# 5. BENEFIT-COST ANALYSIS NARRATIVE

## 5.1 Executive Summary

This benefit-cost analysis (BCA) was conducted for the development of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project for submission to the U.S. Department of Transportation (U.S. DOT) to request $7,200,000 (in 2023 dollars) from the FY2025 Better Utilizing Investments to Leverage Development (BUILD) Grant program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in November 2024. The Project analysis period corresponds to 22 years and includes 3 years of implementation from 2026 to 2028, and 20 years of benefits after operations begin in 2028.

The ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project aims to build a new road inland from the Lake Michigan shoreline. Without mitigation, the existing road has been and will continue to be affected by coastal erosion, resulting in a complete loss of access, significantly impacting residents, visitors, and especially emergency services

The capital cost for this Project is expected to be $9M in undiscounted 2023 dollars. At a 3.1 percent discount rate, the discounted capital costs of the Project are $7.9M in 2023 dollars. The Project operations and maintenance (O&M) costs over the 20-year operating period are projected to be around $158,617 undiscounted or $10,887 discounted to 2023 dollars at 3.1 percent.

The Project benefits include savings in auto travel time, auto vehicle-operating costs, emission damage, traffic injuries, as well as pedestrian and cycling facility amenity benefits, avoided road costs to repair coastal erosion, life saved due to reduced response time of emergency medical services (EMS), and additional Project O&M costs. In discounted 2023 dollars at 3.1 percent per year discount rate, except in the case of carbon dioxide ($CO_2$) emissions, where a 2.0 percent per year discount rate is applied, the Project will generate $34.5M in benefits over the 20-year operating period from 2028 to 2048. This leads to an overall Project Net Present Value of around $26.6M and a Benefit-Cost Ratio (BCR) of 4.4. The overall project benefit matrix can be seen in **Table 5.1**. The overall Project impacts in **Table 5.2** shows the magnitude of the various metrics used in this analysis to quantify the Project benefits.

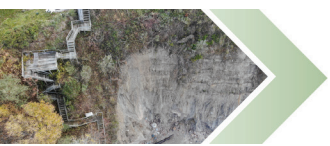
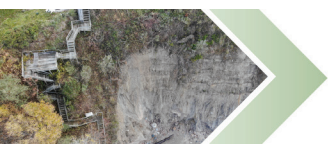


TABLE 5.1 | PROJECT IMPACTS AND BENEFITS SUMMARY

| Current Status/ Baseline & Problem to be Addressed | Change to Baseline/ Alternatives | Population Affected by Impact | Economic Benefit | Monetized Benefits, 2028–2048 (discounted 2023$) |
|---|---|---|---|---|
| The washout on Lakeshore Drive has cutoff north-south access resulting in additional miles traveled and longer travel times | The new road will provide a continuous route for through traffic | Residents and visitors in the project area | Reduced travel time due to reduced vehicle miles and improved travel speeds | $17,661,080 |
| Higher vehicle operating costs since passenger vehicles must make a detour | Vehicle operating cost savings, including reduced fuel costs, due to shorter trips | Residents and visitors in the project area | Reduced vehicle operating costs due to reduced vehicle miles traveled | $7,914,960 |
| Pedestrians and cyclists share the road with passenger vehicles | The addition of a shoulder will enhance safety for all road users | Residents and visitors in the project area | Avoided traffic injuries due to adding shoulders | $542,304 |
| Air pollutants and greenhouse gases generated by passenger vehicles | Shorter trips result in less fuel consumption and less time spent on the road, leading to lower emissions | General public | Lower emissions of air pollutants due to reduced vehicle miles traveled | $1,101,570 |
| No separate path for pedestrians and cyclists | The new non-motorized path will improve amenities for active transportation users | Residents and visitors in the project area | Improvement in the quality of journeys made by pedestrian and cycling facilities | $66,962 |
| Repeated repairs and closures due to the threat of erosion | Constructing a new road inland to avoid the risk of coastal erosion | Residents in the project area | Avoided costs to repair coastal erosion threats to Lakeshore Drive | $346,630 |



| Current Status/ Baseline & Problem to be Addressed | Change to Baseline/ Alternatives | Population Affected by Impact | Economic Benefit | Monetized Benefits, 2028–2048 (discounted 2023$) |
|---|---|---|---|---|
| Increased response times for emergency vehicles on the south side of the closure | Faster emergency medical service response times since the new road will allow for continuous through traffic | Residents in the project area | Improved response time of emergency medical services | $6,988,142 |

*Source: Cambridge Systematics Analysis.*

TABLE 5.2 | SELECT PROJECT IMPACTS, CUMULATIVE 2028–2048

| Metric | Cumulative Impact, 2028–2048 |
|---|---|
| Auto Vehicle-Miles Travel Saved | 23.1 Million Miles Saved |
| Auto Vehicle-Hours Saved | 900,000 Hours Saved |
| $CO_2$ Emissions Avoided | 4,860 metric tons of $CO_2$ Avoided |
| Traffic Injuries Avoided | 3 minor injuries, 2 possible injuries, and 127 property damage only crashes avoided |

*Source: Cambridge Systematics Analysis.*

## 5.2 Introduction

This section summarizes the approach used to conduct a Benefit-Cost Analysis (BCA) of the proposed ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive Project*** for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the BUILD 2025 program. The section is structured as follows:

- **Current Baseline** describes the existing conditions along Lakeshore Drive.
- **Project Overview** contains the background and description of the proposed project.
- **BCA Framework** describes the BCA methodology, its components and assumptions, and the study scenarios.
- **Project Benefits** includes a detailed explanation and calculation of the Project benefits.
- **Project Costs** documents the project capital and operation and maintenance costs and its calculation.
- **Summary of Results** contains the results of the benefit-cost evaluation measures estimated in this BCA.

- **Sensitivity Analysis** documents the results of sensitivity analyses of critical variables' impacts on the BC ratio.

## 5.3 Current Baseline

Lakeshore Drive has long served as the primary access route for many homes and businesses in Saugatuck Township. A bluff collapse in the mid-1980s severed through traffic, and for over 30 years, the road has been dead ended in two directions. The Lakeshore Drive Managed Retreat project aims to construct a new road inland from the Lake Michigan shoreline, where the existing road has been and will continue to be affected by coastal erosion. **Figure 5.1** shows the bluff collapse that led to its closure in 2019. Without mitigation, future closures could result in a complete loss of access, significantly impacting residents, visitors, and especially emergency services.

FIGURE 5.1 | LAKESHORE DRIVE CLOSURE IN 2019

*Source: Lakeshore Drive Feasibility Study. Managed Retreat in Saugatuck Township. September 30, 2022.*

## 5.4 Project Overview

The proposed new road would run between 126th Avenue and 130th Avenue (Wiley Road), within Saugatuck Township. As shown in **Figure 5.1**, this new alignment will feature a complete streets design, including a non-motorized shared-use path and paved shoulders, following AASHTO

guidelines to ensure safety standards are met. By moving the road inland, the project will not only improve its condition but also provide long-term sustainability by mitigating the risks associated with coastal erosion.

In addition to the main corridor, the project will involve improvements to the existing gravel road on 126th Avenue and the construction of three new connector roads extending west from the main corridor. These connectors will provide future access to Chestnut Lane (a public road), Old Owl Drive (a private road), and Tranquility Lane (another private road), as well as a frontage road serving several at-risk parcels.

## 5.5 Benefit-Cost Analysis Framework

The BCA compares the expected contributions (benefits) and costs of the proposed ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project. The BCA followed the U.S. DOT's Benefit-Cost Analysis Guidance for Discretionary Grant Programs, November 2024.[1] As per U.S. DOT's Guidance, a BCA should define the baseline or "No-Build" scenario and the alternative or "Build" scenario. The benefits, disbenefits and additional costs are calculated by comparing the "Build" scenario against the "No-Build" scenario. Since the BCA calculates the anticipated benefits expected to accrue from the "Build" scenario over a specified period and compares them to the anticipated costs of the project, both calculations are discounted into the present to identify their present value.

### Methodological Components

Following U.S. DOT guidance, the key methodological elements of this analysis include:

- Defining existing and future conditions under both the "No-Build" scenario as well as under the "Build" scenario.
- Assessing the project benefits with respect to selection criteria defined by the U.S. DOT over the 20 years of operations beyond the project completion (2028 in this case) when benefits accrue and using U.S. DOT recommended values to monetize benefits or disbenefits.
- Estimating the project capital costs, during project's construction, and the project's operation and maintenance costs over the 20 years of operations beyond the project completion when benefits accrue.
- Establishing 2023 as the base year and presenting all benefits and cost values in 2023 dollars. In instances where certain cost estimates or benefit valuations are expressed in dollar values in other (historical) years prior to 2023, the U.S. Bureau of Labor Statistics' Consumer Price Indexes for All Urban Consumers in those historical years are used to convert these values into 2023 dollars. This adjustment will remove the effects of inflation from nominal values (also called current or year of expenditure dollars) so that their real changes can be compared over time.

[1] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

## Data Sources

The data for this BCA was sourced from a variety of reports and datasets, including:

- **Allegan County Road Commission (ACRC)** provided information on project capital costs, including the timeline, as well as project operations and maintenance costs.
- **Lakeshore Drive Feasibility Study**[2] and **Lakeshore Drive Site Investigation Final Report**[3] served as sources for historical Annual Average Daily Traffic (AADT) and risk assessment data.
- **State of Michigan Traffic Crash Report** provided crash statistics within the project area for the 2014–2024 period.
- On-Road (**EMFAC2021**) emission model,[4] developed by the California Air Resources Board (CARB), used to derive emission rates for relevant pollutants.
- **Blue Star Highway Corridor Safety Plan**[5] provided bike and pedestrian counts to estimate bike and pedestrian volumes within the project area.
- **Saugatuck Township Fire District** supplied EMS response time data.
- **U.S. Census Bureau** used to estimate various demographic and population data including the number of residents within the project area, population aged 18 and over, and workers who drove alone to work.
- **U.S. DOT BCA Guidance**[6] applied values from the guidance and followed its methodology for monetizing benefits.
- **FEMA BCA Sustainment and Enhancement Guidance**[7] referenced for calculating EMS benefits.

