# Memorandum

**To:** Ken Ashfeld, City of Maple Grove Public Works Director

**From:** Nicole Bitzan, AICP, Planner III

**Date:** April 11, 2022

**Subject:** Highway 610 Completion Project – 2022 RAISE Program Application Benefit-Cost Analysis Memorandum

## Introduction

This memorandum summarizes the assumptions, methodology and results developed for the benefit-cost analysis of the No Build and Build Alternatives evaluated as part of the Highway 610 Completion Project – 2022 RAISE Program Application. The objective of a benefit-cost analysis (BCA) is to bring all the direct effects of a transportation investment into a common measure (dollars), and to allow for the fact that benefits accrue over a long period of time while costs are incurred primarily in the initial years. The primary elements that can be monetized are travel time, vehicle crashes, remaining capital value, and maintenance costs. The benefit-cost analysis can provide an indication of the economic desirability of an alternative, but decision-makers must weigh the results against other considerations, effects, and impacts of the project.

The primary issues to be addressed by the project are the travel time and safety benefits associated with trips moving from Maple Grove Parkway, an urban, more signalized corridor, to Highway 610, a higher speed, arterial corridor that provides a more direction connection to I-94 and TH 610. I-94 is the major interstate facility connecting communities and other major centers to the north and west of the Twin Cities and TH 610 is a major freeway facility that serves the northern suburbs of the Twin Cities and is an east-west compliment to the northern beltway of I-94/I-694. The Highway 610 completion, along with the TH 610 and Maple Grove Parkway Interchanges have been planned since the early to mid-1990s to facilitate growth and development of this area. The configuration of the interchanges, overpasses, frontage and/or backage roadways have been thought through and land use and develop has been planned in accordance with these larger system plans. This area is not fully developed but has developed over the last 15 to 20 years with the North Memorial Hospital, Transit Center, School and shopping and housing.

There continues to be development to the west of Maple Grove and this development continues to add traffic to Hennepin County CSAH 30 which feeds into Maple Grove Parkway. The master plan for the area included extending Highway 610 which would relocate longer more regional trips from the Maple Grove Parkway Interchange to the new Highway 610. The Maple Grove Parkway interchange does experience congestion and overloading of the ramps especially the westbound off ramp during the p.m. peak hour. The study corridor is characterized by near-capacity daily traffic volumes, high levels of freight and heavy vehicle activity, and numerous safety concerns.

## Description of Alternatives

For the purpose of this analysis, a No Build and Build Alternative were under consideration.

### No Build Alternative

The No Build Alternative included leaving the existing interchange geometry as is with no modifications or restrictions to current access. The current Maple Grove Parkway is a five-lane divided arterial corridor with double lefts at major intersections and limited access. Properties have been developed adjacent to this corridor and additional widening or capacity would significantly impact private properties. Surrounding development has been planned and constructed with the Highway 610 completion in mind. Significant impacts would occur to properties in the Maple Grove Parkway Interchange area if the Highway 610 completion were not provided. Additionally, a reconfiguration of the current interchange and the Maple Grove Parkway corridor would be needed. High-level parcel impacts in and around the interchange were more than $30 million without any roadway or interchange improvements. The City believes that these types of impacts are not feasible and would negatively impact the business community and vitality of the area.

### Build Alternative

The proposed project would realign CSAH 30 west of I-94 and make a direct connection to TH 610 east of I-94. Due to the orientation of the major routes, travel patterns, and other adjacent connections, access to I-94 is proposed to and from west (connecting to CSAH 30) and also from eastbound TH 610 to southbound I-94. This improvement was studied with key partners and a layout prepared along with a state EAW with some additional federal environmental analysis. The City is currently proceeding through a CATEX process and will require an Interstate Access Request.

## BCA Methodology

The following methodology and assumptions were used for the benefit-cost analysis:

### Main Components

The main components analyzed included:

- Travel time/delay (vehicle hours traveled – VHT)
- Operating costs (vehicle miles traveled – VMT)
- Crashes by severity
- Environmental and air quality impacts
- Quality of life benefits
- Initial capital costs: These costs were broken into distinct categories in accordance with service life (consistent with the recommendations from MnDOT Office of Transportation System Management, July 2018) and were applied evenly over the duration of the construction period.
- Remaining Capital Value: The remaining capital value (value of improvement beyond the analysis period) was considered a benefit and was added to other user benefits.

