend beyond Westward Seafoods, requiring commercial operations beyond that point to provide their own power, water, and sewer utilities. Given the need to improve the roadway's functionality and safety as well as to provide improved access to City-owned utilities, the City is advancing a long-contemplated project to design and construct a project that will improve Captains Bay Road and extend utilities.

The City contracted HDR Engineering, Inc. (HDR) to conduct a Cost-Benefit Analysis (CBA) of the roadway and utility improvements to Captains Bay Road based on 65% Design and Cost Estimates prepared by HDL Engineering Consultants, LLC (HDL)[2]. HDL's design includes

[1] National Marine Fisheries Service, *Fisheries of the United States 2019*, https://media.fisheries.noaa.gov/2021-05/FUS2019-FINAL-webready-2.3.pdf?null=
[2] HDL Engineering Consultants, LLC, *Captains Bay Road Paving and Utility Extension – 65% Review Submittal*, November 2020.

roadway realignment; water, sewer, and electrical utility extensions; separated pedestrian facilities; and curbs, gutters, and storm drains. It also addresses rock fall issues in the Dead Man's Curve area. A CBA prepared for this full buildout project resulted in a benefit-cost ratio (BCR) of less than one, indicating that the benefits do not exceed costs over the life of the project. Projects with positive BCRs compete better for U.S. Department of Transportation (USDOT) Discretionary Grant Funds.

Recognizing the highly competitive nature of state and federal capital funding programs and within the context of achieving a positive BCR, the City contracted with HDR to use the HDL report and cost estimates prepared for the 65% roadway and utilities design[3] to evaluate reduced scope scenarios for road and utility improvements that optimize benefits compared to costs. The goal is to provide the City with optional project scenarios to pursue USDOT Discretionary Grant Funds that can be allocated directly to the City. To this end, HDR developed six road project scenarios and evaluated CBAs, ranging from HDL's full build out to a minimal roadway improvement project with no utilities. HDR conducted the CBAs in conformance with federal guidance regarding evaluation methods and monetization values recommended by the USDOT in its *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*[4].

Table ES-1 summarizes the six project scenarios that were evaluated through the CBA. Separated pedestrian pathways and drainage improvements are common to all project scenarios. To maximize flexibility, each project scenario consists of three segments for scoping and evaluation purposes. Segment A represents Captains Bay Road from its intersection with Airport Road to Westward Seafoods. Segment B extends from Westward Seafoods to North Pacific Fuel. Segment C Extends from North Pacific Seafoods to the end of the route at Offshore Systems Inc. All project costs represent 2020 dollars.

The period of analysis used in the estimation of benefits and costs corresponds to 33 years, including 3 years of design, engineering, and construction as well as 30 full years of operation. As multiple scenarios were considered for the analysis, the total costs range from $13.0 million to $40.5 million in capital expenditures, in 2020 dollars. The capital expenditures considered in the analysis are presented in Table ES-2, by year and scenario. Table ES-3 and Table ES-4 highlight the total undiscounted and discounted benefits by scenario, respectively.

[3] HDL Engineering Consultants, LLC, *Captains Bay Road Paving and Utility Extension – 65% Review Submittal*, November 2020.
[4] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0

Table ES-1: Captains Bay Road Paving and Utility Extension Project Scenarios, 2020 Dollars

Scenario	Scope: Assuming 3-year Construction Program	Segment A Costs	Segment B Costs	Segment C Costs	Total
1. Base Case HDL Full Design	Realignment, utilities extension, separated pedestrian facilities, roadway lighting, Dead Man's Curve rock cut, design speed 45 mph	$20.2 M	$15.7 M	$4.6 M	$40.5 M
2. HDL Baseline with Reduced Utilities	Same as Scenario 1, except no sewer to Segments B and C and no water to Segment C	$19.9 M	$14.4 M	$3.7 M	$38.0 M
3. Existing Alignment with Reduced Utilities	Maintains current alignment and 30 mph design speed; same utility reductions as in Scenario 2; no rock cuts; separated pathway and roadway lighting included	$11.0 M	$8.0 M	$2.2M	$21.2 M
4. Existing Alignment with Slope Work	Similar to Scenario 3, with the addition of selective bluff sloping between Dead Man's Curve and Pyramid Creek	$11.0 M	$11.0 M	$2.2 M	$24.2 M
5. Combination of Scenarios 2 and 3	Segment A, Scenario 3; Segments B and C, Scenario 2	$11.0 M	$14.4 M	$3.7 M	$29.1 M
6. Roadway Paving and Selective Slope Work	Scenario 4, with all utility improvements eliminated; pedestrian pathway and storm drains included	$6.9 M	$4.7 M	$1.4 M	$13.0 M

Note: M = million

Table ES-2: Summary of Capital Expenditures, 2020 Dollars

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
2023	$20.2 M	$19.9 M	$11.0 M	$11.0 M	$11.0 M	$6.9 M
2024	$15.7 M	$14.4 M	$8.0 M	$11.1 M	$14.4 M	$4.7 M
2025	$4.6 M	$3.7 M	$2.2 M	$2.2 M	$3.7 M	$1.4 M
Total[a]	**$40.5 M**	**$38.0 M**	**$21.2 M**	**$24.3 M**	**$29.1 M**	**$13.0 M**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

Table ES-3: Summary Benefits (Undiscounted), 2020 Dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Road Maintenance Costs	$6.9 M	$6.9 M	$6.9 M	$6.9 M	$6.9 M	$6.9 M
Reduced Vehicle Maintenance Costs	$16.1 M	$16.1 M	$16.1 M	$16.1 M	$16.1 M	$16.1 M
Improved Safety	$7.6 M	$7.6 M	$7.6 M	$7.6 M	$7.6 M	$7.6 M
Travel Time Savings	$26.9 M	$26.9 M	$19.1 M	$19.1 M	$19.1 M	$19.1 M
Reduced GHG Emissions	$0.1 M	$0.1 M	$0.1 M	$0.1 M	$0.1 M	$0.1 M
Reduced CAC Emissions	$0.1 M	$0.1 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Residual Value of Assets	-	-	-	-	-	-
Reduced Utility Maintenance Costs	$2.3 M	$2.3 M	$2.3 M	$2.3 M	$2.3 M	-
Avoided Water Leakage	$4.8 M	$4.8 M	$4.8 M	$4.8 M	$4.8 M	-
Total Benefits[a]	**$64.8 M**	**$64.8 M**	**$57.0 M**	**$57.0 M**	**$57.0 M**	**$49.9 M**

Notes: CAC = critical air contaminants; GHG = greenhouse gas
[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

Table ES-4: Summary Benefits (Discounted), 2020 Dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Road Maintenance Costs	$2.6 M	$2.6 M	$2.6 M	$2.6 M	$2.6 M	$2.6 M
Reduced Vehicle Maintenance Costs	$6.1 M	$6.1 M	$6.1 M	$6.1 M	$6.1 M	$6.1 M
Improved Safety	$2.8 M	$2.8 M	$2.8 M	$2.8 M	$2.8 M	$2.8 M
Travel Time Savings	$10.1 M	$10.1 M	$7.2 M	$7.2 M	$7.2 M	$7.2 M
Reduced GHG Emissions	$0.1 M	$0.1 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Reduced CAC Emissions	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Residual Value of Assets	-	-	-	-	-	-
Reduced Utility Maintenance Costs	$0.9 M	$0.9 M	$0.9 M	$0.9 M	$0.9 M	-
Avoided Water Leakage	$1.7 M	$1.7 M	$1.7 M	$1.7 M	$1.7 M	-
Total Benefits[a]	**$24.4 M**	**$24.4 M**	**$21.4 M**	**$21.4 M**	**$21.4 M**	**$18.8 M**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

Based on the CBA conducted (see Table ES-5), the project is expected to generate discount benefits ranging from $18.8 million to $24.4 million, based on a 3 percent real discount rate for carbon dioxide-related impacts and a 7 percent real discount rate for all other impacts per the USDOT CBA guidance[5]. The analysis indicates that the discounted net present value is expected to range from -$14.5 million to $6.3 million and the BCR is expected to range from 0.6 to 1.5. Additional detailed breakdowns of the analysis, including the various assumptions and methodologies, are presented in the body of this document. This document also describes various qualitative benefits that are not monetized in the CBA. These unquantified benefits are relevant when considering the merits of the various proposed project improvements.

Table ES-5: Overall Results of the Cost-Benefit Analysis (Discounted), 2020 Dollars

Evaluation Metrics	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Total Benefits	$24.4 M	$24.4 M	$21.4 M	$21.4 M	$21.4 M	$18.8 M
Total Costs	$38.9 M	$36.6 M	$20.4 M	$23.2 M	$27.6 M	$12.5 M
Net Present Value	-$14.5 M	-$12.2 M	$1.0 M	-$1.8 M	-$6.2 M	$6.3 M
Return on Investment	-37%	-33%	5%	-8%	-22%	50%
Benefit-Cost Ratio	**0.6**	**0.7**	**1.1**	**0.9**	**0.8**	**1.5**
Payback Period (years)	N/A	N/A	28.8	N/A	N/A	15.1
Internal Rate of Return	3.1%	3.6%	7.5%	6.3%	4.7%	11.4%

Note: N/A = not applicable

[5] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0

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Appendix A: Emission Factors

Acronyms

AADT	average annual daily traffic
AML	Alaska Marine Lines
BCR	benefit-cost ratio
CAC	critical air contaminants
CBA	Cost-Benefit Analysis
City	City of Unalaska
CMF	crash modification factor
CO_2	carbon dioxide
DOT&PF	Alaska Department of Transportation and Public Facilities
FY	fiscal year
GHG	greenhouse gas
HDL	HDL Engineering Consultants, LLC
HDR	HDR Engineering, Inc.
ILJA	Infrastructure Investment and Jobs Act
INFRA	Infrastructure for Rebuilding America
mph	mile per hour
NHS	National Highway System
NOFO	Notice of Funding Opportunity
NO_X	nitrogen oxide
NPV	net present value
OSI	Offshore Systems, Inc.
PDO	property damage only
PM	particulate matter
project	Captains Bay Road Paving and Utility Extension Project
PROTECT	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation
RAISE	Rebuilding American Infrastructure with Sustainability and Equity
ROI	Return on Investment
SO_2	sulfur dioxide
STIP	Statewide Transportation Improvement Program
TIFIA	Transportation Infrastructure Finance and Innovation Act
USDOT	U.S. Department of Transportation
VOC	volatile organic compounds
WST	water storage tank

Glossary of Economic Terms

Term	Definition
Benefit-Cost Ratio (BCR)	Reflects the lifecycle benefits relative to the lifecycle costs of a project. A project with a BCR greater than 1 has a positive economic value.
Discount Rate	The rate at which future benefits and costs are discounted.
Discounting	Adjusting for the time value of money. The principle is that benefits and costs that occur sooner in time are more highly valued than those that occur in the distant future. Moreover, it considers the costs associated with diverting the resources needed for an investment from other productive uses in the future.
Lifecycle Benefits	The sum of the present value of benefits for the project.
Lifecycle Costs	Present value of all net project costs, including initial and subsequent costs in real constant dollars.
Net Present Value (NPV)	The difference between the lifecycle benefits and the lifecycle costs. The value of benefits exceeds the value of costs for a project with a positive net present value.
Payback Period	The number of years it takes for the net benefits (lifecycle benefits minus lifecycle costs) to equal the initial construction costs. For a project with a payback period longer than the lifecycle of the project, initial construction costs are not recovered. The payback period varies inversely with the BCR. A shorter payback period yields a higher BCR.
Rate of Return on Investment (ROI)	The discount rate at which benefits and costs are equal. For a project with a rate of return greater than the discount rate, the benefits are greater than the costs, and the project has positive economic value. The user can use rate of return to compare projects with different costs and different benefit flows over different time periods.

1 Introduction

Unalaska, Alaska, the home of Dutch Harbor, is the largest fishing port in the nation by volume caught, and the 2.6-mile-long, gravel Captains Bay Road is a vital transportation link in Unalaska's economy (Figure 1 and Figure 2). Captains Bay Road needs improvements to address its potholed and rutted gravel surface, hazardous driving conditions, pedestrian safety issues, and limited utilities. The City of Unalaska (City) is advancing a long-contemplated project to design and construct a project to pave and improve Captains Bay Road and extend utilities along it. The City contracted HDR Engineering, Inc. (HDR) to conduct a Cost-Benefit Analysis (CBA) of the Captains Bay Road Paving and Utility Extension Project (project) for use in discretionary competitive grant funding programs. This document provides detailed technical information on the economic analyses conducted. The remainder of the document is presented as follows:

- **Section 2 – Methodological Framework:** Introduces the conceptual framework used in the CBA.
- **Section 3 – Project Overview:** Provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the project is expected to generate.
- **Section 4 – General Assumptions:** Discusses the general assumptions used in the estimation of project costs and benefits.
- **Section 5 – Demand Projections:** Provides estimates of travel demand and traffic volumes.
- **Section 6 – Benefits Measurement, Data, and Assumptions:** Details the specific data elements and assumptions used to address the goals of the project.
- **Section 7 – Summary of Findings and Cost-Benefit Analysis Outcomes:** Provides estimates of the net present value (NPV), its benefit-cost ratio (BCR), and other evaluation metrics.
- **Section 8 – Cost-Benefit Analysis Sensitivity:** Provides the outcome of the sensitivity analysis that evaluates the different assumptions made in the analysis, and the impact that the variability of those assumptions may have on the overall results.
- **Section 9 – Project Funding:** Identifies several potential project funding sources, including U.S. Department of Transportation (USDOT) Discretionary Grant Programs, Denali Commission funds, Alaska Department of Transportation and Public Facilities (DOT&PF) Federal Program funding, State General Funds, and Local Improvement District funds.

