Appendix B: Benefit-Cost Analysis

Executive Overview

This Benefit-Cost Analysis was completed for the Glass City Riverwalk project, and follows methods established by U.S. Department of Transportation's (USDOT's) Benefit-Cost Analysis Guidance for Discretionary Grant Programs (January 2020) and the National Cooperative Highway Research Program (NCHRP) in their Report 552: Guidelines for Analysis of Investments in Bicycle Facilities. Benefits for this project were considered as improvements to 5 categories: recreation, decreased auto use, health, mobility, and safety. Results listed in this summary are based on the prescribed discount rate of 7%, and a proposed lifetime of 20 years for the project beginning in 2027.

Table 1 below is a brief summary of the results of this analysis. Under the conservative assumptions made the proposed project will provide an estimated Net Present Value Benefits of $254 million. This is a benefit to cost ratio of 10.7:1. Sensitivity analysis conducted on these results proved them to be robust and reasonably conservative.

Table 1: Net Present Value Benefits with 7% Discount Rate

Present Value of Benefits	Present Value of Costs	Net Present Benefits	Benefit to Cost Ratio
$281,209,398	$26,272,180	$254,937,218	10.70

Project Costs

Cost Estimates for the life of the project were provided by Metroparks Toledo. Below is a summary of project costs, a complete list and the Present Value (PV) calculations are available in the accompanying data files. All costs were associated with the year in which they will occur and discounted at a rate of 7% to obtain the Present Value (PV) of costs.

Table 2: Present Value of Costs with 7% Discount Rate

Category	Timeframe	Annual Average	Total Present Value
Construction	2022-2027	$5,917,040	$22,673,862
Maintenance/Operation	2027-2046	$575,988	$3,734,887
		Total	$26,408,749

Project Benefits

To begin measuring benefits we first forecasted the demand for this path using the Benefit-Cost Analysis of Bicycle Facilities tool developed by the NCHRP and the University of Minnesota[1]. Using data from the National Household Transportation Survey (NHTS) and U.S. Census, NCHRP estimates demand for bicycle facilities in three possible scenarios. The "low" scenario represents the bare minimum expectation for demand, which we do not believe is appropriate for this analysis. Given the unique characteristics of

[1] http://www.pedbikeinfo.org/bikecost_x/ Input parameters: Toledo OH, 2024, Off-Street Bicycle Trail, 0.7%, Residential Density 800 m: 3379, 800 m – 1600 m: 4492, 1600 m- 2400 m: 4545, Facility Length: 2092 meters.

this riverwalk project, and its scenic and central location we believe that the "medium" estimates are the best representation of anticipated demand. We did not use the "high" estimates because we wish to establish a relatively conservative estimation of the expected benefits.

Using current GIS[2] and U.S. Census data[3] we obtained estimates of 8,108 existing cyclists with 131 of those being commuters. With the installation of the riverwalk shared use path we expect 2,510 new cyclists, with 40 of them being new commuters. With an estimated number of users for the new path we followed the precedent of Report 552 in measuring benefits.

Below we discuss the methods used to quantify each category of benefits. A summary of the findings can be found in Table 4 at the end of this section. Note that amounts listed in this section are annual benefits for the life of the project. The discounted total PV of benefits can be found in the executive summary, and intermediate calculations can be found in the accompanying data file.

- ## Recreation

  To obtain a figure for recreation benefits, the estimated number of total new cyclists, minus new commuters, was multiplied by the estimated value of outdoor recreation. NCHRP compiled a wide variety of studies on valuing outdoor recreational activities and generated a typical value of $10/hour in 2004 dollars and that a "typical" day involved about one hour of bike riding. After adjusting to 2018 dollars, that is $13.024 per cyclist per day in benefits. The results of these calculations are presented in Table 3 below.

  The above calculations are based solely on recreational benefits to cyclists, and do not capture the benefits this shared use path will have for pedestrians. There has been little research done in directly quantifying the value of recreation benefits that riverwalk projects like this would provide. However, there is abundant literature describing the immense benefits that have resulted from past projects. An economic impact analysis in Pittsburg found for every public dollar spent on riverfront improvements, $20 in private investments followed[4]. And in San Antonio their renowned riverwalk has overtaken the Alamo as their number one tourist attraction. It is our belief that the recreational benefits of this project go far beyond the scope of the bicycle facilities tool utilized here. According to Report 552 recreational walking is ten times as common as biking. Additionally, we believe that the unique characteristics of this project will attract far more pedestrian use than cyclists. For these reasons, we believe that a very conservative estimate for pedestrian benefits would be double the benefits to cyclists. See results below in Table 3.

