



Memorandum

SRF No. 14743

To: Jesse Vlaminc, Project Manager
Minnesota Department of Transportation

From: Erik Kappelman

Date: February 24, 2023

Subject: Marshall MN 19 RAISE Grant BCA

Overview

This document outlines the process through which the benefit cost analysis (BCA) for this RAISE grant application was created. BCAs of this kind commonly accompany grant applications to show the economic value or liability of a potential change or improvement. The results of this BCA will be presented, followed by the relevant methods and conclusions.

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 assumes no pavement preservation and minimal utility maintenance will be undertaken throughout the analysis period. The route's current safety trends will continue, and vehicle travel times and operating costs are expected to increase as the pavement condition deteriorates over time.

Build Alternative

The proposed improvements include:

- Reconstruction of 1.25-mile segment of MN 19
- Reconstruction of 1.52 miles of sidewalks on both sides of MN 19
- Addition of 0.322 miles of bike lane striping
- Construction of a single lane roundabout (RAB) at County Club Dr., W College Dr., and MN 19
- Several pedestrian and bicycle enhancements with ADA upgrades along 15 intersections to eliminate conflict points and accommodate safer pedestrian movements
- Traffic calming measures throughout the corridor.

Results

Two statistics summarize the findings of the BCA. The first is the benefit cost ratio (B/C) that shows the ratio of measured economic benefits to the total cost of the product. The other is the net present value (NPV) of the project or the benefits minus the costs. The list below displays these statistics along with the costs and benefits. All dollars are displayed as 2021 dollars.

- B/C: 1.18
- NPV: \$3,764,374
- Cost: \$20,949,853
- Benefit: \$24,714,228

These results show the project creates benefits for its community, beyond that of its original capital cost.

Benefit Measures

The methodology used for this BCA is based on Benefit-Cost Analysis Guidance for Discretionary Grant Programs, provided by USDOT. Construction of the project is assumed to occur over a two-year period and be completed in year 2026. The first year of analysis is 2027 and the BCA analyzes the subsequent 20 years ending in 2046. Any values that can be taken from the BCA guidanceⁱ for 2023 are used, like truck driver wages or vehicle occupancy. Other sources are used and referenced, when necessary, in the BCA documentation and Workbook.

The main components analyzed included:

1. Intersection Delay
2. Avoided Delay due to Pavement Condition/Roughness
3. Avoided Vehicle Operating Costs due to Pavement Condition/Roughness
4. Vehicle Fuel Operating Costs
5. Safety Impacts
6. Quality of Life Impacts
7. Pedestrian Amenities
8. Air Quality Impacts
9. Operations and Maintenance
10. Residual Capital Valuation/Project Cost

Intersection Delay

Traffic congestion along MN 19 is a strong motivator for this project. The ICE reportⁱⁱ used throughout this analysis compares safety and operational performance between a No Build scenario and the intersection designs proposed for the Build Alternative. Changes in delay were applied to the appropriate intersections to reflect the changes described in this grant. The difference in delay values was applied to the yearly AADT's interpolated from a base year and future year AADT values from the ICE report. The changes to intersection level delay in a real benefit of \$1.4 million.

Corridor Travel Time Costs

By year 2027 the MN 19 corridor will degrade to a minimal pavement condition rating. As the pavement continues to deteriorate, paved sections would likely be removed by exposing the coarse base layer of the subsurface (i.e. similar to a coarse gravel road). Gravel roads tend to slow drivers down relative to paved roads. The current speed limit for the corridor is 30 mph. Under the gravel condition it is assumed that users slow down by an average of 25%, or 7.5 mph, making the new free flow speed 22.5 mph. The real value of these savings is 13.2 million.

Operating Costs – Roughness

Vehicle operating costs will be higher on a coarse gravel road for all vehicles due to the road quality. Using existing methodology,ⁱⁱⁱ a per-mile cost per vehicle, in terms of damage/operation costs, was calculated and used to value difference in the No Build and No Build scenarios. The total real value of avoided repair cost is approximately \$1.7 million.

Operating Costs – Fuel

Operating cost savings from avoidance of greater VHT due to poor pavement condition and intersection traffic control are calculated using the difference in VMT equivalents of vehicle operation per hour traveled between the two scenarios. The effective vehicle operating cost is based on the BCA guidance operating costs and vehicle type. The real value of the fuel cost savings is approximately \$1.3 million.