## Analysis Period

The **Project Analysis Period** includes the design and engineering and construction of the Project during which capital expenditures are undertaken, plus 20 years of operations beyond the Project completion within which to evaluate the ongoing Project benefits and costs (see **Table 5.3**). This period includes the following:

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[2] Lakeshore Drive Feasibility Study. Managed Retreat in Saugatuck Township. Prepared by Prein&Newhof Inc. for the Alleged County Road Commission (ACRC). September 30, 2022. Retrieved from: https://drive.google.com/file/d/17IBTRyq6iAaBgDBIcaF4pgGP3Q6sIY89/view.

[3] Lakeshore Drive Site Investigation Final Report. Managed Retreat in Saugatuck Township. Prepared by Prein&Newhof Inc. for the Alleged County Road Commission (ACRC). December 29, 2023. Retrieved from: https://drive.google.com/file/d/17LnwwtVuzF79K18cCbZCgk9N9t3zc5v-/view.

[4] California Air Resource Board, On-Road Emission (EMFAC2021) Model.

[5] Saugatuck Township (2024). Blue Star Highway Corridor Safety Plan. Retrieved from: https://drive.google.com/file/d/1Azd8gLCVkNLywaZKj9xFKTbakK9f2ZKb/view.

[6] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

[7] Federal Emergency Management Agency (September 2024). BCA Sustainment and Enhancement Guidance. Retrieved from: https://www.fema.gov/sites/default/files/documents/fema-standard-economic-values-methodology-report-v13-2024.pdf.pdf.

- **Project Implementation Period—**This period includes the design and engineering and construction of the Project during which capital expenditures are undertaken. This period is assumed to begin in September 2026 and end in July 2028 at which point the project will be deemed complete.
- **Project Operating Period—**This period covers the 20-year operating period. The period starts in August 2028, the month immediately following the completion of the construction and when the project open to the public, and concludes in August 2048.

TABLE 5.3 | PROJECT ANALYSIS PERIOD

| Project Phase | Start Date/Year | End Date/Year |
|---|---|---|
| Final design | September 2026 | March 2027 |
| Right-of-way acquisition | September 2026 | June 2027 |
| Construction | July 2027 | July 2028 |
| Operational | August 2028 | August 2048 |

*Source: Allegan County Road Commission (ACRC).*

## "Build" and "No-Build" Scenarios

The project analysis evaluated the long-term benefits to users and society by assessing the balance of costs and benefits associated with constructing the new roadway and non-motorized path inland. This was done by comparing the "Build" scenario with the "No-Build" scenario.

The "No-Build" scenario consists of leaving the roadway configuration as it currently stand. The existing roadway is a two-lane road without shoulders or a non-motorized shared-used path. The main roadway components of the "No-Build" scenario are summarized in **Table 5.4.** The roadway segments are divided into two sections, as previously noted, due to a bluff collapse in the 1980s that cut off through traffic.

TABLE 5.4 | "NO-BUILD" SCENARIO—ROADWAY SEGMENTS

| Road Segment | Total Number of Lanes | Road Length (Miles) |
|---|---|---|
| South of Wiley Road to end | 2 lanes (one in each direction) | 1.02 |
| North of 126th Avenue to end | 2 lanes (one in each direction) | 0.88 |

*Source: Allegan County Road Commission (ACRC).*

The "Build" scenario will build a new two-lane road between 126th Avenue and 130th Avenue (Wiley Road), including a non-motorized shared-used path for pedestrians and cyclists and paved shoulders. The main roadway and non-motorized components of the "Build" scenario are summarized **Table 5.5** and **Table 5.6**, respectively.

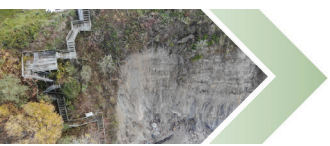


TABLE 5.5 | "BUILD" SCENARIO—ROADWAY SEGMENTS

| Road Segment | Total Number of Lanes | Road Length (Miles) |
|---|---|---|
| New Inland North-South Road, from 126th Avenue to Wiley Road / 130th Avenue | 2 lanes (one in each direction) | 2.04 |
| Chestnut Lane Connector (public road) | 2 lanes (one in each direction) | 0.12 |
| Old Owl Connector (private road) | 2 lanes (one in each direction) | 0.57 |
| Tranquility Lane Connector (private road) | 2 lanes (one in each direction) | 0.11 |
| 126th Avenue | 2 lanes (one in each direction) | 0.33 |

*Source: Allegan County Road Commission (ACRC).*

TABLE 5.6 | "BUILD" SCENARIO—NON-MOTORIZED SHARED-USE PATH

| Non-Motorized Shared-Use Path | Length (Miles) | Width (feet) |
|---|---|---|
| Path Parallel to the New Inland North-South Road, from 126th Avenue to Wiley Road / 130th Avenue | 2.04 | 10 |
| Path Parallel to 126th Avenue | 0.28 | 10 |
| Path Parallel to Wiley Road | 0.47 | 10 |

*Source: Allegan County Road Commission (ACRC).*

## 5.6 Traffic Projections and Vehicle Miles Traveled

The historical Average Annual Daily Traffic (AADT) data for Lakeshore Drive is shown in **Table 5.7**. Based on the available historical AADT, the compound annual growth rates (CAGRs) are estimated and used to forecast the AADT over the 20-year operating period following project completion. This analysis assumes that the historical AADT CAGRs are a good representation of the expected growth in traffic volume over the project operational period.

TABLE 5.7 | HISTORICAL AVERAGE ANNUAL DAILY TRAFFIC ON LAKESHORE DRIVE

| Location | AADT, 1997 | AADT, 2022 | AADT CAGR (1997–2022) |
|---|---|---|---|
| North of 126th Avenue | 224 | 887 | 5.7% |
| **Location** | **AADT, 2002** | **AADT, 2022** | **AADT CAGR (2002–2022)** |
| South of Wiley Rd (or 130th St.) | 384 | 932 | 4.5% |

*Source: Lakeshore Drive Site Investigation Final Report, Managed Retreat in Saugatuck Township. Prepared by Prein&Newhof Inc. for the Alleged County Road Commission (ACRC). December 29, 2023.*

To calculate the additional vehicle miles traveled (VMT) under the "No-Build" scenario and the savings in VMT under the "Build" scenario, the following conservative assumptions are made:

- Trips made by residents near Lakeshore Drive represent 50 percent of the AADT within the project area. This assumption is based on the share of Saugatuck workers 16 years and over who drive alone to get to work (i.e., 60.5 percent) provided by the U.S. Census Bureau, 2022 American Community Survey 5-Year Estimates.
- The average daily traffic is annualized using a factor of 260, assuming 52 weeks per year and 5 workdays in a week.

**Table 5.8** shows the additional VMT per resident within the project area under the "No-Build" Scenario and the estimated savings in VMT by resident within the project area under the "Build" scenario. Under the "No-Build" scenario, residents on the north side must travel an additional 3.13 miles to reach the south side, while south side residents must travel an extra 5.56 miles to reach the north side. In the "Build" scenario, the project is expected to reduce VMT by 50 percent. As a result, residents on the north side would save 1.57 miles while residents on the south side would save 2.78 miles.

TABLE 5.8 | ESTIMATED DAILY VEHICLE MILES TRAVELED BY RESIDENTS WITHIN THE PROJECT AREA UNDER THE "BUILD" AND "NO-BUILD" SCENARIOS

| Location | "No-Build" Scenario—Daily Additional VMT[1] | "Build" Scenario—Daily Saved VMT[2] |
|---|---|---|
| North of 126th Avenue | 3.13 | 1.57 |
| South of Wiley Rd (or 130th St.) | 5.56 | 2.78 |

1 *Source: Allegan County Road Commission (ACRC).*

2 *Source: Estimated by Cambridge Systematics.*

The annual additional vehicle miles traveled (VMT) under the "No-Build" is calculated as follows:

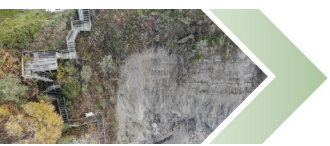
$$\text{Annual AVMT}_{\text{No-Build}} = \text{AADT Residents x AF x Daily AVMT}_{\text{No-Build}}$$

Where:

| | | |
|---|---|---|
| Annual AVMT $_{\text{No-Build}}$ | = | Annual Additional Vehicle Miles Traveled under the "No-Build" scenario |
| AADT | = | AADT Associated with Residents within the Project Area |
| AF | = | Annualization Factor |
| Daily AVMT $_{\text{No-Build}}$ | = | Daily Additional Vehicle Miles Traveled under the "No-Build" scenario |

Meanwhile, the annual VMT saved under the "Build" scenario is calculated as follows:

$$\text{Annual SVMT}_{\text{Build}} = \text{AADT Residents x AF x Daily SVMT}_{\text{Build}}$$



Where:

| | | |
|---|---|---|
| Annual AVMT $_{Build}$ | = | Annual Saved Vehicle Miles Traveled under the "Build" scenario |
| AADT | = | AADT Associated with Residents within the Project Area |
| AF | = | Annualization Factor |
| Daily AVMT $_{Build}$ | = | Daily Saved Vehicle Miles Traveled under the "Build" scenario |

The annual VMT for both the "No-Build" and "Build" scenarios are calculated, and the net annual changes are determined by subtracting the VMT of the "Build" scenario from the VMT of the "No-Build" scenario. The outcomes of these computations are summarized in **Table 5.9**.