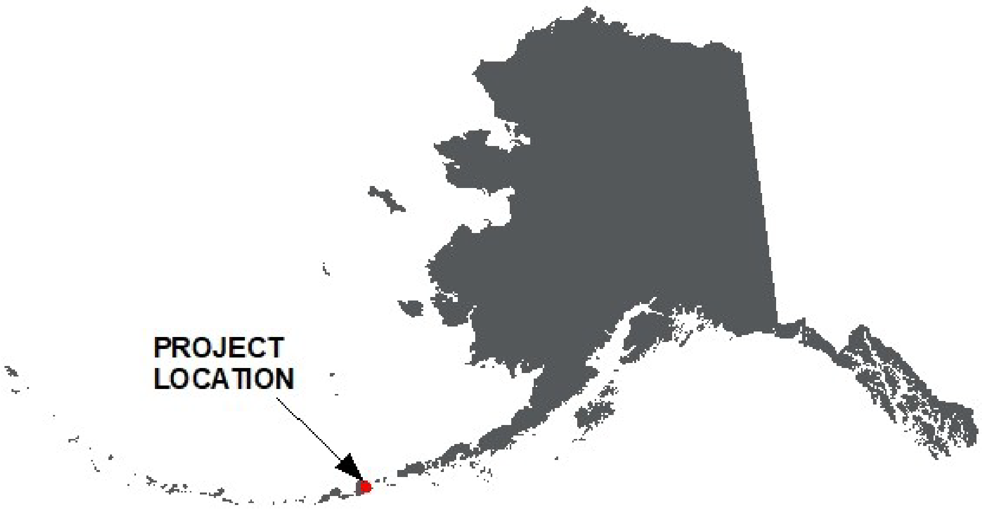


Figure 1: Vicinity Map Showing Unalaska's Location Relative to the Rest of Alaska

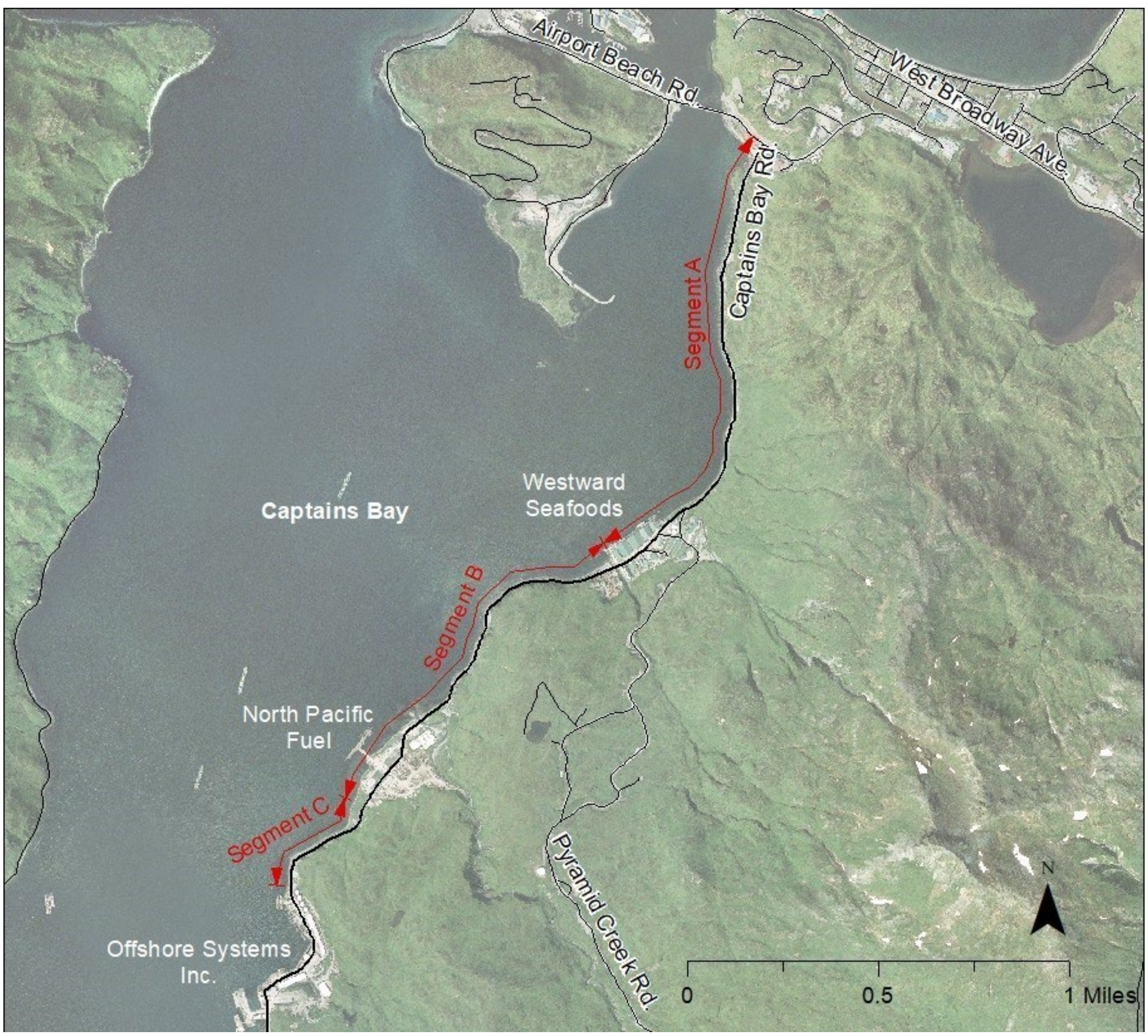


Figure 2: Project Location and Segments

2 Methodological Framework

The CBA conducted for this project includes monetized benefits and costs measured using USDOT guidance[6], as well as the quantitative and qualitative merits of the project. A CBA provides estimates of the benefits that are expected to accrue over a specified period and compares them to the anticipated costs. Costs include both the resources required to develop the project and the costs of maintaining the new or improved facility over time. Estimated benefits are based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms.

While CBA is just one of many tools that can be used in making decisions about infrastructure investments, USDOT believes that CBA provides a useful benchmark from which to evaluate and compare potential transportation investments.

The specific methodology employed for this application was developed using USDOT's CBA guidance[7], which involves:

- Establishing existing and future conditions under the no-build and various build scenarios;
- Using USDOT guidance for the valuation of safety benefits and reductions in air emissions, while relying on industry best practices for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by USDOT; and
- Conducting a sensitivity analysis to assess the impacts of changes in key assumptions.

Key to the development of this CBA and its alternative scenarios, revised estimates, and identification and confirmation of project benefits was robust stakeholder outreach to City public works, public safety, and finance staff as well as the many commercial users of Captains Bay Road who transport their product and supplies along this important route. Stakeholder outreach included in-person and telephone interviews. HDL Engineering Consultants, LLC (HDL), the City's design engineering firm, provided significant insight to the project needs and costs through their 65% design efforts[8] to improve Captains Bay Road. HDL estimates were used to cost out the various scope reductions of the alternative scenarios. The HDR team found that all persons contacted recognized the importance of improving Captains Bay Road and willingly provided the requested information in a timely and complete manner. This cooperation facilitated the development of this CBA and is greatly appreciated.

[6] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0
[7] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0
[8] HDL Engineering Consultants, LLC, *Captains Bay Road Paving and Utility Extension – 65% Review Submittal*, November 2020.

3 Project Overview

3.1 Project Background

Captains Bay Road is located on the southwestern side of Unalaska Island, across Captains Bay from the Carl E. Moses Boat Harbor and accessed by Airport Beach Road. Much of the seafood arriving in Unalaska is transported along Captains Bay Road, which is a 2.6-mile-long, heavily trafficked, industrial gravel road. Industries along the road include seafood processors Westward Seafoods and Trident Seafoods in addition to other marine-related industries, including North Pacific Fuel, Alaska Chadux Corporation, Offshore Systems, Inc. (OSI), and Alaska Marine Lines (AML). Trucking companies such as Matson, CMA-CGM, AML, and Pacific Stevedoring use Captains Bay Road to transport processed seafood to other docks, vessels, and cold storage facilities for shipping internationally. One private residence is located on the road in addition to the bunkhouses at Westward Seafoods, Trident Seafoods, and other businesses. Traffic on Captains Bay Road is predominantly industrial, with an average annual daily traffic (AADT) of 976 vehicles per day[9]. During peak seafood seasons, industrial traffic on Captains Bay Road operates day and night to offload processed seafood in 40-foot containers, return empty containers, and supply the industries and vessels.

Between Airport Beach Road and OSI, Captains Bay Road is unpaved with limited shoulders. Roughly 75 percent of the vehicle traffic consists of semi-trucks and other industrial traffic, whose heavy use combined with poor surface conditions create ruts and potholes in the road, significantly slowing traffic. While the speed limit is 30 miles per hour (mph), driving the design speed only occurs after the City has graded the road, which occurs roughly twice per week to control potholes and rutting. The trucking companies indicate that their drivers require twice the time to complete a round trip from their Captains Bay Road facilities to the container docks for transshipment to Lower 48 and international destinations due to unpaved roadway conditions. In winter, the road's condition is compounded due to ice and snow build up. These road conditions are hazardous and lead to frequent accidents, including semi-trucks, pickups, and personnel vehicles sliding off the road. The road is also dusty on dry, windy days. The rough condition of the road, and the maintenance necessary to fix it, slows industrial traffic, adding to operational costs of industrial users. Rock fall may close one or both lanes of the roadway, affecting traffic until road crews can clear the debris. Rock fall is also a hazard to vehicles and pedestrians when they occur.

Additionally, trucking companies indicate that the rough road conditions contribute to higher-than-normal wear on their vehicles, requiring more frequent maintenance, repair, and replacement. There is a high volume of pedestrian traffic due to seafood processing workers and other employees walking in the roadway, often in less than ideal and low-visibility conditions.

[9] HDL, *Captains Bay Road Paving and Utility Extension Project – Preliminary Roadway Design*, September 7, 2018.

The lack of pedestrian facilities causes vehicle/pedestrian conflicts, resulting in safety issues and requiring lower speeds, especially at night.

3.2 No-Build Scenario

The no-build scenario for the project defines the case in which the project does not proceed and conditions remain as they are today. Specifically, Captains Bay Road remains a gravel road that requires grading two times per week. As the majority of the traffic on Captains Bay Road consists of semi-trucks and other industrial traffic, the roadway is expected to continue to have ruts and potholes, limiting the speed at which vehicles can travel. The poor road conditions not only affect the speed at which vehicles can travel, but also results in vehicles requiring more frequent maintenance due to excessive wear and tear (see Figure 3).

Figure 3: Pacific Stevedoring Truck with Chassis Failure due to Excessive Wear from Poor Conditions along Captains Bay Road, Fall 2021 (photo courtesy of Darin Nicholson)

3.3 Build Scenario

The proposed improvements to Captains Bay Road include paving two 13-foot-wide travel lanes, each with a 2-foot shoulder. A separated pedestrian pathway and street lighting would extend along the road from Airport Beach Road to OSI. The rock bluffs between Deadman's Curve and North Pacific Fuel would be laid back to provide a wider road prism and reduce the likelihood of rockfall affecting traffic or causing injuries.

The 2.6 miles of Captains Bay Road between Airport Beach Road and OSI was broken into three segments for the purpose of this CBA (see Figure 2):

- **Segment A:** Airport Beach Road to Westward Seafoods (1.3 miles);
- **Segment B:** Westward Seafoods to North Pacific Fuel (1 mile); and
- **Segment C:** North Pacific Fuel to OSI (0.3 mile).

In 2020, HDL prepared a preliminary design and associated cost estimate for each segment's roadway and utility improvements[10]. Cost estimates prepared by HDL were used for the purposes of this CBA without checking or validation. The projected cost of $40.5 million, in 2020 dollars (assuming a 3-year construction project), for all project improvements raised concerns about the feasibility of funding the entire project in a timely manner. The City requested project scope reductions be considered as a part of the CBA. Discussions were held with City and HDR staff regarding potential scope reductions and associated cost impacts. The following modifications were identified through this process:

1. Eliminating the extension of sanitary sewer service in Segments B and C;
2. Eliminating the extension of water service in Segment C;
3. Retaining the existing road alignment and the current design speed of 30 mph, and eliminating all laying back of the rock bluffs;
4. Retaining the separated pathway in Segment A, but transitioning to a wider shoulder with rumble strips to accommodate pedestrians in Segments B and C;
5. Retaining the existing road alignment in combination with selective bluff sloping between Deadman's Curve and Pyramid Creek Bridge in Segment B; and
6. Combinations of the various project modifications.

3.4 Project Costs and Schedule

3.4.1 Background

The Scenario 1 (Base Case) design reflects the preliminary cost estimates associated with HDL's 65% Captains Bay Road Paving and Utility Extension design drawings[11]. The Scenario 1 (Base Case) served as the benchmark, with alternative scenarios created by modifying or removing features as requested by the City to facilitate a range of CBA.

The six scenarios, summarized in Table 1, were derived in consultation with City staff and stakeholders, with each being evaluated within the context of the CBA.

[10] HDL Engineering Consultants, LLC, *Captains Bay Road Paving and Utility Extension – 65% Review Submittal*, November 2020.
[11] HDL Engineering Consultants, LLC, *Captains Bay Road Paving and Utility Extension – 65% Review Submittal*, November 2020.

Table 1: Captains Bay Road Paving and Utility Extension Project Scenarios, 2020 Dollars

Scenario	Scope: Assuming 3-year Construction Program	Segment A Costs	Segment B Costs	Segment C Costs	Total
1. Base Case HDL Full Design	Realignment, utilities extension, separated pedestrian facilities, roadway lighting, Dead Man's Curve rock cut, design speed 40 mph	$20.2 M	$15.7 M	$4.6 M	$40.5 M
2. HDL Baseline with Reduced Utilities	Same as Scenario 1, except no sewer to Segments B and C and no water to Segment C	$19.9 M	$14.4 M	$3.7 M	$38.0 M
3. Existing Alignment with Reduced Utilities	Maintains current alignment and 30 mph design speed; same utility reductions as in Scenario 2; no rock cuts; separated pathway and roadway lighting included	$11.0 M	$8.0 M	$2.2M	$21.2 M
4. Existing Alignment with Slope Work	Similar to Scenario 3, with the addition of selective bluff sloping between Dead Man's Curve and Pyramid Creek	$11.0 M	$11.0 M	$2.2 M	$24.2 M
5. Combination of Scenarios 2 and 3	Segment A, Scenario 3; Segments B and C, Scenario 2	$11.0 M	$14.4 M	$3.7 M	$29.1 M
6. Roadway Paving and Selective Slope Work	Scenario 4, with all utility improvements eliminated; pedestrian pathway and storm drains included	$6.9 M	$4.7 M	$1.4 M	$13.0 M

Note: M = million

Evaluating the costs on a segment basis allows for the combination of different project components for each segment. For example, Scenario 4 represents minimal improvements of Scenario 3 for Segment A and could be combined with the Scenario 2 design conditions for Segments B and C. This combination would retain the current alignment of Captains Bay Road in Segment A and use the proposed realignment in Segments B and C, which, in combination with cutting the bluff back, would address the tighter curves on the road.

Phasing the Captains Bay Road improvements by segments also improves the constructability options while controlling traffic impacts. Interviews with industries on Captains Bay Road identified a 5 to 6-week low-activity window between peak fishing and processing Seasons A (January to mid-April) and B (June to September). Street lighting, the pedestrian pathway, and other work outside of the travel lanes could be accomplished during Season B with minimal impacts to traffic.

For Segments B and C, replacing the separated pedestrian path with a wider shoulder and rumble strips was also evaluated. The wider shoulder eliminates the curb and gutter requirements, but widening the roadway requires a thicker structural section than the path to accommodate vehicular traffic. The cost savings projected due to this design modification is around $354,000 for Segment B and $71,000 for Segment C. The cost savings would be applicable to each of the project scenarios.