Safety Impacts

Analysis of safety impacts are based on the changes to traffic control type and the addition of multimodal (e.g. ped/bike) improvements. These changes often result in a reduction of all crashes, auto or pedestrian, by creating a traffic calming effect due to reduced roadway width and enhanced pavement markings. The KABCO crash valuation values, from the BCA guidance, were used to value difference in number of crashes of different types. Three years of crash data were analyzed, 2019-2021, as part of this analysis to create an average per-year crash cost for both No Build and No Build conditions. Table 2 summarizes the predicted crash reductions under the Build scenario.

Table 1. Crashes by Severity and Type (2019-2021)

Type	Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Total
Pedestrian	0	1	2	1	0	4
Motorized	0	1	1	9	43	54
Total	0	2	3	10	43	58

Source: Minnesota Crash Mapping Analysis Tool (MnCMAT2),

The Build scenario addresses issues that the community has observed in terms of safety. These improvements include.

- A one-lane roundabout at the three-legged intersection of W College Dr, Hwy 19, and Country Club Dr.
- Rectangular Rapid Flashing Beacons (RRFBs) near Lyon St and 3rd St.
- Multiple medians with pedestrian refuges between Hill St and Lyon St
- Curb extensions or “bump-outs” will be installed at nearly every intersection along the corridor.
- Two intersections will be converted from minor stop controlled to right-in-right-out (RIRO) intersection type.
- Access management (i.e., reducing drive access to MN 19) throughout the corridor.

Crash Modification Factors (CMF) were used to estimate the individual and collective impact these improvements will have on safety along the corridor. CMFs are factors to determine by what proportion the existing number of crashes would be reduced by a certain improvement. The table below shows the CMFS used for each improvement.

Table 2. CMFs Used in Analysis

Intervention	CMF
Access Management	0.92
Curb Extensions	0.7
RI/RO	0.55
Traffic Calming	0.68
RFRB	0.31
Median	0.14
Roundabout	0.495

Source: <https://www.cmfclearinghouse.org/> direct links in BCA workbook, <https://www.oregon.gov/odot/Engineering/ARTS/CRF-List.xlsx>

Tables 3 and 4 display the results of applying the CMFs over the course of the BCA timeline. Table 3 shows the crash reductions by severity and type. Table 4 shows the same data but the associated value from the BCA guidance has been applied. These tables show nominal results. The total discounted benefit of the changes to safety over the course of the project is \$3.3 million.

Table 3. Crash Reductions by Severity and Type (2027-2046)

Type	Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Total
Pedestrian	0	4	0	0	0	4
Motorized	0	3	9	38	142	192
Total	0	7	9	38	142	196

Table 4. Crash Reduction Value (2027-2046)

Type	Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Total
Pedestrian	-	\$2,300,000	-	-	-	\$2,300,000
Motorized	-	\$1,700,000	\$1,400,00	\$3,100,000	\$600,000	\$5,400,000
Total	-	\$4,000,000	\$1,400,000	\$3,100,000	\$600,000	\$9,100,000

Quality of Life Benefits

The installation of an on-the street dedicated bike lane will increase the efficacy of the bicycle network in Marshall. The 1/3-mile bike lane connects a shared use path more directly to the larger road system allowing existing bikers better access to longer trips. The valuation of this lane is an estimated travel time savings and a general valuation of new miles of bike lane by the number of bike trips. The methods and inputs for this section of analysis come from the National Cooperative Highway Research Program's (NCHRP) Report 552: Guidelines for Analysis of Investments in Bicycle Facilities (2006) and the USDOT BCA guidelines (detailed calculations and references are provided in the Workbook). The real benefit for users in this case is approximately \$280,000.

Pedestrian Amenities

Pedestrian amenities improve the overall experience of travel for pedestrians. Wider sidewalks increase the space available for walking, while also providing a larger buffer between moving vehicles on the road. RFRBs provide safety benefits to pedestrians but also provide decreased wait times for crossing a busy street. Marked crosswalks have a similar effect, but to a lesser extent.

For this analysis, benefits were quantified for increases to sidewalk width, the addition of an RRFB near Lyon St, and marked crosswalks at all intersections. The corridor has an existing sidewalk that needs rebuilding. This project is rebuilding and expanding sidewalks for the entire corridor. The new sidewalks will vary between 6 and 16 feet in width. An estimated average increase of 6 feet was applied to the sidewalks along the corridor. Pedestrian counts were obtained from the existing conditions reports within the ICE report already referenced. The values used to estimate the real value of these changes all come from the January 2023 BCA Guidance. The real value of these amenities over the course of the analysis period is \$1.6 million.