TABLE 5.9 | VEHICLE MILES TRAVELED SAVED BY RESIDENTS WITHIN THE PROJECT AREA UNDER THE "BUILD" SCENARIO, 2028–2048

| Year | "No-Build" VMT = (a) | "Build" VMT = (b) | VMT Savings = (a)–(b) |
|---|---|---|---|
| 2028 | 575,464 | 287,732 | 287,732 |
| 2029 | 1,449,376 | 724,688 | 724,688 |
| 2030 | 1,521,053 | 760,527 | 760,527 |
| 2031 | 1,596,318 | 798,159 | 798,159 |
| 2032 | 1,675,352 | 837,676 | 837,676 |
| 2033 | 1,758,345 | 879,173 | 879,173 |
| 2034 | 1,845,500 | 922,750 | 922,750 |
| 2035 | 1,937,028 | 968,514 | 968,514 |
| 2036 | 2,033,149 | 1,016,574 | 1,016,574 |
| 2037 | 2,134,098 | 1,067,049 | 1,067,049 |
| 2038 | 2,240,121 | 1,120,060 | 1,120,060 |
| 2039 | 2,351,474 | 1,175,737 | 1,175,737 |
| 2040 | 2,468,431 | 1,234,216 | 1,234,216 |
| 2041 | 2,591,276 | 1,295,638 | 1,295,638 |
| 2042 | 2,720,309 | 1,360,154 | 1,360,154 |
| 2043 | 2,855,845 | 1,427,923 | 1,427,923 |
| 2044 | 2,998,218 | 1,499,109 | 1,499,109 |
| 2045 | 3,147,775 | 1,573,887 | 1,573,887 |
| 2046 | 3,304,884 | 1,652,442 | 1,652,442 |
| 2047 | 3,469,930 | 1,734,965 | 1,734,965 |
| 2048 | 1,518,050 | 759,025 | 759,025 |
| **Total** | **46,191,998** | **23,095,999** | **23,095,999** |

*Source: Cambridge Systematics Analysis.*

## 5.7 Project Benefits

The benefits of the project include the reduction of existing costs, or the prevention of future costs related to the “No-Build” scenario.

### Travel Time Savings

The washout on Lakeshore Drive has severed north-south access, resulting in significantly longer travel times for residents within the project area. The ***Protecting Lake Michigan’s Shoreline Communities: Reconnecting Lakeshore Drive*** project will reduce these travel time losses, delivering substantial benefits by saving in-vehicle travel time for residents within the project area. By eliminating detours and improving travel speeds, the project will significantly reduce the time drivers lose.

The VHT for the "No-Build" scenario is calculated using the equation below.

$$\text{Annual AVHT}_{\text{No-Build}} = \text{Annual AVMT} / \text{ATS}_{\text{No-Build}}$$

Where:

| | | |
|---|---|---|
| Annual AVHT $_{\text{No-Build}}$ | = | Annual Additional Vehicle Hours Traveled under the “No-Build” scenario |
| Annual AVMT | = | Annual Additional Vehicle Miles Traveled |
| ATS $_{\text{No-Build}}$ | = | Average Travel Speed (in mph) under the “No-Build” scenario |

Similarly, the VHT for the " Build" scenario is calculated using the equation below.

$$\text{Annual SVHT}_{\text{Build}} = \text{Annual SVMT} / \text{ATS}_{\text{Build}}$$

Where:

| | | |
|---|---|---|
| Annual SVHT $_{\text{Build}}$ | = | Annual Savings in Vehicle Hours Traveled under the “Build” scenario |
| Annual SVMT | = | Annual Savings in Vehicle Miles Traveled |
| ATS $_{\text{Build}}$ | = | Average Travel Speed (in mph) under the “Build” scenario |

**Table 5.10** shows the posted speeds under the "No-Build" and “Build” scenarios. This analysis assumes that the posted speeds are a good representation of the average auto travel speed within the project area.

TABLE 5.10 | AVERAGE TRAVEL SPEEDS FOR THE "BUILD" AND "NO-BUILD" SCENARIOS

| Scenario | Average Auto Travel Speed (mph) |
|---|---|
| "No-Build" | 35 |
| "Build" | 55 |

*Source: Allegan County Road Commission (ACRC).*

To monetize the travel time savings, the annual VHT savings are multiplied by the hourly value of travel time savings and the average vehicle occupancy rate associated with passenger vehicles. This analysis uses the hourly value of travel time savings of $21.1 per person for all-purpose trips[8] and the average vehicle occupancy rate for highway passenger vehicles of 1.52 for all travel.[9]

This analysis assumes that all traffic within the project area are passenger vehicles and does not account for the presence of commercial vehicles, such as trucks and delivery vehicles. This is a conservative assumption because the value of travel time of truck drivers (i.e., $35.7 per person-hour[10]) is higher than the value of travel time of auto users for all purpose trips (i.e., $21.1 per person-hour).

**Table 5.11** shows the monetized travel time savings of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project due to improved travel speeds over the 20-year operating period.

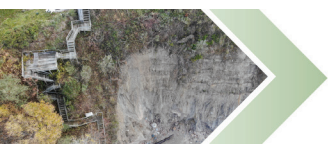
TABLE 5.11 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—TRAVEL TIME SAVINGS, 2028–2048

| Year | VHT Savings | Travel Time Savings (undiscounted 2023$) | Travel Time Savings (2023$ discounted at 3.1%) |
|---|---|---|---|
| 2028 | 11,210 | $359,538 | $308,639 |
| 2029 | 28,235 | $905,540 | $753,973 |
| 2030 | 29,631 | $950,323 | $767,468 |
| 2031 | 31,097 | $997,346 | $781,226 |
| 2032 | 32,637 | $1,046,725 | $795,252 |
| 2033 | 34,253 | $1,098,578 | $809,551 |
| 2034 | 35,951 | $1,153,030 | $824,129 |

[8] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

[9] 2022 National Household Travel Survey.

[10] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.



| Year | VHT Savings | Travel Time Savings (undiscounted 2023$) | Travel Time Savings (2023$ discounted at 3.1%) |
|---|---|---|---|
| 2035 | 37,734 | $1,210,215 | $838,993 |
| 2036 | 39,607 | $1,270,269 | $854,148 |
| 2037 | 41,573 | $1,333,340 | $869,600 |
| 2038 | 43,639 | $1,399,581 | $885,356 |
| 2039 | 45,808 | $1,469,152 | $901,422 |
| 2040 | 48,086 | $1,542,224 | $917,805 |
| 2041 | 50,479 | $1,618,975 | $934,511 |
| 2042 | 52,993 | $1,699,592 | $951,547 |
| 2043 | 55,633 | $1,784,273 | $968,920 |
| 2044 | 58,407 | $1,873,224 | $986,638 |
| 2045 | 61,320 | $1,966,664 | $1,004,707 |
| 2046 | 64,381 | $2,064,823 | $1,023,136 |
| 2047 | 67,596 | $2,167,940 | $1,041,932 |
| 2048 | 29,572 | $948,446 | $442,126 |
| **Total** | **899,844** | **$28,859,800** | **$17,661,080** |

*Source: Cambridge Systematics Analysis.*

## Vehicle Operating Cost Savings

The ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project will reduce VMT by providing a direct route, since the existing road is currently dead ended in two directions, forcing drivers to take longer detours. Shorter routes will generate efficiencies that reduce vehicle operating costs for auto users. To calculate the annual vehicle operating cost savings to be generated by the Project, the following formula is used:

$$\text{Annual VOCS} = \text{Net Change VMT} \times \text{Avg. VOC}$$

Where:

- Annual VOCS = Annual Vehicle Operating Cost Savings
- Net Change VMT = "No-Build" VMT–"Build" VMT
- Avg. VOC = Average Vehicle Operating Cost ($ per VMT) for Light Duty Vehicles

The U.S. DOT BCA guidance provides standard national per-mile values for marginal vehicle operating costs for passenger cars, based on information from the American Automobile

Association.[11] This analysis uses the recommended value for light-duty vehicles of $0.56 per mile, which covers costs like gasoline, maintenance, tires, and depreciation, assuming an average of 15,000 miles driven per year. This value does not include vehicle ownership costs that are mostly fixed or transferable, such as insurance, licensing, registration, taxes, and financing charges.

This analysis also assumes that all traffic within the project area are passenger vehicles and does not account for the presence of commercial vehicles, such as trucks and delivery vehicles. This is a conservative assumption because the average vehicle operating cost per mile traveled for commercial trucks (i.e., $1.27[12]) is much higher than the average vehicle operating cost per mile traveled for light duty vehicles (i.e., $0.56).

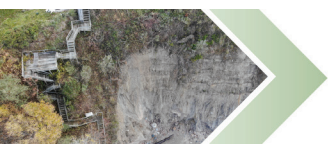
**Table 5.12** shows the monetized VOC savings of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project from reduced light duty vehicle miles traveled over the 20-year operating period.

TABLE 5.12 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—VEHICLE OPERATING COST SAVINGS FROM REDUCED VMT, 2028–2048

| Year | Net change in VMT | Vehicle Operating Cost Savings (undiscounted 2023$) | Vehicle Operating Cost Savings (2023$ discounted at 3.1%) |
|---|---|---|---|
| 2028 | 287,732 | $161,130 | $138,319 |
| 2029 | 724,688 | $405,825 | $337,899 |
| 2030 | 760,527 | $425,895 | $343,947 |
| 2031 | 798,159 | $446,969 | $350,113 |
| 2032 | 837,676 | $469,098 | $356,399 |
| 2033 | 879,173 | $492,337 | $362,807 |
| 2034 | 922,750 | $516,740 | $369,340 |
| 2035 | 968,514 | $542,368 | $376,002 |
| 2036 | 1,016,574 | $569,282 | $382,794 |
| 2037 | 1,067,049 | $597,547 | $389,719 |
| 2038 | 1,120,060 | $627,234 | $396,780 |
| 2039 | 1,175,737 | $658,413 | $403,980 |
| 2040 | 1,234,216 | $691,161 | $411,322 |
| 2041 | 1,295,638 | $725,557 | $418,809 |

[11] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

[12] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.



| Year | Net change in VMT | Vehicle Operating Cost Savings (undiscounted 2023$) | Vehicle Operating Cost Savings (2023$ discounted at 3.1%) |
|---|---|---|---|
| 2042 | 1,360,154 | $761,686 | $426,444 |
| 2043 | 1,427,923 | $799,637 | $434,230 |
| 2044 | 1,499,109 | $839,501 | $442,170 |
| 2045 | 1,573,887 | $881,377 | $450,268 |
| 2046 | 1,652,442 | $925,367 | $458,527 |
| 2047 | 1,734,965 | $971,581 | $466,950 |
| 2048 | 759,025 | $425,054 | $198,142 |
| **Total** | **23,095,999** | **$12,933,759** | **$7,914,960** |

*Source: Cambridge Systematics Analysis.*

## Safety Benefits

Lakeshore Drive is a narrow road with the edge of the bluff within the clear zone, creating safety concerns for both passenger vehicles and pedestrians. The ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project will address these issues by implementing a complete streets design, which includes the addition of a non-motorized shared-used path and paved shoulders.