3.4.2 Cost-Benefit Analysis Approach

The previous section provides details on the development of the project costs. Scenario 1's cost estimate of $40.5 million reflects the full design with all of the desired project elements included. However, preliminary CBAs indicated that Scenario 1 would not produce a desirable CBR, and the City directed the development of Scenarios 2 through 6, eliminating some of the Scenario 1 project elements, in order to lower the project costs and still provide desirable benefits. Additional alternative combinations could be considered for any future analyses of the project.

Table 2 provides the possible annual expenditures for the project by scenario for CBA evaluation purposes. These are construction costs and exclude right-of-way acquisition and permitting costs.

Table 2: Possible Expenditure Profile, 2020 Dollars

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
2023	$20.2 M	$19.9 M	$11.0 M	$11.0 M	$11.0 M	$6.9 M
2024	$15.7 M	$14.4 M	$8.0 M	$11.1 M	$14.4 M	$4.7 M
2025	$4.6 M	$3.7 M	$2.2 M	$2.2 M	$3.7 M	$1.4 M
Total[a]	**$40.5 M**	**$38.0 M**	**$21.2 M**	**$24.2 M**	**$29.0 M**	**$13.0 M**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

4 General Assumptions

The CBA measures benefits against costs throughout a period of analysis, beginning at the start of construction and including 30 full years of operations.

The monetized benefits and costs are estimated in 2020 dollars, with future impacts discounted in compliance with USDOT guidance[12].

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Cost estimates for the reduced scope scenarios were based on the elemental estimates contained within HDL's 65% design[13]. For example, estimates for reduced-scope scenarios resulted from removing utility costs for certain segments from the full build out design.
- Input prices are expressed in 2020 dollars.
- The period of analysis begins in 2023 and ends in 2055. It includes project development and construction years (2023–2025) and 30 full years of operations (2026–2055).
- A constant 3 percent real discount rate for carbon dioxide (CO_2)-related benefits and 7 percent real discount rate for all other benefits are assumed throughout the period of analysis per USDOT guidance[14].
- Roadway and equipment maintenance and operation costs were provided by the City.
- Commercial vehicle maintenance and operational costs were provided by commercial operators.

[12] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0
[13] HDL Engineering Consultants, LLC, *Captains Bay Road Paving and Utility Extension – 65% Review Submittal*, November 2020.
[14] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0

5 Demand Projections

Accurate demand projections are important to ensure reasonable CBA results. The magnitude of the long-term transportation benefits accruing over the project study period are a function of vehicle demand over Captains Bay Road by vehicle type.

5.1 Methodology

Estimates of existing and future daily vehicle volume over Captains Bay Road were obtained from HDL's 2018 technical memorandum[15], provided by the City, and were subsequently confirmed with the City. Specifically, this data was used to estimate annual volumes through the study period (2023–2055). Additionally, the vehicle volumes are disaggregated by segment, based on interviews with businesses along Captains Bay Road; and by vehicle type, estimated from historical percentage shares of truck and passenger vehicles.

5.2 Assumptions

Table 3 provides all assumptions used in the estimation of demand inputs for the project.

Table 3: Assumptions Used in the Estimation of Demand

Variable	Units	Value	Source
AADT – 2017	vehicles/day	976	HDL, 2018, *Technical Memorandum 2 – Captains Bay Road Paving and Utility Extension Project – Preliminary Roadway Design*
AADT – 2044	vehicles/day	1,117	
Growth of AADT	percentage	0.5%	
Percentage of Trucks	percentage	78.0%	Traffic counts from DOT&PF, July 2016
Percentage of Autos	percentage	22.0%	
Share of Volume by Segment			
Segment A (Fraction of Total)	percentage	100.0%	Interviews with business owners on Captains Bay Road
Segment B (Fraction of Total)	percentage	95.5%	
Segment C (Fraction of Total)	percentage	61.9%	

5.3 Demand Projections

The resulting projections for the vehicle volumes by segment are presented in Table 4.

Table 4: Demand Projections

Category	Units	2026	2035	2045	2055
Segment A	vehicles/year	372,629	389,773	409,748	430,746
Segment B	vehicles/year	355,987	372,365	391,448	411,508
Segment C	vehicles/year	230,681	241,294	253,659	266,659

[15] HDL Engineering Consultants LLC. *Technical Memorandum 2 – Captains Bay Road Paving and Utility Extension Project – Preliminary Roadway Design*. Prepared for City of Unalaska. September 7, 2018.

6 Benefits Measurement, Data, and Assumptions

This section describes the measurement approach used for each benefit or impact category. It also provides an overview of the associated methodology, assumptions, and estimates.

6.1 Roadway Improvement Benefits

6.1.1 Reduced Road Maintenance Costs

The City currently incurs significant costs to maintain Captains Bay Road. Specifically, the road is graded two times per week, given its rough condition. Additionally, the City resurfaces the road once or twice per year to replace the gravel either removed from grading operations or shifted into the ditches. The City also performs dust control during dry conditions. All these costs can be eliminated once the road is paved, resulting in reduced road maintenance costs.

6.1.1.1 METHODOLOGY

Annual road maintenance costs between 2016 and 2019 for Captains Bay Road and Ballyhoo Road is shown in Table 5. These annual costs were provided by the City and inflated to 2020 dollars. Costs for Ballyhoo Road were selected as a proxy for the maintenance costs for a paved road under the build scenario, given that Ballyhoo Road experiences similar industrial traffic, is approximately the same length, and is paved.

Table 5: Historical Total Annual Maintenance Costs for Captain Bay Road and Ballyhoo Road

Year	Ballyhoo Road	Captains Bay Road
2016	$68,265	$394,269
2017	$99,642	$281,257
2018	$132,176	$423,566
2019	$55,778	$115,101

Road maintenance costs on a per mile basis under the no-build and build scenarios, multiplied by the road length under each segment, represent the total annual maintenance costs. The difference in total maintenance costs between the no-build and build scenarios determines the reduced road maintenance costs.

6.1.1.2 ASSUMPTIONS

The assumptions used in the estimation of reduced road maintenance costs, based on the annual road maintenance costs shown in Table 5, are summarized in Table 6. The annual costs were used to derive a roadway maintenance cost per mile estimate.

Table 6: Assumptions used in the Estimation of Reduced Road Maintenance Costs 2020 Dollars

Variable	Units	Value	Source
Length of Segment A	miles	1.3	HDR Phasing Analysis
Length of Segment B	miles	0.9	
Length of Segment C	miles	0.3	
Existing Roadway Maintenance Cost	2020$/mile	$119,038	Based on 2016 to 2021 fiscal year costs for Captains Bay Road; data from the City; inflated to 2020 dollars
Estimated Roadway Maintenance Cost After Paving	2020$/mile	$32,828	Based on 2016 to 2021 fiscal year costs for Ballyhoo Road; data from the City; inflated to 2020 dollars

6.1.2 Reduced Vehicle Maintenance Cost

Trucks travelling on Captains Bay Road incur significant vehicle maintenance costs. Dust from the gravel road requires frequent changes to truck air filters and leaf springs. This combined with the rough road conditions cause significant wear and tear to trucks' parts. Local businesses incur high maintenance costs to keep vehicles functioning. These costs can be mitigated substantially with paving.

6.1.2.1 METHODOLOGY

Vehicle maintenance cost savings as a result of paving Captains Bay Road were obtained based on discussions with local businesses, as show in Table 7 below. Total vehicle maintenance cost savings were distributed to each segment based on the respective percent share of traffic volumes.

Table 7: Vehicle Maintenance Cost Savings, 2020 Dollars

Business	Units	Savings	Assumptions
Pacific Stevedoring	$/year	$50,000	Pacific Stevedoring has 4 wing trucks and 3 semi-trucks, with approximately $7,000 savings per vehicle per year
Chadux	$/year	$10,000	Chadux estimated $10,000 in vehicle savings due to paving
Matson	$/year	$176,000	Matson has 22 trucks, with an annual savings of $8,000 per vehicle
APL	$/year	$120,000	APL has 15 trucks, with an annual savings of $8,000 per vehicle
AML	$/year	$160,000	Assuming 20 trucks, with an annual savings of $8,000 per vehicle
Total	**$/year**	**$516,000**	

6.1.2.2 ASSUMPTIONS

The assumptions used in the estimation of reduced vehicle maintenance costs are summarized in Table 8.

Table 8: Assumptions Used in the Estimation of Reduced Vehicle Maintenance Costs

Variable	Units	Value	Source
Annual Commercial Vehicle Maintenance Cost Savings	2020$/year	$516,000	Based on information obtained from interviews with the various businesses along Captains Bay Road (see Table 7); data includes the average savings and the number of trucks

6.1.3 Improved Roadway Safety

Accident costs and impacts on life, limb, and property are a significant component of road user costs. Road safety is a key economic factor in the planning of roads, as well as an important indicator of transportation efficiency. While outside of the economic context, highway safety is often the subject of public concern.

Frequent accidents are observed on Captains Bay Road due to rough road condition. Less tire traction with the reduced gravel on the road over time has caused semi-truck rollovers and vehicles driving off the road. The project proposes to change the road surface from gravel to asphalt, which will improve the road condition for drivers, reducing vehicle accidents on Captains Bay Road.

6.1.3.1 METHODOLOGY

Safety benefits were estimated by monetizing the avoided fatalities, injuries, and property damage only (PDO) incidents from the improved road conditions due to paving Captains Bay Road. Total fatalities, injuries, and PDOs occurring on Captains Bay Road from 2004 through 2021 were obtained from the City to calculate average accidents per year, as shown in Table 9. It was assumed accidents will grow at the same rate as the traffic on Captains Bay Road. Accidents were allocated to each segment proportionally based on the volume of traffic travelling on each segment of the road.

Table 9: Historical Fatalities, Injuries, and PDOs on Captains Bay Road

Year	Overall			Relevant		
	Fatalities	Injuries	PDO Accidents	Fatalities	Injuries	PDO Accidents
2004	-	-	2	-	-	1
2005	-	1	4	-	-	3
2006	-	-	7	-	-	4
2007	-	3	6	-	1	2
2008	-	4	4	-	-	4
2009	-	1	5	-	1	4
2010	-	2	2	-	1	1
2011	-	1	2	-	-	-
2012	-	-	3	-	-	1
2013	-	-	5	-	-	3
2014	-	-	5	-	-	-
2015	-	-	4	-	-	2
2016	-	-	2	-	-	-
2017	-	-	6	-	-	2
2018	-	-	3	-	-	-
2019	-	-	4	-	-	1
2020	-	-	1	-	-	-
2021	-	1	3	-	-	2
Total	**-**	**13**	**68**	**-**	**3**	**30**

Paving Captains Bay Road will improve the road condition for drivers and reduce accidents occurring on the road. As such, a crash modification factor (CMF) has been applied to calculate accidents under the build scenario. In particular, the analysis used the CMF for changing roadway surface of a rural roadway from gravel or dirt to asphalt (CMF ID: 2978), obtained from CMF Clearinghouse[16]. The reduction of accidents was estimated based on the CMF function:

$$CMF = e^{0.1123-0.0003V}$$

Where V reflects the average daily traffic volumes.

In order to estimate the reduced accident costs associated with paving the road, accidents under the no-build and build scenarios were monetized based on the statistical value of life and other accident costs per the USDOT guidance[17]. The difference in total accident costs between the no-build and build scenarios determined the improved safety and reduced accident costs.

6.1.3.2 ASSUMPTIONS

The assumptions used in the estimation of improved roadway safety are summarized in Table 10.

Table 10: Assumptions Used in the Estimation of Improved Roadway Safety

Variable	Units	Value	Source
Value of a Statistical Life	2020$/fatality	$11,739,869	USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, Table A-1, "Value of Reduced Fatalities and Injuries" (February 2021); inflated to 2020 dollars using the GDP Deflator
Cost of Injury	2020$/injury	$199,983	USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, Table A-1, "Value of Reduced Fatalities and Injuries" (February 2021); inflated to 2020 dollars using the GDP Deflator
Cost of PDO	2020$/PDO accident	$4,554	USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, Table A-2, "Property Damage Only (PDO) Crashes" (February 2021); inflated to 2020 dollars using the GDP Deflator
Accident Rate Adjustment	factor	10	Assumed measurement error based on City's estimate that 9 of 10 accidents are unreported based on stakeholder interviews
Segment A Accidents			
Fatality	fatalities/year	0.00	Based on data obtained from the City and adjusted for the accident types that could be impacted by the project, the accident rate adjustments, and the percentage volumes on Segment A
Injury	injuries/year	0.69	
PDO	PDOs/year	6.85	
Segment B Accidents			
Fatality	fatalities/year	0.00	Based on data obtained from the City and adjusted for the accident types that could be impacted by the project, the accident rate adjustments, and the percentage volumes on Segment B
Injury	injuries/year	0.65	
PDO	PDOs/year	6.55	
Segment C Accidents			
Fatality	fatalities/year	0.00	Based on data obtained from the City and adjusted for the accident types that could be impacted by the project, the accident rate adjustments, and the percentage volumes on Segment C
Injury	injuries/year	0.42	
PDO	PDOs/year	4.24	

Note: GDP = Gross Domestic Product

[16] http://www.cmfclearinghouse.org/
[17] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0

6.1.4 Travel Time Savings

The current speed limit for the unpaved Captains Bay Road is 30 mph. However, given the rough road conditions, drivers are unable to drive at the designed speed limit, and sometimes driving speed drops to as low as 10 mph prior to grading. Paving Captains Bay Road will improve road conditions and allow drivers to travel at the speed limit.

6.1.4.1 METHODOLOGY

Total vehicle miles travelled under each segment were divided by the respective driving speed under no-build and build scenarios to estimate total vehicle travel time. Vehicle travel time was then multiplied by the average vehicle occupancy rate to estimate person-hours of travel time, which was monetized based on the value of time assumptions summarized in Table 11 in the following section. The difference in total travel time savings between the no-build and build scenarios determines the total travel time savings.

6.1.4.2 ASSUMPTIONS

The assumptions used in the estimation of travel time savings are summarized in Table 11.