- Maintenance costs

### Analysis Years

This analysis assumed that the Build Alternative would be constructed over a two-year period, starting in year 2023 with completion in year 2024. Therefore, year 2025 was assumed to be the first full year that benefits will be accrued from the project. The analysis focused on the estimated weekday benefits for the twenty-year period from 2025 to 2044[1]. The present value of all benefits and costs was calculated using 2020 as the year of current dollars.

### Economic Assumptions

The value of time and cost of crashes were obtained from the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated March 2022 (Revised)[2]. Local values for vehicle operating costs (excluding emissions costs) were obtained from *Recommended standard values for use in cost-effectiveness and benefit-cost analysis in SFY2022* from MnDOT Office of Transportation System Management, July 2021[3]. Remaining capital value assumptions were consistent with rates from *Recommended remaining capital value factors for use in benefit-cost analysis in SFY 2021*[4], Minnesota Department of Transportation (MnDOT), Office of Transportation System Management, July 2020 (values were adjusted to reflect a seven percent discount rate). The analysis was completed using an assumed discount rate of seven percent.

### Development of Vehicle Hours Traveled (VHT) and Vehicle Miles Traveled (VMT)

- Regional travel time savings due to new connection: quantified
- Nodal travel time savings due to trip shift from Maple Grove Parkway: quantified
- Operating cost increase due to increased VMT: quantified

Regional year 2014 and 2040 VMT and VHT from the Twin Cities Regional Travel Demand Model were summarized for the No Build and Build Alternatives. The regional model captured travel time changes related to trip diversion by facility type. Figure 1 shows the subarea or "area of influence" that was used for the VMT/VHT analysis. Benefits for the years between 2025 and 2040 were interpolated based on model results using an annual growth rate, and benefits for years between 2040 and 2044 were extrapolated using the same growth rate.

In addition to the Regional Travel Demand Model, a microsimulation model was used to capture differences in signal delay at 12 key Maple Grove Parkway intersections that are most impacted by the proposed project. The analysis compared signal delay between the No Build and the Build Alternative for existing conditions (year 2018) using a Synchro/SimTraffic model. Existing traffic counts were

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1 The study used 365 days per year.
2 https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf)
3 https://www.dot.state.mn.us/planning/program/pdf/Table%20A.1%20SV%20L-ML-H%201-July-202
4 http://www.dot.state.mn.us/planning/program/appendix_a.html

obtained in year 2018. Travel pattern shifts for the Build Alternative were developed using travel patterns identified using the Regional Travel Demand model.

Signal delays were quantified for year 2018 p.m. peak hour. These peak hour delays were factored to daily values assuming that the a.m. peak hour and p.m. peak hour delays were split 40 percent/60 percent, respectively. It was also assumed that a.m. and p.m. peak hour delays accounted for 40 percent of the overall daily delay. The values for existing year delay were held constant for the entire analysis period. This should be considered a conservative estimate as traffic volumes are expected to grow.

Total benefit is the sum of all benefits for the period from 2025 to 2044. Savings due to reduction of VMT and VHT were calculated using costs per mile and per hour that account for vehicle occupancy and different vehicle types.

The microsimulation model was used in combination with the RTDM as RTDMs do not provide the fidelity needed to capture differences in user nodal delays observed at the intersection of roadways where traffic control is needed to facilitate right-of-way in navigating the transportation network.