To measure the safety benefits, this analysis uses historical crash data on Lakeshore Drive within the project area provided by the State of Michigan Traffic Crash Reports and Crash Modification Factors (CMF) provided by Crash Modification Factors Clearinghouse.[13]

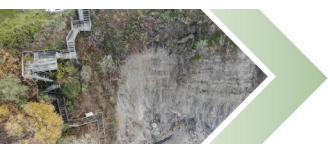
The historical data of crash incidents by KABCO injury severity scale on Lakeshore Drive indicates that there have been no fatalities, two non-incapacitating injuries, one possible injury, and nine no injuries from crashes over the 2014–2024 period.[14]

The Crash Modification Factors Clearinghouse provides a database that helps calculate the expected reduction in crashes after specific countermeasures are implemented. The ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project will increase the shoulder width from 0 to 10 feet on a rural two-lane road, which is estimated to reduce crashes by between 71 percent and 87 percent. This analysis uses a conservative approach and applies the lowest crash reduction factor (CRF) of 71 percent to estimate the safety benefits of the project.[15]

[13] CMF Clearinghouse.

[14] State of Michigan Traffic Crash Report.

[15] Investigating the Effect of Roadside Features on Single-Vehicle Roadway Departure Crashes on Rural Two-Lane Roads by Yichuan Peng, Srinivas Reddy Geedipally, and Dominique Lord (2012).



To estimate the avoided number of injuries by injury severity level due to the introduction of the Project countermeasure, the following equation is used:

$$\text{Avg. Annual CR}i \;=\; \text{Avg. Annual Crashes} \;\text{x}\; \text{CRF}$$

Where:

| | | |
|---|---|---|
| Avg. Annual CR*i* | = | Average Annual Crash Reduction by injury severity level *i* |
| Avg. Annual Crashes | = | Average Annual Crashes on Lakeshore Drive within the Project Area |
| CRF | = | Crash Reduction Factor (i.e., 71 percent) |
| *i* | = | non- incapacitating injury, possible injury, and no injury |

To monetize the safety benefits of the project, the average annual reduction of non- incapacitating injuries, possible injuries, and no injuries is multiplied by the corresponding monetization value of reduced injuries by injury severity level. These values are shown in **Table 5.13**. This analysis assumes that the average annual reduction of non- incapacitating injuries, possible injuries, and no injuries will remain the same over the 20-year operating period.

### TABLE 5.13 | VALUE OF REDUCED FATALITIES AND INJURIES AS A FUNCTION OF KABCO INJURY SCALE

| Item | Non-Incapacitating Injury | Possible Injury | No Injury |
|---|---|---|---|
| Average Annual Crashes[1] | 0.182 | 0.091 | 0.818 |
| Monetization Value of Reduced Injuries (in 2023$ per person)[2] | $246,900 | $118,000 | $5,300 |

[1] *Source: Average Annual Crashes on Lakeshore Drive within the Project Area come from the State of Michigan Traffic Crash Reports.*

[2] *Source: Monetization value of reduced injuries come from the U.S. Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, November 2024.*

**Table 5.14** shows the monetized safety benefits of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project from avoided traffic injuries because of the new shoulders to be provided by the project over the 20-year operating period.

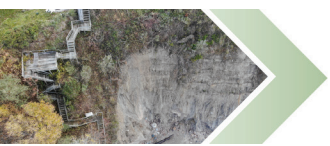
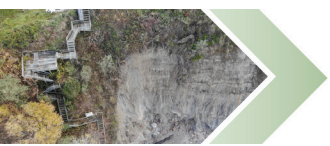


TABLE 5.14 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—SAFETY BENEFITS, 2028–2048

| Year | Avoided Non-incapacitating Injuries (undiscounted 2023$) | Avoided Possible Injuries (undiscounted 2023$) | Avoided No Injuries (undiscounted 2023$) | Total Avoided Injuries (undiscounted 2023$) | Total Avoided Injuries (2023 discounted at 3.1%) |
|---|---|---|---|---|---|
| 2028 | $13,280 | $3,173 | $1,283 | $17,737 | $15,226 |
| 2029 | $31,873 | $7,616 | $3,079 | $42,568 | $35,443 |
| 2030 | $31,873 | $7,616 | $3,079 | $42,568 | $34,377 |
| 2031 | $31,873 | $7,616 | $3,079 | $42,568 | $33,343 |
| 2032 | $31,873 | $7,616 | $3,079 | $42,568 | $32,341 |
| 2033 | $31,873 | $7,616 | $3,079 | $42,568 | $31,369 |
| 2034 | $31,873 | $7,616 | $3,079 | $42,568 | $30,425 |
| 2035 | $31,873 | $7,616 | $3,079 | $42,568 | $29,510 |
| 2036 | $31,873 | $7,616 | $3,079 | $42,568 | $28,623 |
| 2037 | $31,873 | $7,616 | $3,079 | $42,568 | $27,763 |
| 2038 | $31,873 | $7,616 | $3,079 | $42,568 | $26,928 |
| 2039 | $31,873 | $7,616 | $3,079 | $42,568 | $26,118 |
| 2040 | $31,873 | $7,616 | $3,079 | $42,568 | $25,333 |
| 2041 | $31,873 | $7,616 | $3,079 | $42,568 | $24,571 |
| 2042 | $31,873 | $7,616 | $3,079 | $42,568 | $23,832 |
| 2043 | $31,873 | $7,616 | $3,079 | $42,568 | $23,116 |
| 2044 | $31,873 | $7,616 | $3,079 | $42,568 | $22,421 |
| 2045 | $31,873 | $7,616 | $3,079 | $42,568 | $21,747 |
| 2046 | $31,873 | $7,616 | $3,079 | $42,568 | $21,093 |
| 2047 | $31,873 | $7,616 | $3,079 | $42,568 | $20,458 |
| 2048 | $13,280 | $3,173 | $1,283 | $17,737 | $8,268 |
| **Total** | **$632,139** | **$151,058** | **$61,063** | **$844,260** | **$542,304** |

*Source: Cambridge Systematics Analysis.*



## Emissions Reduction Benefits

Pollutant emissions have a cost to the environment. With the new inland roadway, drivers would save both time and miles traveled, leading to a reduction in emissions costs. This part of the analysis focuses on the avoided passenger vehicle emissions resulting from the reduction in VMT.

Major vehicular pollutants include Carbon Dioxide ($CO_2$), Nitrogen Oxides ($NO_x$), Sulfur Dioxide ($SO_2$), and fine Particulate Matter ($PM_{2.5}$). Emission rates for these pollutants depend on vehicle type and average travel speed. This analysis uses the On-Road (EMFAC) emission model developed by the California Air Resources Board (CARB) to obtain emission rates (in grams per mile) for major pollutants emitted by passenger vehicles traveling at an average speed of 35 mph under the "No-Build" scenario and 55 mph under the "Build" scenario in 2024 and 2044. These emission rates are shown in **Table 5.15** and **Table 5.16**.

TABLE 5.15 | EMISSION RATES FOR MAJOR POLLUTANTS EMITTED BY AUTOS TRAVELING AT 35 MPH

| Year | $CO_2$ Emission Rate (grams/VMT) | $NO_X$ Emission Rate (grams/VMT) | $SO_X$ Emission Rate (grams/VMT) | $PM_{2.5}$ Emission Rate (grams/VMT) |
|---|---|---|---|---|
| 2024 | 288.4 | 0.0663 | 0.0029 | 0.0012 |
| 2044 | 227.5 | 0.0212 | 0.0022 | 0.0004 |
| **CAGR** | -1.18% | -5.54% | -1.37% | -5.34% |

*Source: California Air Resources Board, EMFAC 2021.*

TABLE 5.16 | EMISSION RATES FOR MAJOR POLLUTANTS EMITTED BY AUTOS TRAVELING AT 55 MPH

| Year | $CO_2$ Emission Rate (grams/VMT) | $NO_X$ Emission Rate (grams/VMT) | $SO_X$ Emission Rate (grams/VMT) | $PM_{2.5}$ Emission Rate (grams/VMT) |
|---|---|---|---|---|
| 2024 | 315.2 | 0.0671 | 0.0031 | 0.0010 |
| 2044 | 260.0 | 0.0217 | 0.0026 | 0.0004 |
| **CAGR** | -0.96% | -5.49% | -0.88% | -4.48% |

*Source: California Air Resources Board, EMFAC 2021.*

Using the emission rates for relevant pollutants in 2025 and 2044, this analysis estimates the CAGR over this period. This CAGR is then applied to estimate the annual emission rates from 2028 to 2048. Taking a conservative approach, this analysis assumes that the emission rates over the 2045–2048 period are similar to the emission rates in 2044.