Table 11: Assumptions used in the Estimation of Travel Time Savings

Variable	Units	Value	Source
Speed – Unpaved	miles/hour	19	Assumed 3 of 7 days at 10 mph, 2 of 7 days at 20 mph, and 2 of 7 days at 30 mph
Speed – Paved (Scenarios 1 and 2)	miles/hour	40	HDL 2018, *Technical Memorandum 2 – Captains Bay Road Paving and Utility Extension Project —Preliminary Roadway Design*
Speed – Paved (Other Scenarios)	miles/hour	30	
Vehicle Occupancy – Trucks	persons/vehicle	1.00	USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, Section 4.1, "Value of Travel Time Savings" (February 2021)
Vehicle Occupancy – Automobiles	persons/vehicle	1.67	USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, Table A-4, "Average Vehicle Occupancy Rates for Highway Passenger Vehicles" (February 2021)
Value of Travel Time Savings – Trucks	2020$/hour	$31.17	USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, Table A-3, "Value of Travel Time Savings" (February 2021); inflated to 2020 dollars using the GDP Deflator
Value of Travel Time Savings – Automobiles	2020$/hour	$18.12	USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, Table A-3, "Value of Travel Time Savings" (February 2021); inflated to 2020 dollars using the GDP Deflator

6.1.5 Reduced Emissions

Environmental costs are increasingly considered an important component in the evaluation of transportation projects. The primary environmental impact of vehicle use is exhaust emissions, which impose wide-ranging social costs on people, materials, and vegetation. The negative effects of pollution depend not only on the quantity of pollution produced, but also on the types of pollutants emitted as well as the local environmental conditions into which the pollution is being released.

The improved road conditions allow drivers to travel under a higher speed limit, which will reduce associated greenhouse gas (GHG) and critical air contaminant (CAC) emissions.

6.1.5.1 METHODOLOGY

Vehicle miles travelled under each segment were multiplied by the appropriate emission factors under the no-build and build scenarios to estimate total emissions released for nitrogen oxides (NO_X), particulate matter (PM), sulfur dioxide (SO_2), CO_2 and volatile organic compounds (VOC) per year. Each pollutant, measured in tons, was then multiplied by its monetary value (Table 12) to get the total emission costs. The change in total emission costs between no-build and build scenarios indicates the total reduced emission costs as a result of the project.

Table 12: Assumptions Used in the Estimation of Reduced Emissions – Emission Values

Social Cost of Emissions (2020$/metric ton)						
Year	CO_2	NO_X	PM	SO_2	VOC	Source/Comment
2021	$52.63	$16,092	$751,250	$41,798	$0	CO_2 values are based on the *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (August 2016) https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf. Values are inflated from 2007 dollars to 2020 dollars using the GDP Deflator. Per USDOT's *Benefit Cost Analysis Guidance for Discretionary Grant Programs* (February 2021), CO_2 emissions values will be discounted using a 3% discount rate, while all other benefit streams will be discounted by 7%. Other values are from the *Safer Affordable Fuel-Efficient Vehicles Rule for MY2021–MY2026 Passenger Cars and Light Trucks Preliminary Regulatory Impact Analysis* (March 2020), https://nhtsa.gov/sites/nhtsa.dot.gov/files/documents/final_safe_fria_web_version_200701.pdf. Values are inflated from 2016 dollars to 2020 dollars using the GDP Deflator. Values are kept constant after 2050.
2022	$53.64	$16,294	$764,610	$42,608	$0	
2023	$54.65	$16,598	$778,272	$43,518	$0	
2024	$55.66	$16,800	$792,138	$44,429	$0	
2025	$56.68	$17,003	$806,205	$45,441	$0	
2026	$57.69	$17,205	$817,237	$46,049	$0	
2027	$58.70	$17,509	$828,470	$46,757	$0	
2028	$59.71	$17,711	$839,805	$47,466	$0	
2029	$60.72	$17,913	$851,343	$48,174	$0	
2030	$61.74	$18,217	$862,982	$48,781	$0	
2031	$62.75	$18,217	$862,982	$48,781	$0	
2032	$63.76	$18,217	$862,982	$48,781	$0	
2033	$64.77	$18,217	$862,982	$48,781	$0	
2034	$66.80	$18,217	$862,982	$48,781	$0	
2035	$67.81	$18,217	$862,982	$48,781	$0	
2036	$68.82	$18,217	$862,982	$48,781	$0	
2037	$69.83	$18,217	$862,982	$48,781	$0	
2038	$70.84	$18,217	$862,982	$48,781	$0	
2039	$71.86	$18,217	$862,982	$48,781	$0	
2040	$72.87	$18,217	$862,982	$48,781	$0	
2041	$73.88	$18,217	$862,982	$48,781	$0	
2042	$75.90	$18,217	$862,982	$48,781	$0	
2043	$76.92	$18,217	$862,982	$48,781	$0	
2044	$77.93	$18,217	$862,982	$48,781	$0	
2045	$78.94	$18,217	$862,982	$48,781	$0	
2046	$79.95	$18,217	$862,982	$48,781	$0	
2047	$80.96	$18,217	$862,982	$48,781	$0	
2048	$81.98	$18,217	$862,982	$48,781	$0	
2049	$84.00	$18,217	$862,982	$48,781	$0	
2050+	$85.01	$18,217	$862,982	$48,781	$0	

6.1.5.2 ASSUMPTIONS

The assumptions used in the estimation the reduced emissions are summarized in Appendix A.

6.1.6 Residual Value of Assets

6.1.6.1 METHODOLOGY

The residual value of capital assets is calculated in line with USDOT guidance[18], based on an estimated useful life of 30 years for the new roadway structures.

6.1.6.2 ASSUMPTIONS

The assumptions used in the estimation of the residual value are summarized in Table 13.

Table 13: Assumptions Used in the Estimation of Residual Value of Assets

Variable	Units	Value	Source
Useful Life of Road	years	30	City of Unalaska

6.1.7 Roadway Improvement Benefits Not Monetized

The project provides additional benefits that have not been monetized for inclusion in the CBA. While not monetized, consideration of these benefits is appropriate when assessing the worthiness of investments in transportation projects. As stated in the USDOT guidance[19], “when an applicant is unable to either quantify or monetize such benefits, the project sponsor should discuss them qualitatively, taking care to describe how the project is expected to lead to those outcomes.” A summary of the project benefits that have not been monetized is provided below.

6.1.7.1 REDUCED WATER TURBIDITY

Currently, Captains Bay Road is unpaved, with a gravel surface. As shown in Figure 4, gravel and sediment runoff into adjacent water bodies is inevitable, which increases water turbidity and could impact aquatic habitat, including that of salmonids. Paving the road will reduce water turbidity from runoff and consequently improve aquatic habitat.

[18] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0
[19] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021, https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0

Figure 4: Turbidity in Captains Bay along Segment B Caused by Sediment in Runoff from Captains Bay Road

6.1.7.2 TRAVEL TIME SAVINGS FROM AVOIDED ROAD GRADING

Currently, grading occurs twice per week on Captains Bay Road to address potholes and smooth the road, during which time vehicles must follow behind graders at a much lower speed and consequently incur longer travel times. Paving the road will eliminate the grading work, except for snow removal activities, which will result in vehicle travel time savings. However, given the uncertainty around the specific time of day the grading occurs and corresponding traffic volumes would be impacted, the travel time savings from avoided road grading is captured as a qualitative benefit.

6.1.7.3 IMPROVED PEDESTRIAN SAFETY

Currently, there is no pedestrian pathway along Captains Bay Road and the edge of the road is often muddy or has deep snow, causing pedestrians and bicyclists to travel in the roadway instead (see Figure 5). An increased potential of pedestrian/bicyclist-vehicle collisions occur when pedestrians or bicyclists travel down the road to avoid snow and mud on the shoulders. The project will foster pedestrian and bicyclist safety by extending a separated pedestrian pathway and street lighting along the road from Airport Beach Road to OSI. One alternative under consideration includes a separated pedestrian pathway from Airport Beach Road through Segment A to Westward Seafoods, then transitioning to a wider paved shoulder with rumble strips to provide a pedestrian-friendly space in Segments B and C.

Figure 5: Bicyclists Traveling along Captains Bay Road

6.1.7.4 AVOIDED LANE CLOSURE AND INJURIES FROM ROCKFALL

Rockfalls have been observed once or twice per year along Captains Bay Road, which could cause a few hours of lane closure until the road is cleared. Rockfalls also pose significant safety concerns to vehicles, pedestrians, and bicyclists travelling on the road. Certain project scenarios would lay back the rock bluffs between Deadman's Curve and North Pacific Fuel to provide a wider road prism and reduce the likelihood of rockfall affecting traffic or causing injuries.

6.1.8 Benefit Estimates

Table 14 and Table 15 provide the monetized benefit estimates of the Roadway Improvement Benefits by scenario. The estimated present value of discounted benefits over the projected 30-year benefit period ranges from $18.8 to $21.8 million.

Table 14: Estimates of Roadway Improvement Benefits (Undiscounted), 2020 dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Road Maintenance Costs	$6.9 M	$6.9 M	$6.9 M	$6.9 M	$6.9 M	$6.9 M
Reduced Vehicle Maintenance Costs	$16.1 M	$16.1 M	$16.1 M	$16.1 M	$16.1 M	$16.1 M
Improved Safety	$7.6 M	$7.6 M	$7.6 M	$7.6 M	$7.6 M	$7.6 M
Travel Time Savings	$26.9 M	$26.9 M	$19.1 M	$19.1 M	$19.1 M	$19.1 M
Reduced GHG Emissions	$0.1 M	$0.1 M	$0.1 M	$0.1 M	$0.1 M	$0.1 M
Reduced CAC Emissions	$0.1 M	$0.1 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Residual Value of Assets	-	-	-	-	-	-
Total Benefits[a]	**$57.7 M**	**$57.7 M**	**$49.9 M**	**$49.9 M**	**$49.9 M**	**$49.9 M**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

Table 15: Estimates of Roadway Improvement Benefits (Discounted), 2020 dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Road Maintenance Costs	$2.6 M	$2.6 M	$2.6 M	$2.6 M	$2.6 M	$2.6 M
Reduced Vehicle Maintenance Costs	$6.1 M	$6.1 M	$6.1 M	$6.1 M	$6.1 M	$6.1 M
Improved Safety	$2.8 M	$2.8 M	$2.8 M	$2.8 M	$2.8 M	$2.8 M
Travel Time Savings	$10.1 M	$10.1 M	$7.2 M	$7.2 M	$7.2 M	$7.2 M
Reduced GHG Emissions	$0.1 M	$0.1 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Reduced CAC Emissions	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Residual Value of Assets	-	-	-	-	-	-
Total Benefits	**$21.8 M**	**$21.8 M**	**$18.8 M**	**$18.8 M**	**$18.8 M**	**$18.8 M**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

6.2 Utility Upgrade Benefits

In terms of utility improvements, the project primarily involves extension of a City water main along Segment B of Captains Bay Road from Westward Seafoods to North Pacific Fuel. The project would also extend City electricity in conduits that would be buried in the road; however, the major facilities along Captains Bay Road already generate their own power and are not interested in purchasing electricity from the City at this time.

6.2.1 Avoided Water Leakage

The buildings in the North Pacific Fuel area are currently connected to the City's water system through a World War II-era wood stave pipe that branches off the major transmission main along Pyramid Creek Road. This 80-year-old wood stave pipe leaks approximately 50 million gallons of water per year into the ground based on a 2018 analysis by water system operators of water meter readings. Extending a new water main along Captains Bay Road from Westward Seafoods to North Pacific Fuel would eliminate the need for the existing wood stave pipe and would eliminate the associated water leakage and costs.

6.2.1.1 METHODOLOGY

The annual water leakage multiplied by the price of water represents the cost of water leakage. Such cost can be fully eliminated once a new water pipeline is extended along Segment B of Captains Bay Road from Westward Seafoods to North Pacific Fuel. The value of water leaked in 2020 was approximately $122,000.

6.2.1.2 ASSUMPTIONS

The assumptions used in the estimation of avoided water leakage are summarized in Table 16.

Table 16: Assumptions used in the Estimation of Avoided Water Leakage

Variable	Units	Value	Source
Leakage per Day (2018)	gallons/day	130,000	HDR, 2018, *City of Unalaska Water System Master Plan*, prepared for the City
Annual Increase in Leakage	percentage	1.2%	
Price of Water	2020$/thousand gallons	$2.51	Communication with the City's Water Division (Jeremiah Kirchofer), January 5, 2022

6.2.2 Reduced Utility Maintenance Costs

The route of the wood stave water pipe to North Pacific Fuel and it tying into the large-diameter water transmission main along Pyramid Creek Road adds significant complexity to the operation and maintenance of the entire Unalaska water system.

6.2.2.1 METHODOLOGY

The approximate average number of hours per work day spent by water system operators dealing with the operation and maintenance issues related to the wood stave pipeline, times the average burdened hourly rate, times the number of work days per year results in the utility maintenance costs that could be avoided by extending a new water main along Segment B of Captains Bay Road from Westward Seafoods to North Pacific Fuel.

6.2.2.2 ASSUMPTIONS

The assumptions used in the estimation of avoided water leakage are summarized in Table 17.

Table 17: Assumptions used in the Estimation of Reduced Utility Maintenance Costs

Variable	Units	Value	Source
Savings per Year	2020$/year	$72,000	City of Unalaska

6.2.3 Other Qualitative Benefits

6.2.3.1 IMPROVED SYSTEM RELIABILITY

Certain local businesses (such as Westward Seafoods and OSI) along Captains Bay Road are currently self-sufficient, with their own electricity generation. The extended utility services along Captains Bay Road can act as a back-up if any business's private system goes out of service, at which time local businesses will be able to access the City's utility to avoid any service disruptions. As such, the extended utility ensures a robust and reliable system, with seamless utility services.

6.2.3.2 INCREASED WATER SUPPLY

The route of the wood stave water pipe to North Pacific Fuel, branching off the large-diameter water transmission main along Pyramid Creek Road, means the City must always keep the Pyramid 5-million-gallon water storage tank (WST) at least two-thirds full, or 3 million gallons, to comply with water disinfection regulations. This restriction limits the amount of water that can be supplied from the Pyramid water supply system. The project would replace the wood stave pipe and change how North Pacific Fuel is connected to the water system by extending a new water main along Segment B of Captains Bay Road from Westward Seafoods to North Pacific Fuel. Doing so would enable full functionality and increase the water supply capacity of the Pyramid water system. The additional water supply would allow the City to keep up with peak-season water demand and provides a buffer for water supply during emergencies or disaster events.

6.2.3.3 AVOIDED WATER TANK FAILURE

The Pyramid WST currently must always remain operational to provide water service to North Pacific Fuel. The Pyramid WST cannot be taken offline for maintenance without violating drinking water regulations. The tank is currently in critical need of cleaning, inspection, and potentially maintenance. Not doing inspection and maintenance will eventually lead to tank failure. In the absence of the project, the City has contemplated constructing a second Pyramid WST and booster pump station to allow for routine inspection and maintenance of the existing Pyramid WST. Extending a new water main along Segment B of Captains Bay Road from Westward Seafoods to North Pacific Fuel would eliminate the need for the second WST and booster pump station, which would otherwise cost the City more than $10 million dollars[20].