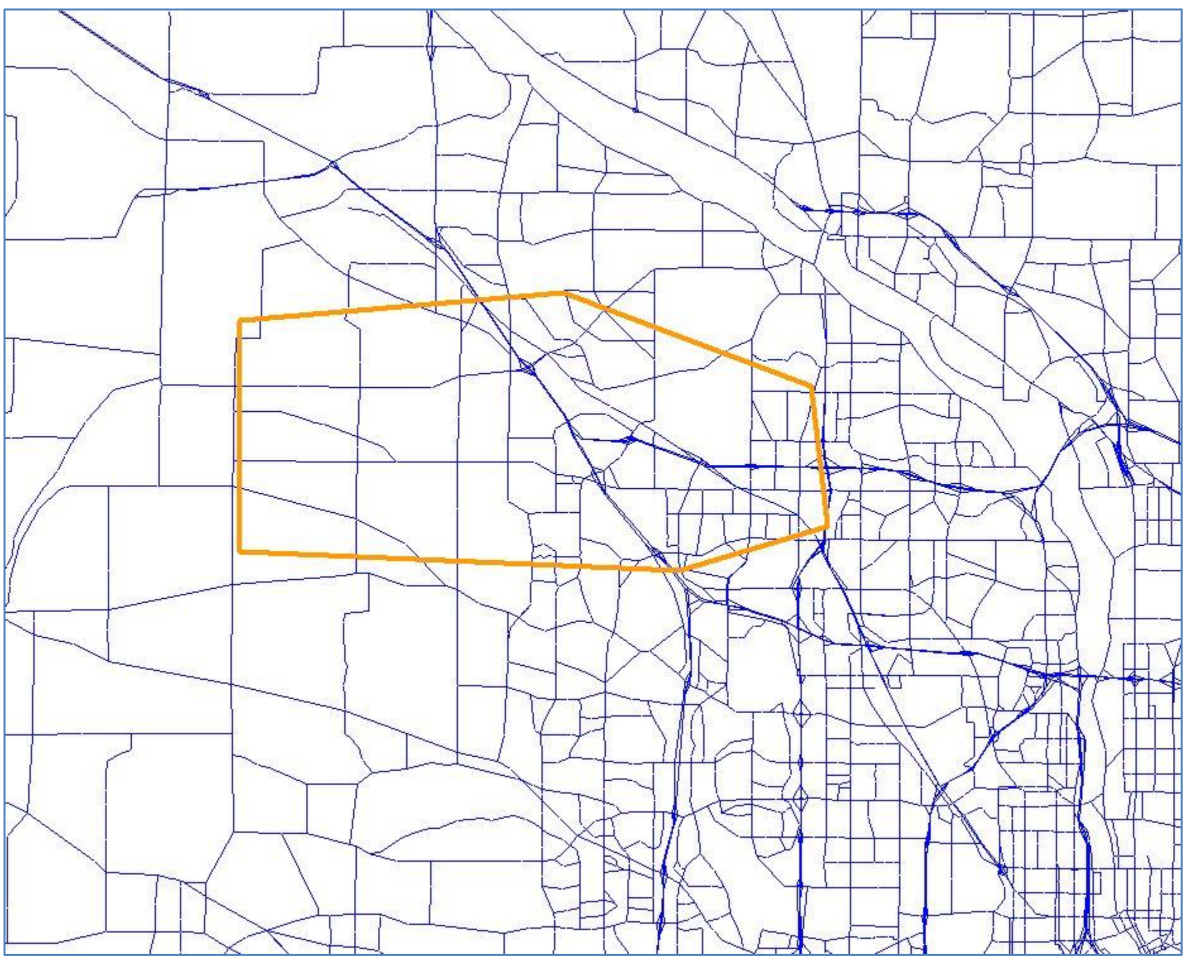

**Figure 1. Travel Demand Model Subarea**

### Vehicle Occupancy, Vehicle Types and Peak Hours

The composite cost per mile used in the benefit-cost analysis accounted for the percentage split of autos and trucks in the travel area. The composite cost per hour accounted for vehicle occupancy ratios, and the percent split of autos and trucks traveling in the area. Key assumptions for these areas included:

- The truck percentage used in the analysis was 8.5 percent, based on Twin Cities Regional Travel Demand Model information – corridor specific.
- Vehicle occupancy that was used in the analysis is consistent with values provided by *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated March 2022 (Revised). The analysis assumed occupancy of 1.67 people per automobile and 1.00 people per truck. These values are from the 2017 National Household Travel Survey.

### Safety Analysis

- Regional travel shifts by roadway classification: quantified

The Build Alternative improves CSAH 30 connection to I-94 and TH 610 by reducing the number of intersections and conflict points. The Twin Cities Regional Travel Demand Model was used to capture shifts in VMT between different facility types. Metro District average crash rates by facility type and severity were obtained from the MnDOT Section Toolkit. Model VMT by facility type was then applied to crash rates by facility type. The crash rates by severity were then applied to the network VMT to estimate crashes by severity. The safety benefit was quantified for years 2014 and 2040 and interpolated/extrapolated based on an annual growth rate to determine total safety benefits for the period from year 2025 to 2044. Crash cost assumptions for the KABCO scale are consistent with values and methodologies published in the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, *March 2022 (Revised)*.