Emission rates are then multiplied by the VMT associated with the "No-Build" and "Build" scenarios shown in **Table 5.9**. The emission rates are converted from grams to metric tons and monetized using the damage cost for major emissions shown in **Table 5.17.**

TABLE 5.17 | DAMAGE COST FOR MAJOR POLLUTANTS, 2028-2048

| Year | NOX (2023$ per Metric Ton) | SOX (2023$ per Metric Ton) | PM2.5 (2023$ per Metric Ton) | CO2 (2023$ per Metric Ton) |
|---|---|---|---|---|
| 2028 | $22,100 | $60,800 | $1,068,200 | $259 |
| 2029 | $22,500 | $62,300 | $1,087,900 | $262 |
| 2030 | $22,900 | $63,700 | $1,108,000 | $267 |
| 2031 | $22,900 | $63,700 | $1,108,800 | $272 |
| 2032 | $22,900 | $63,700 | $1,108,800 | $275 |
| 2033 | $22,900 | $63,700 | $1,108,800 | $280 |
| 2034 | $22,900 | $63,700 | $1,108,800 | $284 |
| 2035 | $22,900 | $63,700 | $1,108,800 | $288 |
| 2036 | $22,900 | $63,700 | $1,108,800 | $292 |
| 2037 | $22,900 | $63,700 | $1,108,800 | $297 |
| 2038 | $22,900 | $63,700 | $1,108,800 | $301 |
| 2039 | $22,900 | $63,700 | $1,108,800 | $305 |
| 2040 | $22,900 | $63,700 | $1,108,800 | $310 |
| 2041 | $22,900 | $63,700 | $1,108,800 | $314 |
| 2042 | $22,900 | $63,700 | $1,108,800 | $319 |
| 2043 | $22,900 | $63,700 | $1,108,800 | $324 |
| 2044 | $22,900 | $63,700 | $1,108,800 | $328 |
| 2045 | $22,900 | $63,700 | $1,108,800 | $333 |
| 2046 | $22,900 | $63,700 | $1,108,800 | $338 |
| 2047 | $22,900 | $63,700 | $1,108,800 | $344 |
| 2048 | $22,900 | $63,700 | $1,108,800 | $348 |

*Source: U.S. Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, November 2024.*

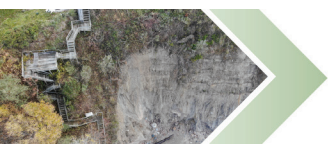
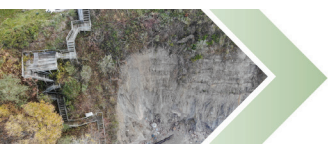


**Table 5.18** shows the monetized emission reduction benefits of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project from reduced light duty vehicle miles traveled over the 20-year operating period.

TABLE 5.18 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—EMISSIONS REDUCTION BENEFITS, 2028–2048

| Year | Emissions Reduction Benefits (2023$ undiscounted) | Emissions Reduction Benefits (2023$ discounted at 3.1%) |
|---|---|---|
| 2028 | $19,101 | $17,267 |
| 2029 | $47,898 | $42,437 |
| 2030 | $50,405 | $43,771 |
| 2031 | $52,999 | $45,113 |
| 2032 | $55,325 | $46,162 |
| 2033 | $58,155 | $47,566 |
| 2034 | $60,910 | $48,837 |
| 2035 | $63,789 | $50,139 |
| 2036 | $66,798 | $51,471 |
| 2037 | $70,173 | $53,010 |
| 2038 | $73,467 | $54,408 |
| 2039 | $76,908 | $55,838 |
| 2040 | $80,758 | $57,484 |
| 2041 | $84,522 | $58,984 |
| 2042 | $88,727 | $60,706 |
| 2043 | $93,125 | $62,468 |
| 2044 | $97,432 | $64,077 |
| 2045 | $103,826 | $66,938 |
| 2046 | $110,620 | $69,914 |
| 2047 | $118,174 | $73,219 |
| 2048 | $52,292 | $31,761 |
| **Total** | **$1,525,404** | **$1,101,570** |

*Source: Cambridge Systematics Analysis.*



## Pedestrian and Cycling Facility Amenity Benefits

Although Lakeshore Drive currently serves as an important route for recreational activities like walking and biking, there is no dedicated path for non-motorized travelers. The ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project will address this issue by adding a 2.79-mile non-motorized shared-use path, complete with clear pavement markings, adequate lighting, and directional signage to enhance safety and convenience for cyclists and pedestrians. In addition, a 10-foot sidewalk will be included in the design. The new non-motorized path will provide amenities that improve the travel experience for cyclists and pedestrians, significantly enhancing the quality and comfort of trips.

To estimate the potential pedestrian and cyclist users of the new non-motorized path, data from Blue Star Highway Corridor Safety Plan[16] are used. Blue Star Highway runs parallel to Lakeshore Drive, primarily serving motor vehicles but with an increasing number of non-motorized users. The safety plan reports annual pedestrian and bicycle activity along shared-use paths from 2019 to 2023. This analysis takes a conservative approach and uses the lowest annual volumes of 420 pedestrian trips and 2,500 bicycle trips reported in 2019 on the Blue Star Highway Corridor to estimate the facility amenity benefits of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project.

To estimate the benefit to a pedestrian walking on the new non-motorized shared-use path, this analysis uses the equation below.

$$\text{BPMW} = \text{SVPFAW} \times \text{ASW}$$

Where:

- BPMW = Benefit to a Pedestrian Walking on the New Sidewalk (in $ per person-mile walked)
- SVPFAW = Sidewalk Value per Foot of Added Width (i.e., $0.11 per foot of added sidewalk width)[17]
- ASW = Additional Sidewalk Width (in feet)

The new sidewalk will generate $1.10 in benefits per person-mile walked. To calculate the annual benefit to pedestrians on the new non-motorized shared-use path, the following formula is applied:

$$\text{ABTP} = \frac{1}{2}\text{ANP} \times \text{SL} \times \text{BPMW}$$

[16] Blue Star Highway Corridor Safety Plan (2024). Retrieved from: https://drive.google.com/file/d/1Azd8gLCVkNLywaZKj9xFKTbakK9f2ZKb/view.

[17] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

Where:

ABTP = Annual Benefits to Pedestrians

ANP = Annual Number of Pedestrians

SL = Sidewalk Length (i.e., 0.86 miles)

BPMW = Benefit to a Pedestrian Walking on the New Sidewalk ($1.10 per person-mile walked)

The non-motorized path length is 2.79 miles but is capped at 0.86 miles, in accordance with U.S. DOT BCA guidance, as this is the average length of a walking trip based on the 2017 National Household Travel Survey.[18]

This analysis applies the rule of half recommended by the U.S.DOT BCA guidance for new users of the facility. This analysis also makes a conservative assumption and estimates that the total number of pedestrians on the new non-motorized shared-use path will remain the same over the 20-year period.

To calculate the benefits for cycling trips on new non-motorized shared-use path, the following formula is used:

$$\text{ABC} = \frac{1}{2}\text{ANC x BLVCM x CPL}$$

Where:

ABTC = Annual Benefits to Cyclists

½ ANC = Annual Number of Cyclists (i.e., 1,250 using the rule of half)

BLVCM = Bike Lane Value per Cycling Mile

CPL = Cycling Path Length (i.e., 2.38 mi)

This analysis assumes a total non-motorized path length of 2.38 miles, as capped by U.S. DOT BCA guidance, even though the actual path length is 2.79 miles.[19] This value reflects the average length of a cycling trip from the 2017 National Household Travel Survey. This analysis also applies the rule of half recommended by the U.S.DOT BCA guidance for new users of the facility.

To monetize these benefits, this analysis uses the U.S. DOT recommended value of the daily benefits of adding cycling paths with at-grade crossings of $1.70 per mile.[20] This analysis makes a

[18] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

[19] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

[20] U.S. DOT Benefit Cost Analysis Guidance (November 2024). Retrieved from: Benefit Cost Analysis Guidance 2024 Update.pdf.

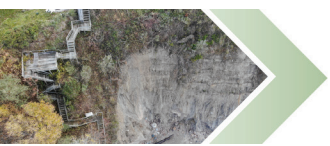
conservative assumption and estimates that the total number of cyclists on the new non-motorized shared-use path will remain the same over the 20-year period.

**Table 5.19** shows the monetized value of the pedestrian and cycling amenity benefits of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project over the 20-year operating period.

TABLE 5.19 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—PEDESTRIAN AND CYCLING AMENITY BENEFITS, 2028–2048

| Year | Annual Benefit to Pedestrians | Annual Benefit to Cyclists | Pedestrian and Cycling Facility Amenity Benefits (undiscounted 2023$) | Pedestrian and Cycling Facility Amenity Benefits (2023$ discounted at 3.1%) |
|---|---|---|---|---|
| 2028 | $83 | $2,107 | $2,190 | $1,880 |
| 2029 | $199 | $5,058 | $5,256 | $4,376 |
| 2030 | $199 | $5,058 | $5,256 | $4,245 |
| 2031 | $199 | $5,058 | $5,256 | $4,117 |
| 2032 | $199 | $5,058 | $5,256 | $3,993 |
| 2033 | $199 | $5,058 | $5,256 | $3,873 |
| 2034 | $199 | $5,058 | $5,256 | $3,757 |
| 2035 | $199 | $5,058 | $5,256 | $3,644 |
| 2036 | $199 | $5,058 | $5,256 | $3,534 |
| 2037 | $199 | $5,058 | $5,256 | $3,428 |
| 2038 | $199 | $5,058 | $5,256 | $3,325 |
| 2039 | $199 | $5,058 | $5,256 | $3,225 |
| 2040 | $199 | $5,058 | $5,256 | $3,128 |
| 2041 | $199 | $5,058 | $5,256 | $3,034 |
| 2042 | $199 | $5,058 | $5,256 | $2,943 |
| 2043 | $199 | $5,058 | $5,256 | $2,854 |
| 2044 | $199 | $5,058 | $5,256 | $2,768 |
| 2045 | $199 | $5,058 | $5,256 | $2,685 |
| 2046 | $199 | $5,058 | $5,256 | $2,604 |
| 2047 | $199 | $5,058 | $5,256 | $2,526 |
| 2048 | $83 | $2,107 | $2,190 | $1,021 |
| **Total** | **$3,940** | **$100,307** | **$104,247** | **$66,962** |

*Source: Cambridge Systematics Analysis.*



## Emergency Medical Service Benefits

Timely emergency response is crucial for survival in life-threatening situations. Increased response times for emergency vehicles on the south side of the closure can impact survival chances. The methodology follows FEMA's Benefit-Cost Analysis Sustainment and Enhancements guidance to estimate the potential loss of life due to the increased response time. The analysis focuses on the link between mortality and EMS response times, specifically for cardiac arrest cases, as these calls are the highest priority and most likely to result in survival. This makes them the most accurate measure of EMS performance. Current EMS response time standards are based on cardiac arrest survival studies, and these calls represent the majority of high-priority EMS incidents.