6.2.4 Benefit Estimates

Table 18 and Table 19 provide the monetized benefit estimates of the Utility Upgrade Benefits. The estimated present value of discounted benefits over the projected 30-year benefit period is $2.6 million under Scenarios 1 through 5; and as anticipated, no Utility Upgrade Benefits occur under Scenario 6.

Table 18: Estimates of Utility Upgrade Benefits (Undiscounted), 2020 Dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Utility Maintenance Costs	$2.3 M	$2.3 M	$2.3 M	$2.3 M	$2.3 M	-
Avoided Water Leakage	$4.8 M	$4.8 M	$4.8 M	$4.8 M	$4.8 M	-
Total Benefits	**$7.1 M**	**$7.1 M**	**$7.1 M**	**$7.1 M**	**$7.1 M**	**-**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

Table 19: Estimates of Utility Upgrade Benefits (Discounted), 2020 Dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Utility Maintenance Costs	$0.9 M	$0.9 M	$0.9 M	$0.9 M	$0.9 M	-
Avoided Water Leakage	$1.7 M	$1.7 M	$1.7 M	$1.7 M	$1.7 M	-
Total Benefits	**$2.6 M**	**$2.6 M**	**$2.6 M**	**$2.6 M**	**$2.6 M**	**-**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

[20] City of Unalaska, *Storage Tank 2 Preliminary Engineering Report*, June 2015. This report indicates $9,825,000 capital cost for the second water tank and the booster station in 2015 dollars, which was inflated to 2020 dollars for this analysis.

7 Summary of Findings and Cost-Benefit Analysis Outcomes

Table 20 through Table 22 summarize the total benefits and CBA outcomes of the project under the various scenarios. Annual costs and benefits are estimated over the lifecycle of the project, consisting of 3 years of project development and construction to 2025 and 30 years of operation starting in 2026.

Table 20: Benefit Estimates by Category (Undiscounted), 2020 Dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Road Maintenance Costs	$6.9 M	$6.9 M	$6.9 M	$6.9 M	$6.9 M	$6.9 M
Reduced Vehicle Maintenance Costs	$16.1 M	$16.1 M	$16.1 M	$16.1 M	$16.1 M	$16.1 M
Improved Safety	$7.6 M	$7.6 M	$7.6 M	$7.6 M	$7.6 M	$7.6 M
Travel Time Savings	$26.9 M	$26.9 M	$19.1 M	$19.1 M	$19.1 M	$19.1 M
Reduced GHG Emissions	$0.1 M	$0.1 M	$0.1 M	$0.1 M	$0.1 M	$0.1 M
Reduced CAC Emissions	$0.1 M	$0.1 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Residual Value of Assets	-	-	-	-	-	-
Reduced Utility Maintenance Costs	$2.3 M	$2.3 M	$2.3 M	$2.3 M	$2.3 M	-
Avoided Water Leakage	$4.8 M	$4.8 M	$4.8 M	$4.8 M	$4.8 M	-
Total Benefits	**$64.8 M**	**$64.8 M**	**$57.0 M**	**$57.0 M**	**$57.0 M**	**$49.9 M**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

Table 21: Benefit Estimates by Category (Discounted), 2020 Dollars

Benefit Category	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Reduced Road Maintenance Costs	$2.6 M	$2.6 M	$2.6 M	$2.6 M	$2.6 M	$2.6 M
Reduced Vehicle Maintenance Costs	$6.1 M	$6.1 M	$6.1 M	$6.1 M	$6.1 M	$6.1 M
Improved Safety	$2.8 M	$2.8 M	$2.8 M	$2.8 M	$2.8 M	$2.8 M
Travel Time Savings	$10.1 M	$10.1 M	$7.2 M	$7.2 M	$7.2 M	$7.2 M
Reduced GHG Emissions	$0.1 M	$0.1 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Reduced CAC Emissions	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M
Residual Value of Assets	-	-	-	-	-	-
Reduced Utility Maintenance Costs	$0.9 M	$0.9 M	$0.9 M	$0.9 M	$0.9 M	-
Avoided Water Leakage	$1.7 M	$1.7 M	$1.7 M	$1.7 M	$1.7 M	-
Total Benefits	**$24.4 M**	**$24.4 M**	**$21.4 M**	**$21.4 M**	**$21.4 M**	**$18.8 M**

[a] Due to rounding, some totals may not correspond with the sum of the separate figures.

Table 22: Overall Results of the Cost-Benefit Analysis (Discounted), 2020 Dollars

Evaluation Metrics	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Total Benefits	$24.4 M	$24.4 M	$21.4 M	$21.4 M	$21.4 M	$18.8 M
Total Costs	$38.9 M	$36.6 M	$20.4 M	$23.2 M	$27.6 M	$12.5 M
Net Present Value	-$14.5 M	-$12.2 M	$1.0 M	-$1.8 M	-$6.2 M	$6.3 M
Return on Investment	-37%	-33%	5%	-8%	-22%	50%
Benefit-Cost Ratio	0.6	0.7	1.1	0.9	0.8	1.5
Payback Period (years)	N/A	N/A	28.8	N/A	N/A	15.1
Internal Rate of Return	3.1%	3.6%	7.5%	6.3%	4.7%	11.4%

Considering all the monetized benefits and costs, the estimated internal rate of return of the project ranges from 3.1 percent for Scenario 1 to 11.4 percent for Scenario 6 (Table 22).

The project is expected to have an NPV that ranges from -$14.5 million for Scenario 1 to $6.3 million for Scenario 6, as well as a BCR that ranges from 0.6 for Scenario 1 to 1.5 for Scenario 6 (Table 22).

Overall, the CBA analysis indicates that the monetized benefits for Scenario 1 (Base Case) are not sufficient to offset the project costs. However, by reducing the scope of the project to exclude some components such as the roadway realignment and utility upgrades (e.g., Scenario 6), the CBA outcomes are quite favorable; the project's monetized benefits do outweigh the project's costs. Figure 6 through Figure 11 show the CBA results for Scenarios 1 through 6.

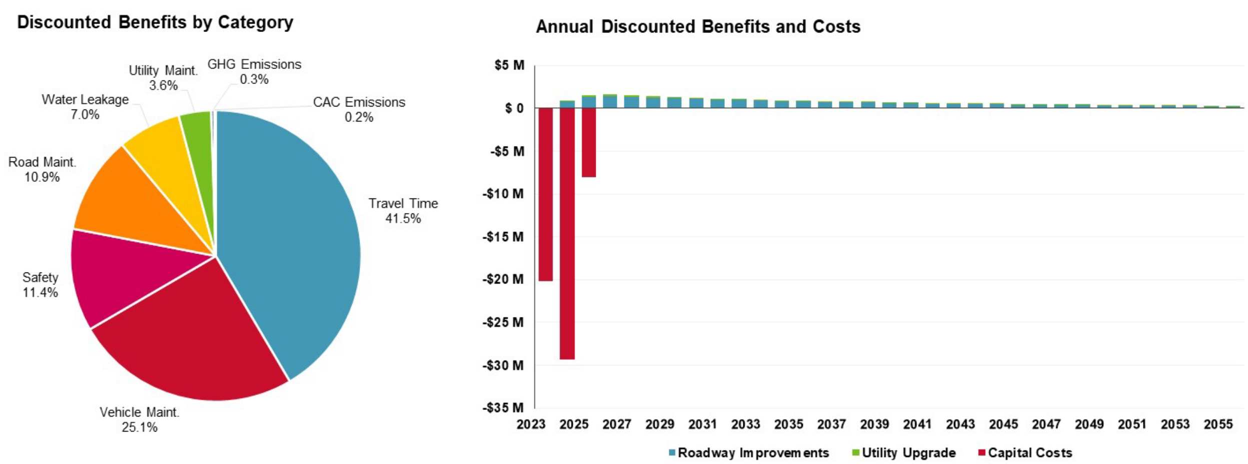


Figure 6: CBA Results – Scenario 1

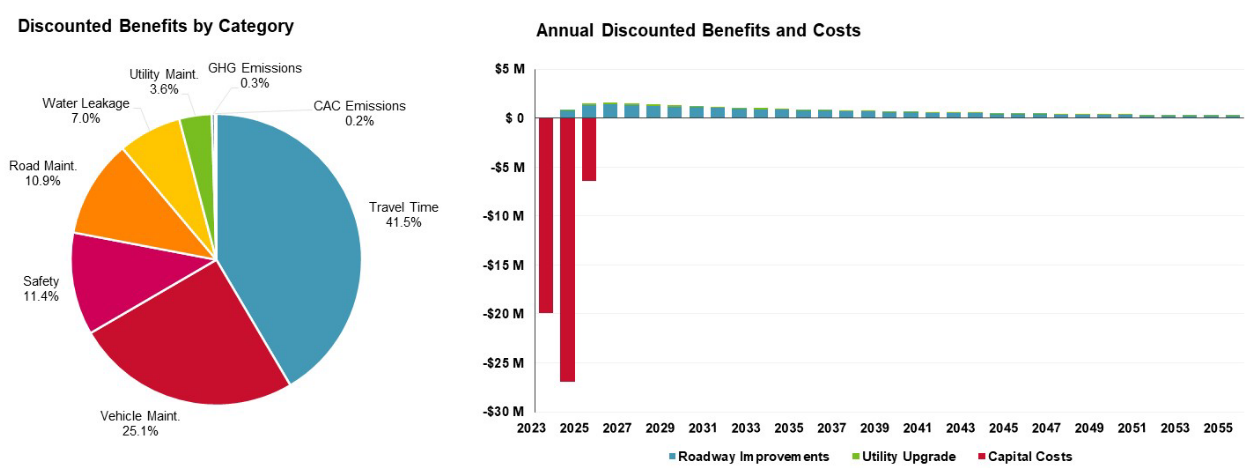


Figure 7: CBA Results – Scenario 2

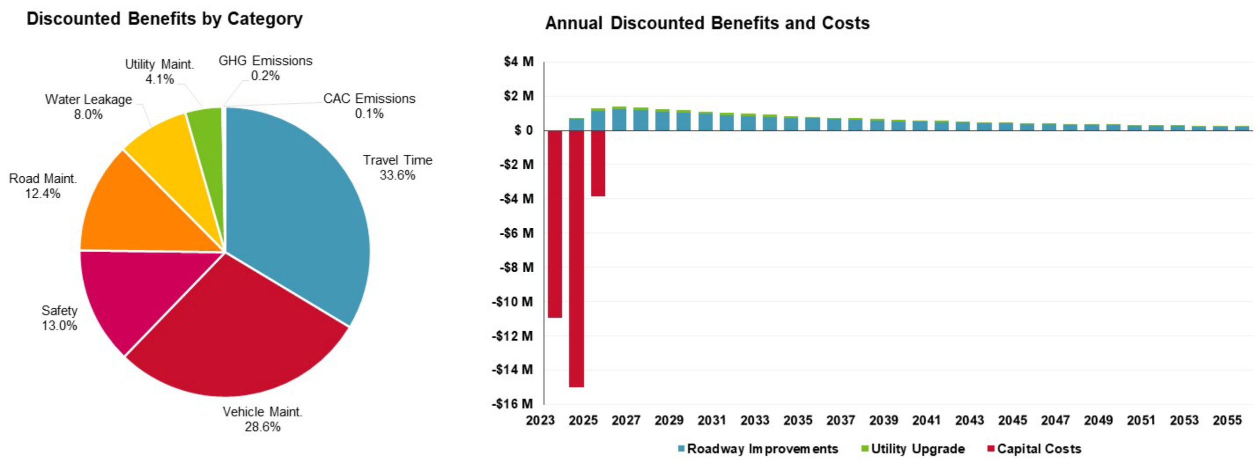


Figure 8: CBA Results – Scenario 3

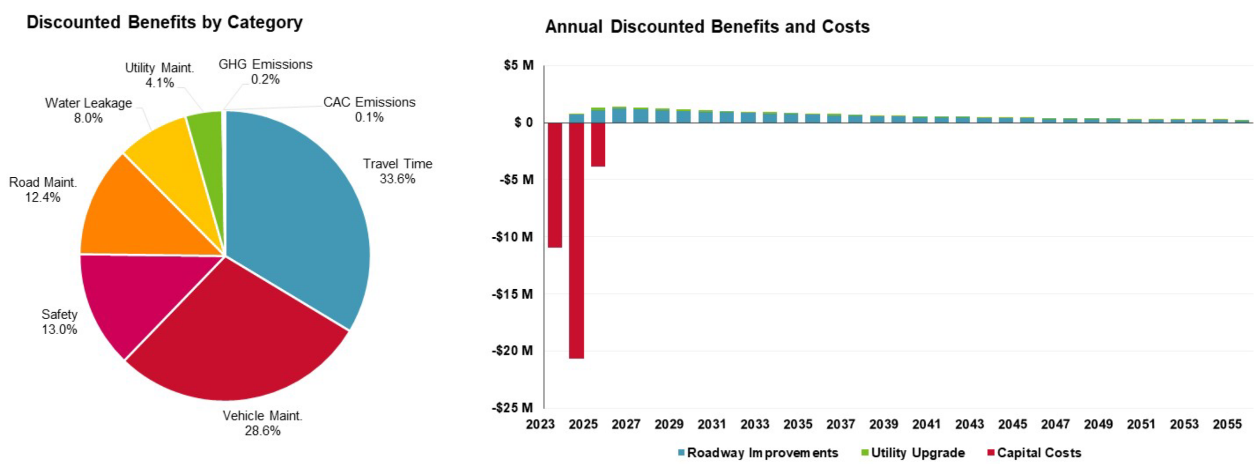
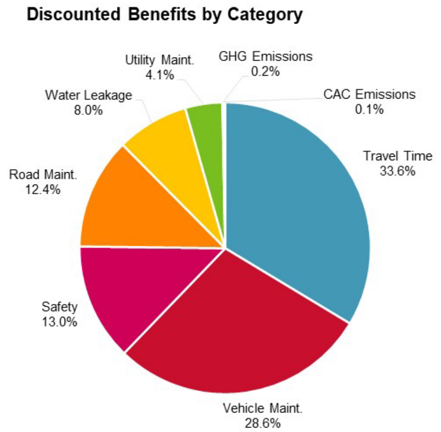