Table 3: Annual Recreations Benefits for Cyclists and Pedestrians

Cyclists	Pedestrians	Total
$11,741,787	$23,483,574	**$35,225,361**

[2] Geographic Information System Mapping data provided by Toledo Metropolitan Area Council of Governments. ()
[3] American Community Survey, 2018 1-year Estimates Table S0801 for Metropolitan Area of Toledo, OH
[4] *Three U.S. Cities Reinventing the Modern Waterfront*, Urban Land Magazine January 2019

- ## Decreased Auto Use

Decreased Auto Use benefits encompasses benefits from reduced congestion, reduced air pollution, and user cost savings. Following the guidance of NCHRP Report 552, we assume that the 40 new bicycle commuters were previously driving to work, and that they work 5 days a week 47 weeks a year. An average commute of 6 miles was used per a report compiled by the Brookings Institute[5]. Finally, NCHRP estimates a savings of $0.13 per mile ($2006) in urban areas. In the figure below you can see that this, adjusted to $2018, produced an estimated savings of $17,978 annually.

$$\mathbf{40}\ \boldsymbol{commuters} \cdot \$\mathbf{0.13}/\boldsymbol{mile} \cdot \mathbf{6}\ \boldsymbol{miles} \cdot\ \mathbf{235}\ \boldsymbol{days} \cdot \mathbf{2} \cdot \mathbf{1.226} = \$\mathbf{17,978}$$

- ## Health

Health benefits are measured in reduced healthcare costs caused by the increase in physical activity associated with the new cyclists. NCHRP researched ten studies on the effects of physical activity on healthcare costs and determined a median value of $128 annually per capita. Multiplying the expected number of new cyclists by the value of $128 and adjusting to $2018 results in annual benefits of $393,889. It is worth noting that we did not account for the increased health benefits to pedestrians using the riverwalk, so we know that the true measure of health benefits would be greater than this.

- ## Mobility

Mobility describes the benefits associated with bicycle mobility improvement. NCHRP Report 552 finds that bicycle commuters are willing to spend 20.38 extra minutes per trip to travel on an off-street bicycle path such as the one proposed by this project. Using an average value of $12/hour to value time, this means a benefit of $4.08 per trip. Multiplying this benefit by the assumed number of trips for all bicycle commuters and adjusting to $2018 the annual benefit is $402,017.

$$\mathbf{171}\ \boldsymbol{commuters} \cdot \$\mathbf{4.08}/\boldsymbol{trip} \cdot \mathbf{235}\ \boldsymbol{days} \cdot \mathbf{2} \cdot \mathbf{1.226} = \$\mathbf{402,017}$$

- ## Safety

This category measures the benefits gained from a reduction in cyclist and pedestrian injuries and fatalities. The provision of a shared use path off-road facility would allow cyclist and pedestrians to travel a safe distance away from vehicles, thus reducing the number of vehicle accidents involving pedestrians and cyclists.

To measure these benefits, we utilized data from the Ohio Department of Transportation's (ODOT's) GCAT Crash Analysis Tool for the city of Toledo. USDOT's guidance is to use a timeframe of 3 to 7 years for this data, we chose to use the most recent 3 years in order to capture the trend of increasing injuries and fatalities in Ohio[6]. For pedestrians we analyzed crashes within a 0.5-mile

[5] Kneebone, Elizabeth and Natalie Holmes. The growing distance between people and jobs in Metropolitan America. Brookings Metropolitan Policy Program. March 2013. Available at: http://www.brookings.edu/~/media/research/files/reports/2015/03/24-job-proximity/srvy_jobsproximity.pdf

[6] Walking & Biking Safety in Ohio GroundWork, Issue 46. Available at: https://www.middletontownship.com/wp-content/uploads/2020/04/GroundWork-Issue-46-Walking-Biking-Safety-in-Ohio.pdf

radius of the project (approx. 10 minutes walking), and for cyclists we used a baseline assumption of a 2-mile radius. Literature on this subject suggests a radius between 1.5 miles and 5 miles is appropriate for cyclists. Our 2-mile radius is at the low end of this range to keep our estimates conservative. Using this data, we calculate the expected annual number of injuries and fatalities as an average of the past three years.