Applying statewide average crash rates by facility type was preferred for estimating a change in crashes compared to using existing crash rates because several of the corridors with notable volume shift (between future No Build and Build conditions) do not currently exist or have current or planned major geometric reconfigurations. Additionally, the project is expected to produce shifts in traffic across the much of the northwest metro, resulting in widespread corridor VMT impacts.

### Environmental and Air Quality Impacts

Annual VMT in the surrounding transportation network is expected to be impacted by Highway 610 completion. The change in VMT between No Build and Build conditions was obtained from the regional travel demand model and applied to emission rates by vehicle type. Average emission rates per vehicle type were obtained from the Environmental Protection Agency's Motor Vehicle Emission Simulator (MOVES) version 3. Emission rates per vehicle type are provided in the attached BCA Workbook. Total change in emissions was valued in accordance with the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated March 2022 (Revised).

### Maintenance Costs

Roadway maintenance costs, associated with maintaining the additional roadway infrastructure under the Build Alternative, were considered as an additional cost to the Build Alternative. An annual maintenance cost of $8,100 per lane mile, which derived from maintenance reports for similar facility types within Minnesota was applied in this analysis. This maintenance cost included costs associated with striping, snow plowing, minor repairs, and shoulder maintenance. Other maintenance costs between the alternatives were assumed to be similar.

### Calculation of Remaining Capital Value

Because many components of the initial capital costs have service lives well beyond the 20-year analysis period, the remaining capital value was calculated for the Build Alternative. This value was expressed in terms of 2020 dollars and was added to other user benefits in accordance with USDOT guidance. In determining remaining capital value, the initial costs of the proposed alternatives were separated into the following categories:

- Right of Way
- Major Structures
- Grading and Drainage
- Sub-Base and Base
- Surface
- Miscellaneous Costs – Includes mobilization, removals, utility relocation, traffic control, contingency (risk), and program delivery. These were assumed to be sunk costs and assigned zero remaining capital value.

### Factors Not Quantified

Several factors were not quantified as part of the analysis because review of initial data indicates low potential to yield substantial benefit. These factors included the following:

- Trips lying outside the specified subarea may accrue benefits that were not accounted for.
- Operating cost savings from improved vehicle efficiency due to increased average vehicle speeds in Build Alternative.
- Crash costs associated with network trips diverting to/from different facility types outside of the specified sub-area were not quantified.
- The methodology does not specifically monetize any transit benefits.
- Improved access and emergency response times to North Memorial Hospital that is adjacent to the Maple Grove Parkway corridor.

## Monetizing Qualitative Benefits

Since the project includes multi-use trails, it is important to quantify the qualitative benefits of the improvements. The methodology used in this section has been previously used in Minnesota and was approved by Minnesota Department of Transportation. The following methodology and assumptions are recommended.

### Main Components

The main components include:

- Cyclists' Mobility
- Cyclists' Mortality (Health)
- Cyclists' Recreation
- Cyclists' Facility Improvement (Amenity)
- Reduced Auto-Use

### Demand Model

Cycling demand was calculated using the methodology developed by National Cooperative Highway Research Program's *National Cooperative Highway Research Program's (NCHRP) Report 552: Guidelines for Analysis of Investments in Bicycle Facilities (2006)*[5] for Build Alternative in comparison with No Build Alternative. The models and methodologies were complemented with engineering judgment, locally developed demand models and knowledge to identify the most likely value within the possible range.

### Population Near Project Area

GIS buffer analysis using 2015-2019 American Community Survey Estimates with 2020 census tracts were used for estimating the population within 0.25-mile, 0.25-0.5 mile and 0.5-1 mile distance from the multi-use trail.

### Relevant Population Characteristics

The characteristics were obtained from multiple sources including:

- Maple Grove Comprehensive Plan (2040) to obtain the population growth[6]
- 2015-2019 American Community Survey Estimates to determine the portion of the population between 20-65 years old
- 2019 ACS 5-Year Estimates (Table S0801) for MN to determine cycling commuters[7]
- *NCHRP Report 552 (2006)*[5] to determine the percentage of adults who commute.
- *Benefit-Cost Analysis Guidance for Discretionary Grant Programs - March 2022 (Revised)* to determine the average cycling trip length (miles).