Figure 9: CBA Results – Scenario 4



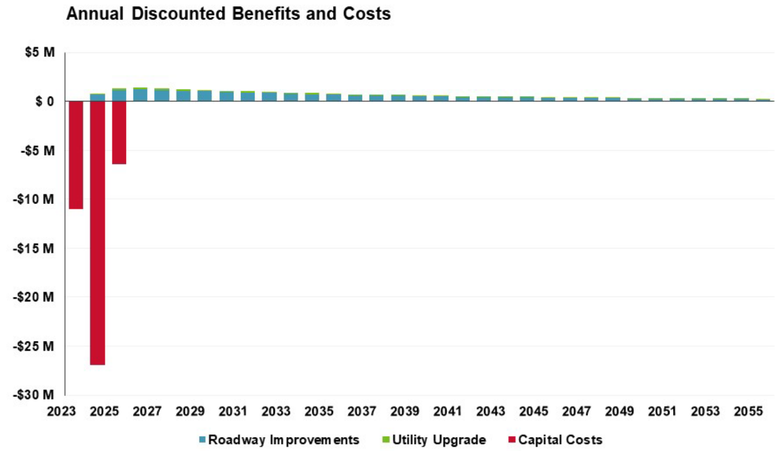
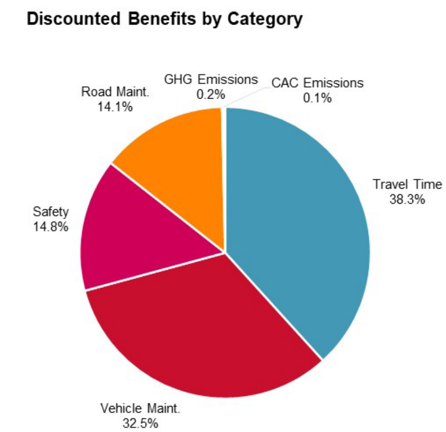


Figure 10: CBA Results – Scenario 5



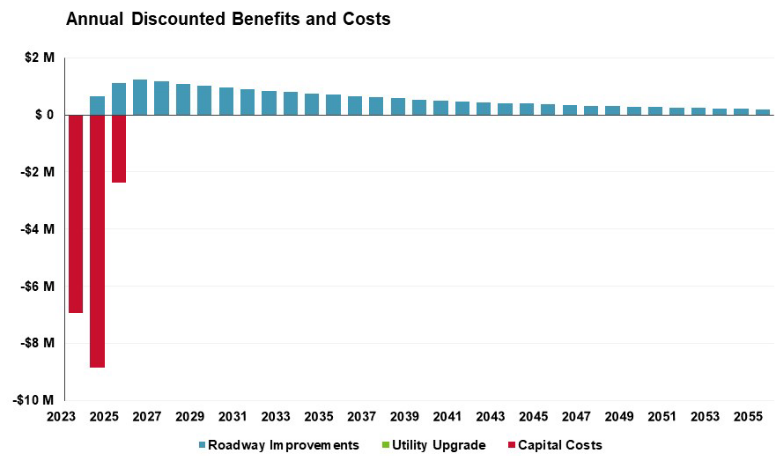


Figure 11: CBA Results – Scenario 6

8 Cost-Benefit Analysis Sensitivity

The CBA presented in the previous sections relies on many assumptions and long-term projections, all of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the CBA outcomes: the “critical variables.”

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables—how much the final results would vary with reasonable departures from the “preferred” or most likely value for the variable; and
- Assess the robustness of the CBA and evaluate them, particularly whether the conclusions reached under the “preferred” set of input values are significantly altered by reasonable departures from those values.

The sensitivity analysis considered assessing the impacts that variables such as capital costs, vehicle traffic, accident rates, and others have on the results for each scenario. Table 23 highlights the changes applied to each of those variables for the sensitivity analysis.

Table 23: Definition of Sensitivities Assessed

Parameter	Changes in the Parameter
Change in Capital Cost	Increase capital costs by 15%
	Decrease capital costs by 15%
Change in Vehicle Volume	Increase vehicle volume by 25%
	Decrease vehicle volume by 25%
Change in Accident Rates	Increase accident rates by 50%
	Decrease accident rates by 50%
Discount Rate	Consider a 3% discount rate for benefits and costs
Study Period	Assume a shorter study period with 20 years of operations

Figure 12 highlights the impacts a change to the capital cost, vehicle volume, and accident rates has on the BCR by scenario. Based on the chart, it is evident that changing the capital costs and vehicle volume is expected to have a notable impact on the BCR, while changes to the accident rate is expected to result in a relatively smaller impact.

For Scenarios 1, 2, and 5, despite reducing the capital cost by 15 percent or increasing the vehicle traffic by 25 percent, the BCR would remain below the BCR threshold of 1. This implies that for those scenarios, the benefits would not exceed the costs. Additionally, it indicates that capital costs would have to decrease in the future, additional vehicle traffic would be needed, or a combination of the two would be necessary to push the BCR beyond the threshold.

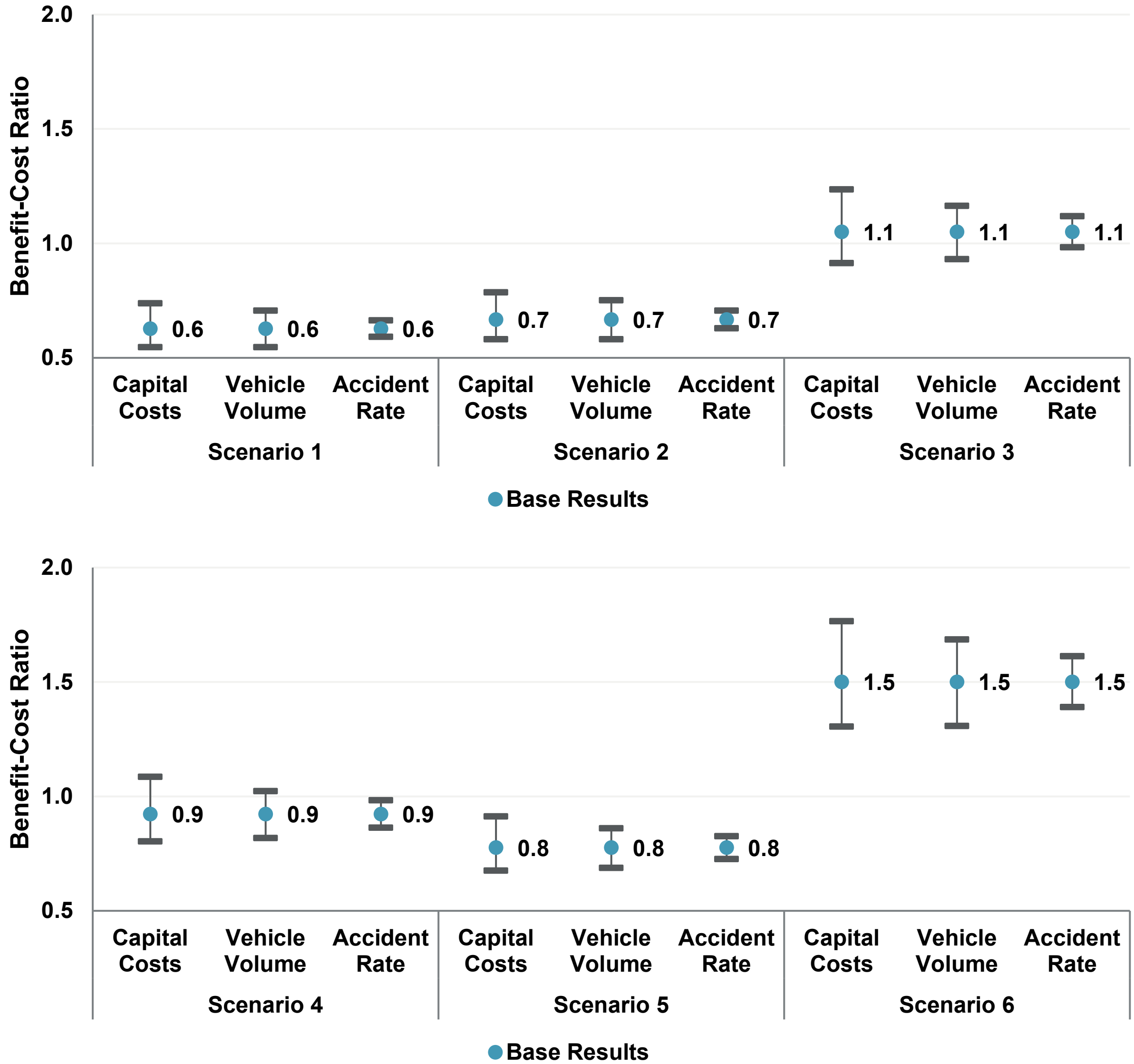


Figure 12: Sensitivity Analysis Results

For Scenario 3, while the base results indicate a BCR greater than 1, Figure 12 indicates a capital cost increase of 15 percent or a vehicle volume decrease of 25 percent would result in the BCR just below 1. Therefore, potential capital cost increase or a decline in vehicle volumes could result in the cost of the project exceeding its monetized socioeconomic benefits. Meanwhile, for Scenario 4, if capital costs declined by 15 percent or vehicle volumes increased by 25 percent, the BCR could exceed the threshold of 1.

For Scenario 6, Figure 12 indicates the BCR for the scenario is robust and despite the impacts, the BCR remains above 1.

Table 24 highlights the results of the sensitivity analysis as a result of changing the discount rate and study period. As expected, by applying a lower discount rate of 3 percent to all impacts and not just CO_2-related impacts, all future impacts are expected to increase. It is also expected that the total benefits are expected at a larger magnitude relative to the total costs, therefore increasing the BCR in all scenarios. Meanwhile, reducing the years of benefits in the study period from 30 to 20 years is expected to result in a slight decline in the BCR due to a reduction of years in which benefits are monetized.

Table 24: Sensitivity Analysis Results

Sensitivity	Scenario	Original BCR	New BCR
Discount Rate	Scenario 1	0.6	1.6
	Scenario 2	0.7	1.7
	Scenario 3	1.1	2.7
	Scenario 4	0.9	2.4
	Scenario 5	0.8	2.0
	Scenario 6	1.5	3.8
Study Period	Scenario 1	0.6	0.6
	Scenario 2	0.7	0.7
	Scenario 3	1.1	1.0
	Scenario 4	0.9	0.9
	Scenario 5	0.8	0.7
	Scenario 6	1.5	1.4

9 Project Funding

9.1 Funding Sources – Identification and Evaluation

This section provides a summary overview of some of the potential external funding sources that could be used to support funding of the Captains Bay Road Paving and Utility Extension Project.

9.1.1 Federal Funding Sources (Transportation)

Federal funding sources discussed in this section include various grants awarded to projects on a competitive basis in periodic (typically annual) funding opportunities. Additionally, projects may be eligible for federal loans at reduced interest rates and fees compared to similar commercial loans.

9.1.1.1 REBUILDING AMERICAN INFRASTRUCTURE WITH SUSTAINABILITY AND EQUITY GRANTS PROGRAM[21]

Overview and Key Features

The Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grant program is a successor of the Transportation Investment Generating Economic Recovery and Better Utilizing Investments to Leverage Development grants programs, which together have been providing funding opportunities since 2009 for construction or repair of transportation infrastructure projects of significant importance in the local or regional economies.

The Infrastructure Investment and Jobs Act (IIJA) of 2021 expanded this program by adding a new component to fund large projects (i.e., with assessed costs of more than $100 million) in need of federal funding assistance. The modified program is now codified in federal statute under one program, the National Infrastructure Investments (23 U.S. Code 6701 and 6702 for large and smaller projects, respectively). The existing RAISE grants program is expected to continue as the Local and Regional Project Assistance.

For the next 5 fiscal years (FY 2022 to FY 2026), the IIJA authorizes this program at $1.5 billion per year, subject to future appropriations, and provides advance appropriations of $1.5 billion per year, resulting in potentially $3 billion available annually for the program in the next 5 years.

The program also requires a 50-50 split between urban and rural projects and limits the share of funds going to any one state (currently set by the IIJA at 15 percent).

Based on the Notice of Funding Opportunity (NOFO) for FY 2021, the following are notable features and requirements of the RAISE program:

- Eligible applicants for RAISE grants include state and local governments as well as government agencies such as transit agencies, port authorities, and metropolitan

[21] The full Notice of Funding Opportunity (NOFO) for the RAISE Grants Program will be issued on or before January 30, 2022. Applications must be submitted by 5:00 PM Eastern on April 14, 2022.

planning organizations. In general, it is expected that the eligible applicant submitting the application will administer and deliver the project.
- The federal share of project costs for which an expenditure is made under the RAISE grant program may not exceed 80 percent for a project located in an urban area. The Secretary may increase the federal share of costs above 80 percent for projects located in rural areas. Non-federal sources include state funds originating from programs funded by state revenue, local funds originating from state or local revenue-funded programs, or private funds.
- The application for funding must include prescribed forms, as well as a project narrative document and a CBA, with the model used to conduct this analysis and a report documenting this analysis and results, including the present value of the project's benefits and costs, and its BCR.
- The primary selection criteria include improvement in safety, environmental sustainability, quality of life, economic competitiveness (i.e., improvement in movement of goods and people that reduces costs of doing business and improves local freight connectivity), and state of good repair.
- Secondary selection criteria include partnership (i.e., extent of collaboration and commitment of parties involved in the project) and innovation (i.e., in project construction, delivery, or financing).

The FY 2021 competition awarded funding to 63 construction projects, including 31 rural and 32 urban projects, with funding ranging from $1.6 to $24 million. The cost of the submitted projects ranged from $1.9 to $110 million. The award as a share of total project costs typically ranged between approximately 25 and 60 percent of project costs; although in a few cases of small rural projects, the award share amounted to nearly 100 percent.

Evaluation and Comments

The Captains Bay Road Paving and Utility Extension Project may be a good candidate for the RAISE program based on the following:

- It is well aligned with the RAISE program's general scope and objectives: it is a rural project with local importance and with a value of less than $100 million.
- It is well aligned with primary evaluation criteria used in previous competition rounds, particularly safety and economic competitiveness.
- The RAISE program is well funded for the next 5 years, potentially increasing the number of awards and therefore the chance of obtaining an award for any individual submission.

In addition:

- Applications for RAISE program grants require a CBA. Although a project positive net present value, or BCR greater than 1, is not a requirement, HDR's experience is that this increases the chance of an award.

- The amount of an award rarely amounts to the stated target of maximum of 80 percent of project costs; most awards are in the range of 25 to 60 percent and less than $30 million. This implies the need for leveraging other sources of funding.
- Certain costs of the project may not be eligible for funding under the RAISE program. This includes costs not directly related to the future performance of the road such as utility installation and repairs.

9.1.1.2 INFRASTRUCTURE FOR REBUILDING AMERICA GRANTS

Overview and Key Features

The IIJA renames the Nationally Significant Freight and Highway Projects program as the Nationally Significant Multimodal Freight and Highway Projects program. The current funding of the program amounts to $8 billion over 5 years, and an additional $6 billion is authorized for future appropriations.

The Infrastructure for Rebuilding America (INFRA) program is generally intended to fund large projects (generally with a cost of at least $100 million) of national or regional economic importance. However, there is a set-aside for small projects with total costs of less than $100 million. The IIJA increased this set-aside from 10 to 15 percent.