To measure the value of avoided injuries and fatalities we followed the USDOT's Benefit-Cost Analysis Guidance[7]. Per their guidelines, injuries were associated with severities on the KABCO scale and monetized with values from Table A-1 in Appendix A. To assume a 100% reduction in accidents does not seem reasonable, so we used a Crash Modification Factor (CMF) of 0.75[8], equating to a 25% reduction in crashes. This CMF is designated for use on 6-lane roadways, which our project is not. However, we deemed this to be the most appropriate CMF available and a very conservative estimate of the expected reduction.

This process yielded an estimate of $3,796,408 in annual benefits from prevented crashes.

Table 4: Summary of Annual Benefits

Recreation	$35,225,361
Decreased Auto Use	$17,978
Health	$393,889
Mobility	$402,017
Safety	$3,796,408
Total	**$39,835,653**

Sensitivity Analysis

Several major assumptions were made in this analysis to reach conclusions that we did. We believe that our assumptions were all very conservative and represent a reasonable assessment of the expected Net Benefits. In this section we will briefly discuss some of the major assumptions made, and how realistic changes in these parameters would affect calculations. Finally, we present the effects of these proposed changes in Table 5. Our focus in this section will be the two largest areas of benefits, Recreation and Safety, as these are also where the most significant assumptions were made.

In the area of recreation benefits there are two major assumption we will assess. The first is the use of the medium scenario of projected demand, vice the low or high scenarios. We hold that the low scenario is not a reasonable parameter for this analysis, for the reasons listed previously. The high scenario of demand estimates 3,722 new cyclists adding to 12,086 existing. Obviously, this is a large difference and thus a highly influential factor of the analysis. Table 5 lists the impacts these changes would have on the Net Benefits of the project. The other major area of uncertainty in the recreation category is the measurement of pedestrian benefits. We believe the proposed doubling of cyclist

[7] Benefit Cost Analysis Guidance for Discretionary Grant Programs January 2020, U.S. Department of Transportation. Appendix A: Recommended Parameter Values

[8] http://www.cmfclearinghouse.org using the Countermeasure: Install Shared Use Path (ID: 9250)

benefits is very conservative, but for this sensitivity analysis we will consider the scenario that the benefits are equal (an absolute minimum in our opinion).

Next is Safety. The first assumption we assessed is the chosen radius for crash data. Our choice of 2 miles was already on the very conservative side of the appropriate range, so we expanded to 5 miles. This is still within the reasonable range established by the literature. Next, we tested a change in the CMF. The proposed path would offer a completely off-road alternative to a very heavily trafficked route. Therefore, we believe that the true reduction in accidents will be much larger than the 25% used in the analysis. In this test we replaced the previous CMF with a 50% reduction in accidents and measured the change.

The final point of consideration in this section is the real discount rate. Given that costs for this project are incurred in the beginning and benefits throughout the lifetime, the affect of the real discount rate is disproportionate on the two. To illustrate how a change in the real discount rate might affect this analysis we consider a 2% change in either direction from the prescribed 7% in the analysis.

Table 5: Results of Sensitivity Analysis

Proposed Change	New NPV of Benefits	Change
Baseline, no change	$254,973,218	$0
High Scenario of Demand	$378,296,488	+ $123,323,270
Lower Pedestrian Rec. Benefits	$172,049,137	- $82,924,081
5 Mile Radius for Crash Data	$273,189,822	+ $18,216,604
50% Reduction in Crashes	$281,736,972	+ $26,763,754
5% Real Discount Rate	$341,183,412	+ $86,210,194
9% Real Discount Rate	$193,008,711	- $61,964,507

The results of this sensitivity analysis determined that our initial findings are quite robust and in fact conservative. Except for changes in the discount rate, which represents a potential change in either direction, there is only one result in this analysis that lowered the expected NPV of benefits. And even under this most stringent parameter change the expected NPV of benefits is still $172 million. That is a benefit to cost ratio of **7.55:1**. Clearly this project is overwhelmingly beneficial to the community.