To estimate the number of cardiac arrests treated by EMS within the project area, the following formula is used:

$$\text{Avg. ANCA\_EMS} = [\text{Population Served} \times 92.3] / 100{,}000$$

Where:

| | | |
|---|---|---|
| Avg. ANCA_EMS | = | Average Annual Number of Cardiac Arrests Treated by EMS |
| Population Served | = | Population within the Project Area 18 years old and over |

The number of cardiac arrests treated by EMS within the project area is estimated to be 0.1515.

To estimate the population served by EMS and at risk of cardiac arrest, the following steps are taken:

- Estimate the number of people living in close proximity to the new inland road and connectors. This involves using data on the number of houses from the Lakeshore Drive Feasibility Study[21] as well as various demographic data from the U.S. Census Bureau, including the share of owner-occupied houses (80.1 percent) and renter-occupied houses (19.9 percent) in Saugatuck Township from the 2022 American Community Survey[22] and the average household size of 2.3 for owner-occupied units and 1.73 for renter-occupied units for Allegan County from the U.S. Census Bureau 2020 Decennial Survey.[23] To calculate for the total number of residents, the number of houses Is multiplied with the share of owner and renter occupied houses and the average household size.
- Estimate the number of peoples 18 years old and over, to exclude young people who are not at risk of cardiovascular disease according with the Centers for Disease Control and Prevention.[24] The share of the population 18 years old and over in Saugatuck Township (i.e., 79 percent) is calculated using data from the U.S. Census Bureau 2020 Decennial Survey and multiplied to

[21] Lakeshore Drive Feasibility Study. Managed Retreat in Saugatuck Township. Prepared by Prein&Newhof Inc. for the Alleged County Road Commission (ACRC). September 30, 2022. Retrieved from: https://drive.google.com/file/d/17IBTRyq6iAaBgDBIcaF4pgGP3Q6sIY89/view.

[22] American Community Survey (ACS).

[23] https://data.census.gov/table?g=040XX00US26&d=DEC+Demographic+Profile.

[24] Heart Disease Facts | Heart Disease | CDC.

the total number of residents to estimate the number of residents 18 years old and over within the Project area.

**Table 5.20** shows the estimated population and people 18 years old and over within the Project area.

TABLE 5.20 | ESTIMATED NUMBER OF RESIDENTS WITHIN THE PROJECT AREA SERVED BY EMS

| Location | Number of Houses[1] | Number of Residents in Owner-Occupied Houses[2] | Number of Residents in Renter-Occupied Houses[2] |
|---|---|---|---|
| South of Wiley Road to end | 70 | 129 | 24 |
| North of 126th Avenue to end | 80 | 147 | 28 |
| **Total** | **150** | **276** | **52** |

| Residents within the Project Area | Value[2] |
|---|---|
| Total Number of Residents | 328 |
| Estimated Residents 18 years old and over | 259 |

1 *Source: Number of homes comes from Lakeshore Drive Feasibility Study. Managed Retreat in Saugatuck Township. September 30, 2022.*

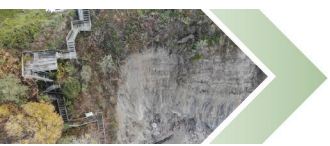
2 *Source: Cambridge Systematics Analysis.*

Data from the Saugatuck Township Fire District on response times from January 1, 2022, to October 9, 2024, show that the average response time for the northern section of the Lakeshore Drive was 10.8 minutes, while the average response time for the southern portion of Lakeshore Drive was 7.28 minutes. Using the average travel speed for the "No-Build" and "Build" scenarios shown in **Table 5.10**, the average EMS response time for the northern and southern sections of the project improve to 6.9 minutes and 4.6 minutes respectively as shown in **Table 5.21**.

TABLE 5.21 | "BUILD" AND "NO-BUILD" SCENARIOS—AVERAGE EMS RESPONSE TIME

| Scenario | Location | Average Travel Speed (mph) | Average EMS Response Time (min) |
|---|---|---|---|
| "No-Build" | North of 126th Avenue to end | 35 | 10.8 |
| "No-Build" | South of Wiley Road to end | 35 | 7.3 |
| "Build" | North of 126th Avenue to end | 55 | 6.9 |
| "Build" | South of Wiley Road to end | 55 | 4.6 |

*Source: Cambridge Systematics Analysis.*



To calculate the probability of survival from cardiac arrest under the "Build" and "No-Build" scenarios, this analysis applies the assumptions and formulas provided by FEMA Benefit-Cost Analysis Re-engineering[25] to estimate the loss of emergency medical services. This analysis assumed that EMS is contacted immediately after cardiac arrest, and all EMS units are equipped with defibrillators and trained staff. The probability of survival from cardiac arrest under the "No-Build" and "Build" scenarios is estimated using the formulas below. These computations yield the results shown in **Table 5.22**.

$$PS_{No-Build} = [1 + e^{-0.260 + 0.106\,(Avg\ RTNB + 1) + 0.139\,(Avg\ RTNB + 2)}] - 1$$

$$PS_{Build} = [1 + e^{-0.260 + 0.106\,(Avg\ RTB + 1) + 0.139\,(Avg\ RTB + 2)}] - 1$$

Where:

PS $_{No-Build}$ = Probability of Survival from Cardiac Arrest under the "No-Build" Scenario

Avg RTNB = Average EMS Response Time under the "No-Build" Scenario

PS $_{Build}$ = Probability of Survival from Cardiac Arrest under the "Build" Scenario

Avg RTB = Average EMS Response Time under the "Build" Scenario

**TABLE 5.22 | "BUILD" AND "NO-BUILD" SCENARIOS—PROBABILITY OF SURVIVAL FROM CARDIAC ARREST**

| Location | "No Build" Scenario, Probability of Survival | "Build" Scenario, Probability of Survival |
|---|---|---|
| North of 126th Avenue to end | 0.0590 | 0.1409 |
| South of Wiley Road to end | 0.1292 | 0.2211 |

*Source: Cambridge Systematics Analysis.*

The probability of survival from cardiac arrest under the "No-Build" and "Build" scenarios and the number of cardiac arrests treated by EMS within the Project area (i.e., 0.1515) are used to estimate the number of deaths under the "Build" and "No-Build" scenarios using the following formulas:

$$Avg\ ANDCA_{No-Build} = Avg.\ ANCA\_EMS\ x\ (1 - PS_{No-Build})$$

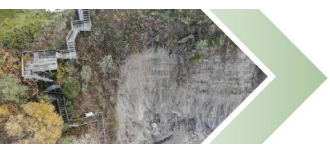
Where:

Avg ANDCA $_{No-Build}$ = Average Annual Number of Deaths due to Cardiac Arrest under the "No-Build" Scenario

Avg. ANCA_EMS = Average Annual Number of Cardiac Arrests Treated by EMS

PS $_{No-Build}$ = Probability of Survival from Cardiac Arrest under the "No-Build" Scenario

[25] FEMA Benefit-Cost Analysis Re-engineering (BCAR). Development of Standard Economic Values. Version 13 September 2024.



$$\text{Avg ANDCA}_{\text{Build}} = \text{Avg. ANCA\_EMS x } (1 - \text{PS}_{\text{Build}})$$

Where:

| | | |
|---|---|---|
| Avg ANDCA $_{\text{Build}}$ | = | Average Annual Number of Deaths due to Cardiac Arrest under the "Build" Scenario |
| Avg. ANCA_EMS | = | Average Annual Number of Cardiac Arrests Treated by EMS |
| PS $_{\text{Build}}$ | = | Probability of Survival from Cardiac Arrest under the "Build" Scenario |

The average number of lives saved per year from improved (decreased) EMS response times due to the project is estimated using the formula below. These computations yield the results shown in **Table 5.23**. This analysis assumes that the number of lives saves per year remain the same over the 20-year operating period.

$$Avg.ANDCA = \text{Avg. ANCA}_{No-Build} - \text{Avg. ANCA}_{Build}$$

Where:

| | | |
|---|---|---|
| Avg ANDCA | = | Average Number of Lives Saved per Year due to Improved EMS Response Time |
| Avg ANDCA $_{\text{Build}}$ | = | Average Annual Number of Deaths due to Cardiac Arrest under the "Build" Scenario |
| Avg ANDCA $_{\text{No-Build}}$ | = | Average Annual Number of Deaths due to Cardiac Arrest under the "No-Build" Scenario |

**TABLE 5.23 | "BUILD" AND "NO-BUILD" SCENARIOS—AVERAGE NUMBER OF LIVES SAVED PER YEAR DUE TO IMPROVED EMS RESPONSE TIME**

| Location | "No Build" Scenario | "Build" Scenario | Average Number of Lives Saved per Year due to Improved EMS Response Time |
|---|---|---|---|
| North of 126th Avenue to end | 0.1426 | 0.1302 | 0.0124 |
| South of Wiley Road to end | 0.1319 | 0.1180 | 0.0139 |

*Source: Cambridge Systematics Analysis.*

To monetize the number of lives saved due to the decrease in response time of EMS, this analysis utilizes the value of statistical life of $13,200,000.[26]

**Table 5.24** shows the monetized value of the EMS response time benefits of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project over the 20-year operating period.

[26] U.S. DOT Departmental Guidance on Valuation of a Statistical Life in Economic Analysis. Retrieved from: https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis.