Based on the NOFO for FY 2021, the following are notable features of the program:

- The eligible projects would be those located on the National Highway System (NHS), projects that add capacity on the Interstate System to improve mobility, or projects in a national scenic area.
- The requirements for large projects include generation of national or regional economic, mobility, or safety benefits; cost effectiveness; and contribution to INFRA program goals that include improving safety, reliability, and infrastructure condition as well as congestion reduction and environmental sustainability.
- The requirements for small projects are not stated explicitly. The NOFO only states that “For a small project to be selected, the Department must consider the cost-effectiveness of the proposed project and the effect of the proposed project on mobility in the State and region in which the project is carried out.”
- Merit criteria considered in project evaluation include: (1) support for national or regional economic vitality; (2) climate change and environmental justice impacts; (3) racial equity and barriers to opportunity; (4) leveraging of federal funding; (5) potential for innovation; and (6) performance and accountability.
- INFRA grants may be used for up to 60 percent of future eligible project costs. Other federal assistance may satisfy the non-federal share requirement for an INFRA grant, but total federal assistance for a project receiving an INFRA grant may not exceed 80 percent of future eligible project costs.

Evaluation and Comments

The Captains Bay Road Paving and Utility Extension Project may be less well suited for the INFRA program. Its eligibility based on project location (NHS, national scenic area) would have to be confirmed in future rounds of the program, particularly how they apply to small rural projects.

However, the project is well aligned with general INFRA program objectives, particularly as it relates to supporting local economic vitality and improving safety. As for the RAISE program, certain project costs (such as utility installation and repairs) may not be eligible for this funding.

9.1.1.3 RURAL SURFACE TRANSPORTATION PROGRAM (NEW)

Overview and Key Features

The IIJA authorized funding for the Rural Surface Transportation program, totaling $2 billion over the next 5 years. Funding for FY 2022 is set at $300 million.

This program will provide competitive grants to improve and expand the surface transportation infrastructure in rural areas. The funded projects will support increased regional connectivity, improve safety and reliability of people and freight movement, generate regional economic growth, and improve quality of life. Notable eligible projects include:

- A highway safety improvements project, including a project to improve a high-risk rural road;
- A project on a publicly owned highway or bridge that provides or increases access to an agricultural, commercial, energy, or intermodal facility that supports the economy of a rural area; and
- A project to develop, establish, or maintain an integrated mobility management system, a transportation demand management system, or on-demand mobility services.

Evaluation and Comments

The Captains Bay Road Paving and Utility Extension Project may be a good candidate for this program as it is well aligned with program goals and the type of projects intended for funding.

Projects selected must be cost effective, implying that a CBA of the project will be required for the grant application submission. The future NOFO for this program will help determine the detailed project requirements and cost eligibility.

9.1.1.4 PROMOTING RESILIENT OPERATIONS FOR TRANSFORMATIVE, EFFICIENT, AND COST-SAVING TRANSPORTATION (NEW)

Overview and Key Features

The Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) program will provide grants for resilience improvements through formula funding and competitive grants to projects that protect surface transportation assets and make them more resilient.

The formula funding portion of the program is an apportionment for each state to carry out projects authorized under the PROTECT program, similar to other formula funded programs. Under this program, eligible projects include those that use natural infrastructure or the construction or modification of storm surge, flood protection, or aquatic ecosystem restoration elements that are functionally connected to a transportation improvement. This may include projects such as installation or upgrades of culverts designed to withstand 100-year flood events, or installation or upgrades of tide gates to protect highways.

The competitive grant portion of the PROTECT program encompasses three programs for capital improvement projects outlined below.

1. **Resilience Improvement Grants:** These grants are intended for projects that improve the ability of an existing surface transportation asset to withstand weather events or possible natural disasters and impacts of changing environmental conditions. The IIJA authorized funding totaling $980 million over the next 5 fiscal years.
2. **Community Resilience and Evacuation Grants:** These program grants are intended for projects that strengthen and protect emergency evacuation routes in a community. The IIJA authorized funding totaling $140 million over the next 5 fiscal years.
3. **At-Risk Coastal Infrastructure Grants:** These program grants are intended for projects that strengthen the resiliency of existing highways to protect them from weather events, natural disasters, or changing environmental conditions. The IIJA authorized funding totaling $140 million over the next 5 fiscal years.

Evaluation and Comments

Given the scope and location of the Captains Bay Road Paving and Utility Extension Project, it can be expected to significantly improve the resiliency of the Captains Bay Road. Therefore, this project may be a good candidate for the Resilience Improvements program, both for the formula funding to be administered by the State of Alaska as well as the competitive grant program portion. In both instances, the objectives of the project may have to emphasize its aspects related to resiliency improvements in addition to promoting the local economic vitality.

The project is also well aligned with the At-Risk Coastal Infrastructure Grants. However, funding for this program as currently approved by the IIJA is relatively small at $25 to $30 million annually. The program could likely provide only small supplemental funding.

The future NOFO for the above programs will help determine the details of applicant eligibility, project cost eligibility, and other project requirements.

9.1.1.5 DENALI COMMISSION

The Denali Commission is an independent federal agency established in 1998 to provide critical utilities, infrastructure, and economic support throughout Alaska. With the creation of the Denali Commission, Congress acknowledged the need for increased inter-agency cooperation and focus on Alaska’s remote communities.

Denali Commission Transportation Program

The Denali Commission's Transportation Program was originally created in 2005 as part of the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users legislation and accompanying amendments to the Denali Commission Act of 1998. The program included two major components: rural roads and waterfront development.

The roads portion of the program targets basic road (including local board road) improvement projects that connect rural communities to one another and the state highway system as well as opportunities to enhance rural economic development. The waterfront portion of the program addresses port, harbor, barge landing, and other rural waterfront needs. The Denali Commission's Transportation Advisory Committee is the body that advises the Federal Co-Chair on transportation needs in rural Alaska and evaluates project applications.

The Denali Commission's Road Program has been unfunded for several years. However, it is receiving $15.0 million for DOT&PF's COVID Response Funds to fund its program for 2022. A NOFO will be issued once the final agreement is reached with DOT&PF and the funding becomes available for grants to communities, Tribes, and other eligible applicants.

The Denali Commission is designated to receive $75.0 million through the IIJA to fund rural transportation projects. The $75.0 million will be allocated over the 5-year life of the IIJA. The Denali Commission is currently developing requirements for distributing the funds through grants to eligible applicants. A NOFO will be issued once the program requirements are finalized.

Evaluation and Comments

Unique to Denali Commission Transportation Program is that even though it is federally funded, Denali Commission funds can potentially be used to provide local match to leverage other federal funds. Given the relatively small size of the Denali Commission's Transportation Program and the high demand for rural transportation projects throughout rural Alaska, these funds may be best used to fund the project match requirements of a different federal discretionary grant program or to fund a specific, lower-cost project carved out of the Captains Bay Road Paving and Utility Extension Project, such as addressing the rock fall issues between Deadman's Curve and Pyramid Creek.

9.1.1.6 TRANSPORTATION INFRASTRUCTURE FINANCE AND INNOVATION ACT LOANS

Overview and Key Features

The Transportation Infrastructure Finance and Innovation Act (TIFIA) of 1998 established a federal credit program for eligible transportation projects of national or regional significance under which the USDOT may provide three forms of credit assistance: secured (direct) loans, loan guarantees, and standby lines of credit. The program's fundamental goal is to leverage federal funds by attracting substantial private and other non-federal co-investment. The program awards credit assistance to eligible applicants, which include state Departments of Transportation, transit operators, special authorities, local governments, and private entities.

The TIFIA Rural Project Initiative is aimed at helping improve transportation infrastructure in America's rural communities.[22] Under this initiative, an eligible surface transportation project (which includes roads) in a qualified rural area, costing between $10 and $100 million, can obtain a loan offering significant savings over traditional TIFIA loans and other commercial financing products, including:

- Loans for up to 49 percent of the project's eligible costs (compared to 33 percent under traditional TIFIA);
- Fixed interest rates equal to one half of the U.S. Treasury rate of equivalent maturity of the loan at the time of closing (traditional TIFIA loans have interest rates equal to the U.S. Treasury rate at the time of closing); and
- If the cost of the eligible project is under $75 million, all borrower fees may be waived.

Evaluation and Comments

The Captains Bay Road Paving and Utility Extension Project well matches the profile of projects intended for this program. However, it is noted that this program represents a financing mechanism. The TIFIA loan will have to be repaid; therefore, long-term funding sources would still have to be identified.

9.1.2 State Funding Sources

In Alaska, the vast majority of transportation capital programs are federally funded. State programs are funded as capital appropriations from general funds. In FY 2022, state-funded programs total approximately $170 million out of the total capital program of more than $1.1 billion.[23] Capital appropriations for federal program match amount to $87 million. Other state-funded programs include overhaul of Alaska Marine Highway System vessels and state equipment fleet replacement.

The Statewide Transportation Improvement Program (STIP), with its Surface Transportation Program, is the largest state-administered capital program. However, its funding comes mostly from federal allocations.

9.1.2.1 ALASKA STATEWIDE TRANSPORTATION IMPROVEMENT PROGRAM

Overview and Key Features

Each state is required to develop a STIP covering a period of at least 4 years. The STIP is a staged, multi-year, statewide intermodal program of transportation projects proposed for federal funding under Title 23 U.S. Code or the Federal Transit Act. The Alaska STIP is a 4-year program for transportation system preservation and development.

Project selection is based on nomination, an open process in which the public is invited to participate. DOT&PF nominates projects on the NHS and the Alaska Highway System based on the need to upgrade sections that are below standards, accomplish initial hard surfacing or

[22] https://www.transportation.gov/buildamerica/financing/tifia/tifia-rural-project-initiative-rpi
[23] DOT&PF, House Finance Committee Capital Program & FY2022 Request Overview, May 5, 2021, http://www.akleg.gov/basis/get_documents.asp?session=32&docid=26270

pavement rehabilitation, and provide safety improvements or capacity increases. DOT&PF does not use a scoring/competition system for these funds.[24]

DOT&PF requests project nominations from the public for projects in the Community Transportation Program. A project qualifies under the Community Transportation Program if it is a local road or transit development, or uses technology to improve traffic flow or safety.

For FY 2022, the Alaska STIP/Surface Transportation Program approved funding amounting to $680 million (as of May 2021). The IIJA authorizes new federal-aid highway formula funding that will provide roughly $3.5 billion in highway funding for Alaska over 5 years to construct, rebuild, and maintain its roads and highways.[25]

Evaluation and Comments

Given its profile, the Captains Bay Road Paving and Utility Extension Project, is suitable for inclusion in the Community Transportation Program and recommendation for STIP. HDR understands that the project has been proposed to the State of Alaska as a part of STIP funding.[26]

9.1.3 Other Funding Sources

In addition to external funding sources, local funding such as Local Improvement District funding may be applicable.

Potential external funding sources are also available for the non-transportation elements of the project from sources such as the U.S. Department of Agriculture – Rural Development, U.S. Bureau of Reclamation, U.S. Department of Commerce, and Alaska Energy Authority.

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[24] DOT&PF, Statewide Transportation Improvement Program, https://dot.alaska.gov/stwdplng/cip/stip/projects/index.shtml
[25] Press Release, Alaska to Receive Big Benefits from Infrastructure Package – Infrastructure Investment and Jobs Act Passes Senate, August 10, 2021, https://www.murkowski.senate.gov/press/release/alaska-to-receive-big-benefits-from-infrastructure-package
[26] City of Unalaska, *Capital Projects Update*, December 9, 2021, https://www.ci.unalaska.ak.us/sites/default/files/fileattachments/Public%20Works/page/7841/capital_projects_update_12-09-21_compressed.pdf

Appendix A: Emission Factors

This appendix presents the emission factors used in the estimation of reduced emissions as a result of the roadway improvements. The appendix presents the annual emission factors for select pollutants by vehicle type and average speeds.

Truck Emission Factors

Table A-1 through Table A-4 provide emission factors for trucks for the years 2021 through 2055.

Table A-1: Emission Factors for Trucks (15 mph)

Emissions per Gallon of Fuel Burned – Trucks (grams/miles)						
Year	NO_X	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.615	0.077	0.015	0.001	356	Based on MOVES average annual emission factors for trucks in Unalaska; MOVES model run in November 2021
2022	0.592	0.072	0.014	0.001	353	
2023	0.568	0.066	0.013	0.001	349	
2024	0.544	0.061	0.011	0.001	346	
2025	0.520	0.055	0.010	0.001	342	
2026	0.496	0.050	0.009	0.001	338	
2027	0.473	0.044	0.008	0.001	335	
2028	0.449	0.039	0.006	0.001	331	
2029	0.425	0.034	0.005	0.001	328	
2030	0.401	0.028	0.004	0.001	324	
2031	0.398	0.028	0.003	0.001	322	
2032	0.395	0.027	0.003	0.001	320	
2033	0.392	0.026	0.003	0.001	319	
2034	0.388	0.025	0.003	0.001	317	
2035	0.385	0.025	0.003	0.001	315	
2036	0.382	0.024	0.003	0.001	313	
2037	0.379	0.023	0.003	0.001	311	
2038	0.376	0.023	0.002	0.001	309	
2039	0.372	0.022	0.002	0.001	307	
2040	0.369	0.021	0.002	0.001	305	
2041	0.369	0.021	0.002	0.001	305	
2042	0.369	0.021	0.002	0.001	304	
2043	0.369	0.021	0.002	0.001	304	
2044	0.369	0.021	0.002	0.001	304	
2045	0.369	0.021	0.002	0.001	304	
2046	0.369	0.021	0.002	0.001	303	
2047	0.368	0.021	0.002	0.001	303	
2048	0.368	0.021	0.002	0.001	303	
2049	0.368	0.021	0.002	0.001	302	
2050	0.368	0.021	0.002	0.001	302	
2051	0.368	0.021	0.002	0.001	302	
2052	0.368	0.021	0.002	0.001	302	
2053	0.368	0.021	0.002	0.001	302	
2054	0.368	0.021	0.002	0.001	302	
2055	0.368	0.021	0.002	0.001	302	

Note: CO_2 = carbon dioxide; MOVES = Motor Vehicle Emission Simulator; mph = mile per hour; NO_X = nitrogen oxide; PM = particulate matter; SO_2 = sulfur dioxide; VOC = volatile organic compounds

Table A-2: Emission Factors for Trucks (20 mph)