[5] *National Cooperative Highway Research Program's (NCHRP) Report 552: Guidelines for Analysis of Investments in Bicycle Facilities (2006)*
[6] https://www.maplegrovemn.gov/DocumentCenter/View/1718/Maple-Grove-2040-comprehensive-plan-PDF?bidId=
[7] https://data.census.gov/cedsci/table?q=cycling%20commuter&g=0400000US27&tid=ACSST5Y2019.S0801

### Cycling Demand - New and Existing Daily Cyclists (Commuters and Recreational)

The first step to determine cycling demand is to estimate the population residing near the assumed facilities. Bicycle demand and benefit calculations were based on a methodology described in the *NCHRP Report 552 (2006)*[5]. A buffer analysis was performed around the project area using 2015-2019 American Community Survey Estimates with 2020 census tracts. The census tract data was apportioned based on the area meaning if 25% of the tract was in the buffer than 25% of the population from the 2015-2019 ACS estimates was included in the buffer. Buffers were created at the quarter-mile, half-mile, and one-mile distances from the project (Figure 2). The population residing within these distances of the project was the population assumed to use the new facilities at propensities that vary with distance. Of the population residing in the buffers, the number of commuters for cycling was estimated and the state average of bicycle commuters (.7 percent) was used. The *NCHRP Report 552 (2006)*[5] supplied multipliers to estimate new commuters and existing and new total riders based on the number of existing commuters. For the existing total riders, the report suggests three different models to calculate low, moderate and high estimates of riders due to large variability in bicycle usage in different cities and even larger differences between different neighborhoods within a city. The study allows applying local knowledge and judgement to choose a most likely point estimate within the range of demand levels estimated by those three models. The judgement criteria included design detail of the facility, land use, how suggested facility fits into a larger system, existing counts, etc. For the current project, moderate estimate of total daily cyclists and a 50 percent existing rate was assumed for benefit estimation. Existing rate is the share of daily cyclists in the project area that can be assumed to be existing cyclists and not induced by new infrastructure.

Since cycling demand estimated total daily cyclists, all calculated benefits were multiplied by the annual use. Annual use was determined by type of cyclist, recreational or commuter. All benefits impacting recreational use was multiplied by 275 days (9 months) while benefits impacting commuters were multiplied by 250 (50 weeks multiplied by 5 days).