Air Quality Impacts

Changes in emissions are expected to be impacted by the time vehicles spend idling at each of the project intersections. The change in intersection delay between No Build and Build conditions was obtained from travel time analysis and converted to equivalents of vehicle-miles traveled (VMT) by applying fuel consumption for idling vehicles to average miles per gallon for passenger cars. The change in VMT equivalents was then 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 January 2023. The real value of emissions is approximately \$330,000.

Maintenance and Operations

Maintenance costs were estimated at from the current average, \$50,000^{iv} per year. This includes winter snowplowing and salting, fixing small surface issues, and other routine maintenance. These costs are applied to Build and No Build scenarios equally.

Watermain breaks along the corridor occur relatively often, averaging about one-per-year^{iv} in the last eight years. Part of this project would be replacing these aging watermains. Repair in these situations is valued at \$10,000 in the No Build scenario. The frequency of watermain breaks is expected increase if the current infrastructure is not replaced. To represent this under the No Build, the real cost of watermain breaks increase 1% each year to represent the increased likelihood of additional failures. This is a rough estimate, but 1% per year is conservative. Taking these costs into account, the real cost for maintenance and operations is approximately \$280,000.

Capital Costs and Residual Value

The undiscounted 2025/2026 capital costs of the project are about \$30.2 million. The analysis period covers the first 20 years of the life of the improvement. The improvements have useful service lives longer than 20 years. Calculating the residual value of a project means calculating the left-over value of the capital projects. This represents the time after the 20 year analysis period but before the capital assets have fully depreciated. This is estimated based on 20-year average lifespans and depreciation rates of the different components of the project, e.g. right-of-way versus pavement. The real residual value of the project is about \$1.4 million.

Qualitative Benefits

Improved Storm Water Management

In addition to allowing for the repair of existing watermains, the stormwater infrastructure is also upgraded under the Build condition. The project design takes stormwater into account to reduce erosion around and under the road. Stormwater can also carry harmful chemicals or pollutants from

the roadway itself or elsewhere. Quantitatively valuing these impacts is difficult due to the diffuse nature of the economic benefits accrued. The community benefits from reduced erosion and controlling the pollutants like road oil are unquestionable, but deciding precisely how to measure that benefit is complex. Reducing erosion will extend the life of the project and the overall benefit to the community.

Avoided Crashes on Detours

Under the No Build condition of MN 19 will degrade and become less functional. This increases the likelihood of closures and detours. Increased closure is due to the worsening water infrastructure and degrading pavement/surface quality. These detours will increase the likelihood of crashes on the detour routes and would likely increase the overall crash rates on the route relative to when there is no detour.

Utility Replacement and Repair Benefits

The BCA partially quantifies the benefits of the opportune replacement of the watermain along the corridor. The utility lines under the road, other than the watermain, will get refurbished or replaced as part of this project. The repairs to the system benefit all community members by providing more reliable access to necessities like electricity, internet or other.

Bicyclist Benefits

Under the No Build condition, the surface will be less conducive to riding bicycles, either for recreation or commuting. Pedestrian and bicycle data from the 2020 ICE report shows more than 900 crossings over the 13-hour observation period. Under the No Build condition, the bicyclists of those 900 crossings will ride on a rougher less desirable surface. Bike riders might avoid MN 19 entirely and follow longer detoured paths, incurring more costs. The Build scenario offers an improved riding surface for cyclists as well as better water drainage to avoid water pooling near the curb. The extension of the bike lane on the west side of the corridor is one of many improvements along the corridor that benefit cyclist.

Conclusion

This BCA was created using standard methods and inputs found in the federal BCA guidance. The results of the BCA show that the project benefits are more than the costs and will have a positive impact on the City of Marshall and users of MN 19. The analysis conducted meets the best practices described by the USDOT and displays the high value of this project. Refer to the MN 19 BCA workbook spreadsheet file for full details.

ⁱ Benefit-Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, Revised January 2023. <https://www.transportation.gov/sites/dot.gov/files/2023-01/Benefit%20Cost%20Analysis%20Guidance%202023%20Update.pdf>

ⁱⁱ Intersection Control Evaluation Report, TH 19 (College Drive) – S. 4th Street to Bruce Street. Marshall Minnesota, July 14th, 2020

ⁱⁱⁱ NCHRP Report 720 – Estimating the Effects of Pavement Condition on Vehicle Costs

^{iv} Lyon County Maintenance Department/MnDOT