Emissions per Gallon of Fuel Burned – Trucks (grams/miles)						
Year	NOx	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.506	0.061	0.013	0.001	310	Based on MOVES average annual emission factors for trucks in Unalaska; MOVES model run in November 2021
2022	0.485	0.056	0.012	0.001	306	
2023	0.464	0.052	0.011	0.001	303	
2024	0.443	0.048	0.010	0.001	300	
2025	0.422	0.043	0.009	0.001	297	
2026	0.402	0.039	0.008	0.001	293	
2027	0.381	0.035	0.006	0.001	290	
2028	0.360	0.030	0.005	0.001	287	
2029	0.339	0.026	0.004	0.001	284	
2030	0.318	0.022	0.003	0.001	281	
2031	0.315	0.021	0.003	0.001	279	
2032	0.313	0.021	0.003	0.001	277	
2033	0.310	0.020	0.003	0.001	276	
2034	0.307	0.020	0.003	0.001	274	
2035	0.304	0.019	0.002	0.001	272	
2036	0.302	0.019	0.002	0.001	271	
2037	0.299	0.018	0.002	0.001	269	
2038	0.296	0.017	0.002	0.001	267	
2039	0.294	0.017	0.002	0.001	266	
2040	0.291	0.016	0.002	0.001	264	
2041	0.291	0.016	0.002	0.001	264	
2042	0.291	0.016	0.002	0.001	264	
2043	0.291	0.016	0.002	0.001	263	
2044	0.290	0.016	0.002	0.001	263	
2045	0.290	0.016	0.002	0.001	263	
2046	0.290	0.016	0.002	0.001	262	
2047	0.290	0.016	0.002	0.001	262	
2048	0.290	0.016	0.002	0.001	262	
2049	0.290	0.016	0.002	0.001	262	
2050	0.290	0.016	0.002	0.001	261	
2051	0.290	0.016	0.002	0.001	261	
2052	0.290	0.016	0.002	0.001	261	
2053	0.290	0.016	0.002	0.001	261	
2054	0.290	0.016	0.002	0.001	261	
2055	0.290	0.016	0.002	0.001	261	

Table A-3: Emission Factors for Trucks (30 mph)

Emissions per Gallon of Fuel Burned – Trucks (grams/miles)						
Year	NOx	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.391	0.043	0.011	0.001	266	Based on MOVES average annual emission factors for trucks in Unalaska; MOVES model run in November 2021
2022	0.372	0.040	0.010	0.001	263	
2023	0.354	0.037	0.009	0.001	260	
2024	0.335	0.034	0.008	0.001	257	
2025	0.316	0.030	0.008	0.001	254	
2026	0.298	0.027	0.007	0.001	251	
2027	0.279	0.024	0.006	0.001	248	
2028	0.261	0.021	0.005	0.001	245	
2029	0.242	0.018	0.004	0.001	242	
2030	0.224	0.015	0.003	0.001	239	
2031	0.221	0.015	0.003	0.001	238	
2032	0.219	0.014	0.002	0.001	236	
2033	0.217	0.014	0.002	0.001	235	
2034	0.214	0.013	0.002	0.001	233	
2035	0.212	0.013	0.002	0.001	232	
2036	0.210	0.013	0.002	0.001	230	
2037	0.207	0.012	0.002	0.001	229	
2038	0.205	0.012	0.002	0.001	227	
2039	0.203	0.012	0.002	0.001	226	
2040	0.200	0.011	0.002	0.001	224	
2041	0.200	0.011	0.002	0.001	224	
2042	0.200	0.011	0.002	0.001	224	
2043	0.200	0.011	0.002	0.001	224	
2044	0.200	0.011	0.002	0.001	224	
2045	0.200	0.011	0.002	0.001	223	
2046	0.200	0.011	0.002	0.001	223	
2047	0.200	0.011	0.002	0.001	223	
2048	0.200	0.011	0.002	0.001	223	
2049	0.200	0.011	0.002	0.001	223	
2050	0.200	0.011	0.002	0.001	222	
2051	0.200	0.011	0.002	0.001	222	
2052	0.200	0.011	0.002	0.001	222	
2053	0.200	0.011	0.002	0.001	222	
2054	0.199	0.011	0.002	0.001	222	
2055	0.199	0.011	0.002	0.001	222	

Table A-4: Emission Factors for Trucks (40 mph)

Emissions per Gallon of Fuel Burned - Trucks (grams/miles)						
Year	NO_X	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.391	0.043	0.011	0.001	266	Based on MOVES average annual emission factors for trucks in Unalaska; MOVES model run in November 2021
2022	0.372	0.040	0.010	0.001	263	
2023	0.354	0.037	0.009	0.001	260	
2024	0.335	0.034	0.008	0.001	257	
2025	0.316	0.030	0.008	0.001	254	
2026	0.298	0.027	0.007	0.001	251	
2027	0.279	0.024	0.006	0.001	248	
2028	0.261	0.021	0.005	0.001	245	
2029	0.242	0.018	0.004	0.001	242	
2030	0.224	0.015	0.003	0.001	239	
2031	0.221	0.015	0.003	0.001	238	
2032	0.219	0.014	0.002	0.001	236	
2033	0.217	0.014	0.002	0.001	235	
2034	0.214	0.013	0.002	0.001	233	
2035	0.212	0.013	0.002	0.001	232	
2036	0.210	0.013	0.002	0.001	230	
2037	0.207	0.012	0.002	0.001	229	
2038	0.205	0.012	0.002	0.001	227	
2039	0.203	0.012	0.002	0.001	226	
2040	0.200	0.011	0.002	0.001	224	
2041	0.200	0.011	0.002	0.001	224	
2042	0.200	0.011	0.002	0.001	224	
2043	0.200	0.011	0.002	0.001	224	
2044	0.200	0.011	0.002	0.001	224	
2045	0.200	0.011	0.002	0.001	223	
2046	0.200	0.011	0.002	0.001	223	
2047	0.200	0.011	0.002	0.001	223	
2048	0.200	0.011	0.002	0.001	223	
2049	0.200	0.011	0.002	0.001	223	
2050	0.200	0.011	0.002	0.001	222	
2051	0.200	0.011	0.002	0.001	222	
2052	0.200	0.011	0.002	0.001	222	
2053	0.200	0.011	0.002	0.001	222	
2054	0.199	0.011	0.002	0.001	222	
2055	0.199	0.011	0.002	0.001	222	

Passenger Vehicle Emission Factors

Table A-5 through Table A-8 provide emission factors for trucks for the years 2021 through 2055.

Table A-5: Emission Factors for Passenger Vehicles (15 mph)

Emissions per Gallon of Fuel Burned – Passenger Vehicles (grams/miles)						
Year	NO_X	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.056	0.021	0.001	0.000	125	Based on MOVES average annual emission factors for vehicles in Unalaska; MOVES model run in November 2021
2022	0.051	0.019	0.001	0.000	123	
2023	0.046	0.017	0.001	0.000	120	
2024	0.041	0.015	0.001	0.000	118	
2025	0.036	0.013	0.001	0.000	115	
2026	0.031	0.011	0.001	0.000	112	
2027	0.026	0.009	0.001	0.000	110	
2028	0.020	0.008	0.001	0.000	107	
2029	0.015	0.006	0.000	0.000	105	
2030	0.010	0.004	0.000	0.000	102	
2031	0.009	0.004	0.000	0.000	101	
2032	0.008	0.004	0.000	0.000	100	
2033	0.008	0.003	0.000	0.000	99	
2034	0.007	0.003	0.000	0.000	98	
2035	0.006	0.003	0.000	0.000	97	
2036	0.005	0.003	0.000	0.000	96	
2037	0.004	0.003	0.000	0.000	95	
2038	0.003	0.002	0.000	0.000	94	
2039	0.003	0.002	0.000	0.000	93	
2040	0.002	0.002	0.000	0.000	92	
2041	0.002	0.002	0.000	0.000	92	
2042	0.002	0.002	0.000	0.000	92	
2043	0.001	0.002	0.000	0.000	92	
2044	0.001	0.002	0.000	0.000	92	
2045	0.001	0.002	0.000	0.000	91	
2046	0.001	0.002	0.000	0.000	91	
2047	0.001	0.002	0.000	0.000	91	
2048	0.001	0.002	0.000	0.000	91	
2049	0.001	0.002	0.000	0.000	90	
2050	0.001	0.002	0.000	0.000	90	
2051	0.001	0.002	0.000	0.000	90	
2052	0.001	0.002	0.000	0.000	90	
2053	0.001	0.002	0.000	0.000	90	
2054	0.001	0.002	0.000	0.000	90	
2055	0.001	0.002	0.000	0.000	90	

Table A-6: Emission Factors for Passenger Vehicles (20 mph)

Emissions per Gallon of Fuel Burned – Passenger Vehicles (grams/miles)						
Year	NOx	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.055	0.019	0.001	0.000	108	Based on MOVES average annual emission factors for vehicles in Unalaska; MOVES model run in November 2021
2022	0.050	0.017	0.001	0.000	106	
2023	0.045	0.015	0.001	0.000	104	
2024	0.040	0.014	0.001	0.000	101	
2025	0.035	0.012	0.001	0.000	99	
2026	0.030	0.010	0.001	0.000	97	
2027	0.025	0.009	0.001	0.000	95	
2028	0.020	0.007	0.000	0.000	93	
2029	0.015	0.005	0.000	0.000	91	
2030	0.010	0.004	0.000	0.000	88	
2031	0.009	0.003	0.000	0.000	87	
2032	0.008	0.003	0.000	0.000	87	
2033	0.007	0.003	0.000	0.000	86	
2034	0.007	0.003	0.000	0.000	85	
2035	0.006	0.003	0.000	0.000	84	
2036	0.005	0.003	0.000	0.000	83	
2037	0.004	0.002	0.000	0.000	82	
2038	0.003	0.002	0.000	0.000	82	
2039	0.003	0.002	0.000	0.000	81	
2040	0.002	0.002	0.000	0.000	80	
2041	0.002	0.002	0.000	0.000	80	
2042	0.002	0.002	0.000	0.000	79	
2043	0.001	0.002	0.000	0.000	79	
2044	0.001	0.002	0.000	0.000	79	
2045	0.001	0.002	0.000	0.000	79	
2046	0.001	0.002	0.000	0.000	79	
2047	0.001	0.002	0.000	0.000	78	
2048	0.001	0.002	0.000	0.000	78	
2049	0.001	0.002	0.000	0.000	78	
2050	0.001	0.002	0.000	0.000	78	
2051	0.001	0.002	0.000	0.000	78	
2052	0.001	0.002	0.000	0.000	78	
2053	0.001	0.002	0.000	0.000	78	
2054	0.001	0.002	0.000	0.000	78	
2055	0.001	0.002	0.000	0.000	78	

Table A-7: Emission Factors for Passenger Vehicles (30 mph)

Emissions per Gallon of Fuel Burned – Passenger Vehicles (grams/miles)						
Year	NOx	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.048	0.015	0.001	0.000	86	Based on MOVES average annual emission factors for vehicles in Unalaska; MOVES model run in November 2021
2022	0.044	0.014	0.001	0.000	85	
2023	0.039	0.012	0.001	0.000	83	
2024	0.035	0.011	0.000	0.000	81	
2025	0.031	0.010	0.000	0.000	79	
2026	0.026	0.008	0.000	0.000	78	
2027	0.022	0.007	0.000	0.000	76	
2028	0.017	0.006	0.000	0.000	74	
2029	0.013	0.004	0.000	0.000	72	
2030	0.009	0.003	0.000	0.000	71	
2031	0.008	0.003	0.000	0.000	70	
2032	0.007	0.003	0.000	0.000	69	
2033	0.007	0.002	0.000	0.000	69	
2034	0.006	0.002	0.000	0.000	68	
2035	0.005	0.002	0.000	0.000	67	
2036	0.004	0.002	0.000	0.000	67	
2037	0.004	0.002	0.000	0.000	66	
2038	0.003	0.002	0.000	0.000	65	
2039	0.002	0.002	0.000	0.000	64	
2040	0.001	0.001	0.000	0.000	64	
2041	0.001	0.001	0.000	0.000	64	
2042	0.001	0.001	0.000	0.000	63	
2043	0.001	0.001	0.000	0.000	63	
2044	0.001	0.001	0.000	0.000	63	
2045	0.001	0.001	0.000	0.000	63	
2046	0.001	0.001	0.000	0.000	63	
2047	0.001	0.001	0.000	0.000	63	
2048	0.001	0.001	0.000	0.000	63	
2049	0.001	0.001	0.000	0.000	62	
2050	0.001	0.001	0.000	0.000	62	
2051	0.001	0.001	0.000	0.000	62	
2052	0.001	0.001	0.000	0.000	62	
2053	0.001	0.001	0.000	0.000	62	
2054	0.001	0.001	0.000	0.000	62	
2055	0.001	0.001	0.000	0.000	62	

Table A-8: Emission Factors for Passenger Vehicles (40 mph)

Emissions per Gallon of Fuel Burned – Passenger Vehicles (grams/miles)						
Year	NOx	VOC	PM	SO_2	CO_2	Source/Comment
2021	0.047	0.011	0.001	0.000	80	Based on MOVES average annual emission factors for vehicles in Unalaska; MOVES model run in November 2021
2022	0.043	0.010	0.001	0.000	78	
2023	0.039	0.009	0.000	0.000	76	
2024	0.034	0.008	0.000	0.000	75	
2025	0.030	0.007	0.000	0.000	73	
2026	0.026	0.006	0.000	0.000	72	
2027	0.022	0.005	0.000	0.000	70	
2028	0.017	0.004	0.000	0.000	68	
2029	0.013	0.003	0.000	0.000	67	
2030	0.009	0.002	0.000	0.000	65	
2031	0.008	0.002	0.000	0.000	65	
2032	0.007	0.002	0.000	0.000	64	
2033	0.007	0.002	0.000	0.000	63	
2034	0.006	0.002	0.000	0.000	63	
2035	0.005	0.002	0.000	0.000	62	
2036	0.004	0.002	0.000	0.000	61	
2037	0.004	0.001	0.000	0.000	61	
2038	0.003	0.001	0.000	0.000	60	
2039	0.002	0.001	0.000	0.000	60	
2040	0.001	0.001	0.000	0.000	59	
2041	0.001	0.001	0.000	0.000	59	
2042	0.001	0.001	0.000	0.000	59	
2043	0.001	0.001	0.000	0.000	58	
2044	0.001	0.001	0.000	0.000	58	
2045	0.001	0.001	0.000	0.000	58	
2046	0.001	0.001	0.000	0.000	58	
2047	0.001	0.001	0.000	0.000	58	
2048	0.001	0.001	0.000	0.000	58	
2049	0.001	0.001	0.000	0.000	58	
2050	0.001	0.001	0.000	0.000	57	
2051	0.001	0.001	0.000	0.000	57	
2052	0.001	0.001	0.000	0.000	57	
2053	0.001	0.001	0.000	0.000	57	
2054	0.001	0.001	0.000	0.000	57	
2055	0.001	0.001	0.000	0.000	57	