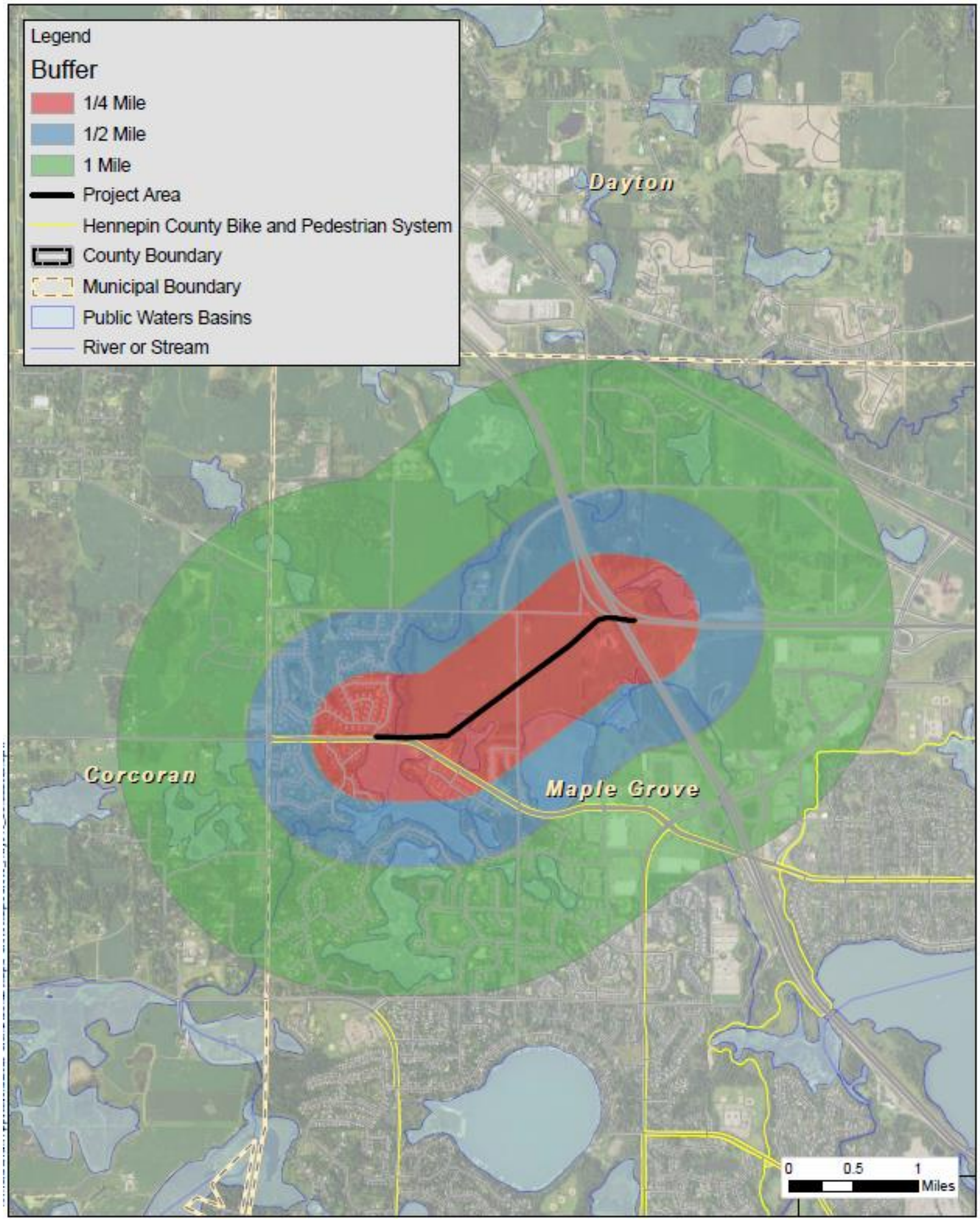


***Figure 2. Cycling Demand Buffers***

## Walking Demand

*NCHRP Report 552 (2006)*[5] states that building new walk facilities is not likely to tangibly increase walking demand as opposed to bicycling for a couple of reasons including: walking is much more common than bicycling and walking facilities are much more widespread than bike facilities. To be conservative in the benefit quantification, no new walkers (and consequently no pedestrian benefits) were assumed in the BCA.

## Mobility Cost Savings

To estimate the value bicyclists place on mobility, the *NCHRP Report 552 (2006)*[5] recommends applying the value of time to the additional travel time bicycle commuters are willing to travel out of their way to get to the facilities. Researchers defined five facility types as:

A) Off-road facilities,
B) In-traffic facilities with bike lane and no on-street parking,
C) In-traffic facilities with a bike lane and on-street parking,
D) In-traffic facilities with no bike lane and no on-street parking, and
E) In-traffic facilities with no bike lane but with on-street parking

These facility types were used to conduct a stated preference survey. The resultant logit model suggests that bicyclists were willing to travel an additional 21.6 minutes to use an off-street facility instead of a street with no facility and no on-street parking. Table 1 summarizes some of NCHRP's suggested mobility benefits that are relevant to the project.

**Table 1. Mobility benefits of different bicycle facility improvements**

| Base facility | Improved facility | Minutes |
|---|---|---|
| B | A | 5.2 |
| D | A | 21.6 |
| E | A | 30.5 |
| E | C | 16.4 |

US Highway 8 Reconstruction Project area's existing conditions are assumed to be a 'D' facility type and the build scenario is assumed as category A.

After multiplying by the value of time ($16.60/hour)[8], the values were applied to new and existing commuters to calculate the mobility benefit. An adjustment factor was added to the NCHRP method to account for the existing facilities in the proximity of the segment of interest. The mobility yielded a total benefit of $229K (undiscounted) over the 20-year evaluation period. Mobility benefits of weekend travel were not included in this estimate.