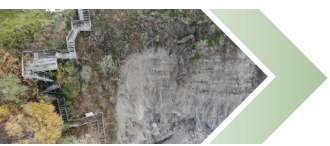
TABLE 5.24 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—EMS RESPONSE TIME BENEFITS, 2028–2048

| Year | Cost of lives saved per year due to the decrease in EMS response time (undiscounted 2023$) | Cost of lives saved per year due to the decrease in EMS response time (2023$ discounted at 3.1%) |
|---|---|---|
| 2028 | $228,554 | $196,198 |
| 2029 | $548,529 | $456,717 |
| 2030 | $548,529 | $442,985 |
| 2031 | $548,529 | $429,665 |
| 2032 | $548,529 | $416,746 |
| 2033 | $548,529 | $404,215 |
| 2034 | $548,529 | $392,061 |
| 2035 | $548,529 | $380,273 |
| 2036 | $548,529 | $368,839 |
| 2037 | $548,529 | $357,749 |
| 2038 | $548,529 | $346,992 |
| 2039 | $548,529 | $336,558 |
| 2040 | $548,529 | $326,439 |
| 2041 | $548,529 | $316,624 |
| 2042 | $548,529 | $307,103 |
| 2043 | $548,529 | $297,869 |
| 2044 | $548,529 | $288,913 |
| 2045 | $548,529 | $280,226 |
| 2046 | $548,529 | $271,800 |
| 2047 | $548,529 | $263,628 |
| 2048 | $228,554 | $106,542 |
| **Total** | **$10,879,149** | **$6,988,142** |

*Source: Cambridge Systematics Analysis.*

## Resilience Benefits

Continued erosion will lead to further road failures, as evidenced by past closures. Since 1988, the road has been subject to repeated disruptions, including a 90-day closure in 2019 that was only



temporarily addressed with a fix. With the proposed new road, no closures are expected due to natural hazards. The Lakeshore Drive Feasibility Study (2022) assessed various risk factors such as the likelihood of shear failures, bluff stability over both short- and long-term periods, and potential continued bluff recession based on historical data. The assessment categorized risks into short-term and long-term projections. Approximately 29 percent of the study area was identified as at risk in the short-term, meaning the roadway could be structurally compromised within the next 15 years or during a period of high-water levels in Lake Michigan.

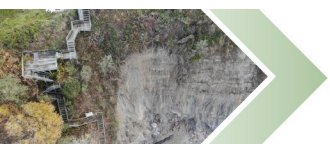
Based on this analysis, it is assumed that without mitigation, the Lakeshore Drive will likely be compromised by 2035. In the short term, damage is expected to occur by 2035, with a repair completed in 2020 costing $400,000 for 200 feet of road. Using this cost as a baseline, repairs in 2035 are projected to cost $500,000 in 2023 dollars, adjusted for inflation.

The projected savings in damage mitigation due to erosion prevention over the 20-year period amount to $500,000 in undiscounted 2023 dollars, with a discounted value of $346,630 in 2023 dollars.

**Table 5.25** shows the monetized resilience benefits of the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project over the 20-year operating period.

TABLE 5.25 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—RESILIENCE BENEFITS, 2028–2048

| Year | Savings in Physical Damage due to Erosion (undiscounted 2023$) | Savings in Physical Damage due to Erosion (2023$ discounted at 3.1%) |
|---|---|---|
| 2028 | $0 | $0 |
| 2029 | $0 | $0 |
| 2030 | $0 | $0 |
| 2031 | $0 | $0 |
| 2032 | $0 | $0 |
| 2033 | $0 | $0 |
| 2034 | $0 | $0 |
| 2035 | $500,000 | $346,630 |
| 2036 | $0 | $0 |
| 2037 | $0 | $0 |
| 2038 | $0 | $0 |
| 2039 | $0 | $0 |
| 2040 | $0 | $0 |



| Year | Savings in Physical Damage due to Erosion (undiscounted 2023$) | Savings in Physical Damage due to Erosion (2023$ discounted at 3.1%) |
|---|---|---|
| 2041 | $0 | $0 |
| 2042 | $0 | $0 |
| 2043 | $0 | $0 |
| 2044 | $0 | $0 |
| 2045 | $0 | $0 |
| 2046 | $0 | $0 |
| 2047 | $0 | $0 |
| 2048 | $0 | $0 |
| **Total** | **$500,000** | **$346,630** |

*Source: Cambridge Systematics Analysis.*

## Project Benefits Summary

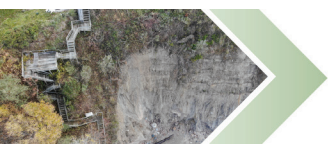
Total benefits to be generated by the ***Protecting Lake Michigan's Shoreline Communities: Reconnecting Lakeshore Drive*** project are estimated at around $55.6M undiscounted and $34.6M discounted to 2023 dollars over the 20-year operating period (see **Table 5.26**).

TABLE 5.26 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—PROJECT BENEFITS SUMMARY, 2028-2048

| Benefit Category | Benefit (undiscounted 2023$) | Benefit (discounted 2023$) |
|---|---|---|
| Travel Time Savings | $28,859,800 | $17,661,080 |
| Vehicle Operating Cost Savings | $12,933,759 | $7,914,960 |
| Safety Benefits | $844,260 | $542,304 |
| Emissions Reduction Benefits | $1,525,404 | $1,101,570 |
| Pedestrian and Cycling Facility Amenity Benefits | $104,247 | $66,962 |
| Emergency Medical Service Benefits | $10,879,149 | $6,988,142 |
| Resilience Benefits | $500,000 | $346,630 |
| **Total Benefits[1]** | **$55,646,620** | **$34,621,647** |

*Source: Cambridge Systematics Analysis.*

[1] *Total Benefits only reflects the benefits generated by the project and does not include the operation and maintenance (O&M) costs.*



## 5.8 Project Costs

### Project Capital Costs

The capital costs for the proposed project (see **Table 5.27**) are primarily associated with construction, totaling $7.2M, in addition to $200,000 for design, $700,000 for right-of-way acquisition, and contingency cost amounting to $900,000. The total capital expenditure for the project is projected to reach $9M in undiscounted 2023 dollars.

TABLE 5.27 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—PROJECT CAPITAL COSTS

| Project Capital Costs | Undiscounted 2023$ |
|---|---|
| Design | $200,000 |
| Right-of-Way Acquisition | $700,000 |
| Construction | $7,200,000 |
| Contingency | $900,000 |
| **Total** | **$9,000,000** |

*Source: Allegan County Road Commission (ACRC).*

The project capital costs will be incurred over the 2026–2028 period (see **Table 5.28**). The final design is expected to be completed in March 2027 while the right-of-way acquisition will begin in September 2026 and is expected to conclude by June 2027. The construction phase is planned to take place from July 2027 to July 2028, with the project expected to become operational in August 2028.

TABLE 5.28 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—SCHEDULE OF PROJECT CAPITAL COSTS

| Project Phase | Start Date/Year | End Date/Year |
|---|---|---|
| Final Design | September 2026 | March 2027 |
| Right-of-way acquisition | September 2026 | June 2027 |
| Construction | July 2027 | July 2028 |

*Source: Allegan County Road Commission (ACRC).*

**Table 5.29** shows the life cycle Project capital costs. After applying a 3.1 percent discount rate, the project capital costs total nearly $7.9M.

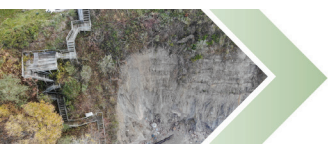


TABLE 5.29 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—LIFE CYCLE PROJECT COSTS

| Year | Project Capital Costs (undiscounted 2023$) | Project Capital Costs (2023$ discounted at 3.1%) |
|---|---|---|
| 2026 | $394,286 | $359,778 |
| 2027 | $4,555,714 | $4,032,012 |
| 2028 | $4,050,000 | $3,476,656 |
| **Total** | **$9,000,000** | **$7,868,446** |

*Source: Cambridge Systematics Analysis.*

## Project Operations and Maintenance (O&M) Costs

The project O&M costs are related to the upkeep of the roadway, connectors, and non-motorized paths. **Table 5.30** shows the annual O&M costs associated with the "No-Build" scenario. Since the existing roadway does not include a non-motorized path, there are no O&M costs in the "No-Build" scenario. This analysis assumes that the annual O&M costs associated with the "No-Build" scenario remain the same over the 20-year operating period.

TABLE 5.30 | NO-BUILD SCENARIO—ANNUAL O&M COSTS

| Location | Annual O&M Cost per Mile[1] (2023$) | Road Length (Miles) | Annual O&M Cost (2023$) |
|---|---|---|---|
| South of Wiley Road to end | $4,350 | 1.02 | $4,437 |
| North of 126th Avenue to end | $4,350 | 0.88 | $3,828 |

[1] *Source: Allegan County Road Commission 2023 Transportation Asset Management Plan. Retrieved from: https://www.alleganroads.org/uploads/4/8/8/5/488583/acrc-complianceplan2023.pdf.*

The proposed new inland North-South road will span from 126th Avenue to 130th Avenue (Wiley Road) within Saugatuck Township. In addition to the main road, the project includes improvements to the existing gravel road on 126th Avenue and the construction of three new connector roads extending west from the main corridor. The estimated O&M cost for the new roadways is $4,250 per mile per year, with the O&M cost for the new non-motorized path estimated at $1,000 per mile per year. **Table 5.31** and **Table 5.32** outline the annual O&M costs for each roadway, connector, and non-motorized path. This analysis assumes that the annual O&M costs associated with the "Build" scenario remain the same over the 20-year operating period.