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[8] Benefit Cost Analysis Guidance for Discretionary Grant Programs, dated January 2020

### Mortality (Health) Cost Savings

Exercise helps to keep people healthy, thereby reducing their annual health costs. *The Benefit-Cost Analysis Guidance for Discretionary Grant Programs - March 2022 (Revised)* estimates that the daily physical activity of new cyclist, either commuter or recreational, saves each of them $6.31 daily. The first twenty years after project implementation, it was estimated that these savings totaled over $363K (undiscounted).

### Recreation Cost Savings

Examining the value people place on different recreational activities, the *NCHRP Report 552 (2006)*[5] estimates that one hour of bicycle recreation is worth $10. The BCA assumed that a "typical" day of bicycling included one hour of activity. Applying this value to the new daily recreational riders yielded a total benefit of $686M (undiscounted) over the evaluation period.

### Cycling Facility Improvement (Amenity) Cost Savings

Various dedicated cycling facility improvements can affect journey preferences among cyclists. The *Benefit-Cost Analysis Guidance for Discretionary Grant Programs - March 2022 (Revised)* estimates a benefit of $1.42 per new cyclist, either commuter or recreational, per cycling mile for a cycling path with at-grade crossing where no comparable parallel facility exists. Since the new trail length of 2.02 miles measures below the national average length of a cycling trip (2.38 miles), the actual length was used. The estimated savings for cycling facility improvement totaled over $175K (undiscounted) over the evaluation period.

### Reduced Auto (Congestion) Cost Savings

As the new bicycle facilities encourage a mode shift to bicycle commuting from automobile commuting, it was assumed that the region would see benefits related to reduced congestion. These benefits include lower travel times through improved traffic flow, reduced emissions, and operational savings for bicyclists. The *NCHRP Report 552 (2006)*[5] estimated that the benefit derived per commuter is $0.13 per mile for city centers and $0.08 for suburban areas. Given the project location, land use, congestion and air pollution level, an average of these two values, $0.105, was used. The actual length of the trail, 2.02 miles, versus the national average cycling trip length of 2.38 miles was used. The project generated roughly $5K (undiscounted) in benefits over the evaluation period. This is a conservative estimate.

### Factors Not Quantified

Several factors are not quantified as part of this methodology because review of initial data indicates low potential to yield substantial cost or benefit. These factors include the following:

- Operations costs due to being part of a currently functioning trail network and roadway facility.
- Trips lying outside the specified subarea may accrue benefits that were not accounted for.

- No safety benefit is assumed for the suggested facilities mainly because there is no consensus in the literature that bicycle facilities can necessarily decrease the total number of bicycle crashes and in some cases off-street facilities have been found to be riskier than bike lanes[9].
- Child cyclists: the official documentation in NCHRP Report 552 (2006) does not cover this category of facility beneficiaries.

## BCA RESULTS

The benefit-cost analysis provides an indication of the economic desirability of a scenario, but results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is greater than 1.0. The larger the ratio number, the greater the benefits per unit cost. Results of the benefit-cost analysis are included in Table 2 below. See link for the complete benefit-cost analysis workbook.

**Table 2 – Results (7% Discount Rate)**

| | Initial Capital Cost (2020 Dollars) | Project Benefits (2020 Dollars) | Benefit-Cost Ratio | Net Present Value (2020 Dollars) |
|---|---|---|---|---|
| No Build vs. Build | $35.5 million | $107.8 million | 3.04 | $72.3 million |

[9] NCHRP Report 552: Guidelines for Analysis and Investments in Bicycle Facilities (2006), p 34.
Jensen, S.U., "Bicycle Tracks and Lanes: a Before-After Study", Transportation Research Board 87th Annual Meeting. Washington, D.C., 2008.
Rodegerdts, L. A., B. Nevers, B. Robinson, J. Ringert, P. Koonce, J. Bansen, T. Nguyen, J. McGill, D. Stewart, J. Suggett, T. Neuman, N. Antonucci, K. Hardy, and K. Courage, Signalized Intersections: Informational Guide, Report No. FHWA-HRT-04-091, USDOT, FHWA, August 2004.
Federal Highway Administration (FHWA), "Separated Bike Lane Planning and Design Guide: Appendix", US Department of Transportation, FHWA, May 2015. p A-5
http://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-8-47, Table 3