### TABLE 5.31 | BUILD SCENARIO—ESTIMATED ANNUAL O&M COSTS OF THE NEW INLAND ROAD AND CONNECTORS

| Road / Connectors | Annual O&M Cost per Mile[1] (2023$) | Road/ Connector Length (Miles) | Annual O&M Cost (2023$) |
|---|---|---|---|
| New Inland North-South Road, from 126th Avenue to Wiley Road / 130th Avenue | $4,250 | 2.04 | $8,670 |
| Chestnut Lane Connector (public road) | $4,250 | 0.12 | $510 |
| Old Owl Connector (private road) | $4,250 | 0.57 | $2,423 |
| Tranquility Lane Connector (private road) | $4,250 | 0.11 | $468 |
| 126th Avenue improvements | $4,250 | 0.33 | $1,403 |
| **Total** | | | **$13,473** |

[1] *Source: Allegan County Road Commission (ACRC).*

### TABLE 5.32 | BUILD SCENARIO—ESTIMATED ANNUAL O&M COSTS OF THE NON-MOTORIZED SHARED-USE PATH

| Non-motorized Shared-Use Path | O&M Cost per Mile[1] (2023$) | Non-motorized Shared-Use Path Length (Miles) | Annual O&M Cost (2023$) |
|---|---|---|---|
| Path Parallel to the new N-S Roadway Corridor | $1,000 | 2.04 | $2,040 |
| Path Parallel to 126th Avenue | $1,000 | 0.28 | $280 |
| Path Parallel to Wiley Road | $1,000 | 0.47 | $470 |
| **Total** | | | **$2,790** |

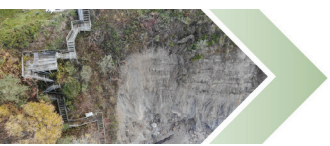
[1] *Source: Allegan County Road Commission (ACRC).*

As shown in **Table 5.33**, the total O&M cost under the "No-Build" scenario is $163,923, while the O&M cost for the "Build" scenario is $322,540. By applying a 3.1percent discount rate, the total discounted O&M cost for the entire project is $105,294 for the "No-Build" scenario and $207,181 for the "Build" scenario. The net O&M cost, calculated by subtracting the "Build" O&M cost from the "No-Build" O&M cost, is $101,887.

TABLE 5.33 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—O&M COSTS, 2028–2048

| Year | No-Build O&M Costs (undiscounted 2023$) = (a) | Build O&M Costs (undiscounted 2023$) = (b) | Net O&M Costs (undiscounted 2023$) = (b) –(a) | No-Build O&M Costs (2023$ discounted at 3.1%) = (c) | Build O&M Costs (2023$ discounted at 3.1%) = (d) | Net O&M Costs (2023$ discounted at 3.1%) = (d) –(c) |
|---|---|---|---|---|---|---|
| 2028 | $3,444 | $6,776 | $3,332 | $2,956 | $5,817 | $2,861 |
| 2029 | $8,265 | $16,263 | $7,998 | $6,882 | $13,541 | $6,659 |
| 2030 | $8,265 | $16,263 | $7,998 | $6,675 | $13,133 | $6,459 |
| 2031 | $8,265 | $16,263 | $7,998 | $6,474 | $12,738 | $6,264 |
| 2032 | $8,265 | $16,263 | $7,998 | $6,279 | $12,355 | $6,076 |
| 2033 | $8,265 | $16,263 | $7,998 | $6,091 | $11,984 | $5,893 |
| 2034 | $8,265 | $16,263 | $7,998 | $5,907 | $11,624 | $5,716 |
| 2035 | $8,265 | $16,263 | $7,998 | $5,730 | $11,274 | $5,544 |
| 2036 | $8,265 | $16,263 | $7,998 | $5,558 | $10,935 | $5,378 |
| 2037 | $8,265 | $16,263 | $7,998 | $5,390 | $10,606 | $5,216 |
| 2038 | $8,265 | $16,263 | $7,998 | $5,228 | $10,287 | $5,059 |
| 2039 | $8,265 | $16,263 | $7,998 | $5,071 | $9,978 | $4,907 |
| 2040 | $8,265 | $16,263 | $7,998 | $4,919 | $9,678 | $4,759 |
| 2041 | $8,265 | $16,263 | $7,998 | $4,771 | $9,387 | $4,616 |
| 2042 | $8,265 | $16,263 | $7,998 | $4,627 | $9,105 | $4,478 |
| 2043 | $8,265 | $16,263 | $7,998 | $4,488 | $8,831 | $4,343 |
| 2044 | $8,265 | $16,263 | $7,998 | $4,353 | $8,566 | $4,212 |
| 2045 | $8,265 | $16,263 | $7,998 | $4,222 | $8,308 | $4,086 |
| 2046 | $8,265 | $16,263 | $7,998 | $4,095 | $8,058 | $3,963 |
| 2047 | $8,265 | $16,263 | $7,998 | $3,972 | $7,816 | $3,844 |
| 2048 | $3,444 | $6,776 | $3,332 | $1,605 | $3,159 | $1,553 |
| **Total** | **$163,923** | **$322,540** | **$158,617** | **$105,294** | **$207,181** | **$101,887** |

*Source: Cambridge Systematics Analysis.*



## 5.9 Summary of Results

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

- Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.
- Benefit-Cost Ratio (BCR): The present value of incremental benefits is divided by the present value of incremental costs to yield the BCR. The BCR expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of the costs.
- Payback Period: The payback period refers to the period required to recover the funds expended on a Project. When calculating the payback period, the time value of money (discounting) is not considered.

**Table 5.34** summarizes the results of the BCA. Benefits and costs are presented in undiscounted and discounted at 3.1 percent per year, except in the case of savings in $CO_2$ emission costs, where a 2.0 percent per year discount rate is applied. All project benefits and costs are estimated over the analysis period which includes the design and engineering and construction of the Project during which capital expenditures are undertaken, plus 20 years of operations beyond the Project completion within which to evaluate the ongoing Project benefits and costs.

The total net benefits from the project within the analysis period are **$34.5M** (including the project O&M costs) in discounted 2023 dollars. The total project capital costs, including engineering and construction, are calculated to be **$7.91M** in discounted 2023 dollars. The difference of the discounted project benefits and costs equal a NPV of **$26.6M**, resulting in a BCR of **4.4.**

TABLE 5.34 | PROTECTING LAKE MICHIGAN'S SHORELINE COMMUNITIES: RECONNECTING LAKESHORE DRIVE—BENEFIT-COST ANALYSIS SUMMARY

| Project Costs | Undiscounted 2023$ | 2023$ discounted at 3.1% |
|---|---|---|
| Capital Cost | $9,000,000 | $7,868,446 |
| **Total Project Capital Cost** | **$9,000,000** | **$7,868,446** |

| Project Benefits | Undiscounted 2023$ | 2023$ discounted at 3.1% |
|---|---|---|
| Operation and Maintenance Cost | -$158,617 | -$101,887 |
| Travel Time Savings | $28,859,800 | $17,661,080 |

| Project Benefits | Undiscounted 2023$ | 2023$ discounted at 3.1% |
|---|---|---|
| Vehicle Operating Cost Savings | $12,933,759 | $7,914,960 |
| Safety Benefits | $844,260 | $542,304 |
| Emissions Reduction Benefits | $1,525,404 | $1,101,570 |
| Pedestrian and Cycling Facility Amenity Benefits | $104,247 | $66,962 |
| Emergency Medical Service Benefits | $10,879,149 | $6,988,142 |
| Resilience Benefits | $500,000 | $346,630 |
| **Total Project Benefits** | **$55,488,002** | **$34,519,761** |
| Net Present Value (NPV) | **$46,488,002** | **$26,651,315** |
| Benefit-Cost Ratio (BCR) | **6.2** | **4.4** |

*Source: Cambridge Systematics Analysis.*

## 5.10 Sensitivity Analysis

A sensitivity analysis is used to help identify which variables have the greatest impact on the BCA results. This analysis can be used to estimate how changes to key variables from their preferred value affect the results and how sensitive the results are to these changes. This allows for the assessment of the strength of the BCA, including whether the results reached using the preferred set of input variables are significantly different by reasonable departures from those values. **Table 5.35** summarizes the key variables which have been evaluated for sensitivity.

TABLE 5.35 | SENSITIVITY TESTS—ALTERNATIVE VALUES FOR KEY PARAMETERS

| Test No. | Parameter | Original Value | Original Source | Alternative Value |
|---|---|---|---|---|
| 1 | Reduction in Project VMT for residents North of 126th Avenue and South of 130th Street | Project will reduce VMT by 50% | Conservative assumption based on data provided by the ACRC on reduced VMT to be experienced by residents within the project area | Project will reduce VMT by 25% |
| 2 | Population within the Project Area at Risk of Cardiac Arrest | 79% | Estimated based on the share of population 18 years old and over | 39.5% |

| Test No. | Parameter | Original Value | Original Source | Alternative Value |
|---|---|---|---|---|
| 3 | Project Capital Cost<br>Project Annual O&M Cost | Project Capital Cost = $9 million (undiscounted 2023$).<br>Annual O&M Cost = $158,617 (undiscounted 2023$) | ACRC | Project Capital Cost increased by 100%.<br>Annual Project O&M Cost increased by 100% |

*Source: Cambridge Systematics Analysis.*

**Table 5.36** presents the benefits generated by the project and the corresponding benefit-cost ratio using the alternative values for key variables. The results of the sensitivity analysis indicates the following:

- **Test 1—**A VMT reduction of 25 percent yields a benefit-cost ratio of 3.3, with a NPV of $18,065,787 in 2023 dollars.
- **Test 2—**A lower share of the population within the project area at risk of cardiac arrest yields a benefit-cost ratio of 4.0, with a NPV of $23,374,508 in 2023 dollars.
- **Test 3—**The increase in the project capital and O&M costs by 100 percent (i.e., the project capital and O&M cost expenditures has doubled) yields a benefit-cost ratio of 2.2, with a NPV of $19,088,528 in 2023 dollars.

TABLE 5.36 | RESULTS OF THE SENSITIVITY ANALYSIS

| Evaluation Measures | Test 1 (2023$ discounted at 3.1%) | Test 2 (2023$ discounted at 3.1%) | Test 3 (2023$ discounted at 3.1%) | Combined Tests 1, 2 and 3 (2023$ discounted at 3.1%) |
|---|---|---|---|---|
| Total Project Benefits = PB | $25,934,233 | $31,242,954 | $34,825,421 | $22,453,653 |
| Total Project Costs = PC | $7,868,446 | $7,868,446 | $15,736,892 | $15,736,892 |
| Net Present Value = PB–PC = NPV | $18,065,787 | $23,374,508 | $19,088,528 | $6,716,761 |
| Benefit-Cost Ratio = BCR = PB / PC | 3.3 | 4.0 | 2.2 | 1.4 |

*Source: Cambridge Systematics Analysis.*