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Memorandum

To: Michael S. Bowman, Sr, White Earth Council Public Work Division

From: Nick Semeja, PE, Senior Engineer

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Subject: Minnesota Trunk Highway 200 Project – 2019 BUILD 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 Minnesota Trunk Highway 200 Project – 2019 BUILD 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, changes in vehicle operating costs, vehicle crashes, environmental impacts, 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, operations costs, safety, and environmental benefits associated with trips moving reliably across the TH 200 corridor through White Earth, Minnesota. TH 200 is an integral part of transportation system of the Reservation. It transects the Reservation from east to west, with continuity from the State line to US Highway 2 near Duluth. The Highway 200 Project will improve travel safety, promote equitable transportation access, and support the economy of White Earth Reservation and the surrounding region.

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 includes leaving the TH 200 and Blair Road corridors in their current geometric and operational state, as described in the above sections of this document. Intensified rehabilitation and maintenance activities to keep the corridors operational are expected to persist over the upcoming years.

Build Alternative

The Build Alternative consists of constructing various geometric and operational enhancements on TH 200 to increase safety and mobility. Specific design elements intended for TH 200 are as follows:

- Shoulders widened to approximately 8 feet for entire project segment
- Ditch and inslope repair for entire segment (4-to-1 minimum slope)
- Clear zone extensions as necessary throughout entire project segment
- Installation of lighting at key intersections (CSAH 3, CSAH 4, and CSAH 7)
- Installation of turn lanes at high-crash locations (T 190 just west of Perch Lake and Blair Road)
- Resurfacing and superelevation adjustment at curves near Perch Lake to be compliant with speeds limit
- Highway realignment to flatten horizontal curves and installation of pedestrian path at Roy Lake
- Installation of warning chevrons (Perch Lake and Roy Lake areas), advanced curve warning signs (Perch Lake area), and enhanced edge lines at highway curves (Roy Lake area)

In addition to the TH 200 improvements, a White Earth Nation (WEN) road (Blair Road) that connects TH 200 to local reservation communities will be reconstructed with a paved surface and expanded shoulder. Reconstruction on Blair Road will reduce roadway maintenance costs while improving mobility and safety across the region.

BCA Methodology

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

1. **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
   - Initial capital costs: Capital costs were expected to be incurred in year 2022
   - 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.
   - Rehabilitation and maintenance costs
2. **Analysis Years**: This analysis assumed that the project would begin construction in year 2022. Project construction was assumed to take one year. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The analysis focused on annual benefits for the twenty-year period from 2023 to 2042[1]. The present value of all benefits and costs was calculated using 2017 as the year of current dollars.

[1] The study used 365 days per year.

3. **Economic Assumptions**: The value of time, vehicle operating costs, cost of crashes, and damage costs for emissions were obtained from the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*[2], dated December 2018. The analysis was completed using assumed discount rate of seven percent.

4. **Development of Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT)**:

   Year 2018 and year 2045 TH 200 VHT were developed using existing and forecast AADTs, corridor length, and average travel speed from the MnDOT District 4 Shoulder Widening Study (in Attachment A). The shoulder widening study applied *Highway Capacity Manual* (HCM) methodologies to determine increase in free-flow speed based on the increased shoulder and clear zone width. Traffic volumes were assumed to be similar between the No Build and Build Alternatives

   The existing TH 200 corridor also periodically experiences flooding near Roy Lake. Realignments and grade improvements under the Build Alternative are expected to remove flood risk and associated vehicle diversion. Diversion route length, average duration of road closure, and annual frequency/probability of flooding was provided by MnDOT District 4 staff. VHT and VMT savings are captured for motorists no longer needing to divert ten miles to the detour route.

   Benefits for the years between 2018 and 2045 were interpolated using a linear annual growth rate. Total benefit is the sum of all benefits for the period from 2023 to 2042. 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.

5. **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 12 percent, which was based on existing year AADT and HCAADT counts obtained from the MnDOT Traffic Mapping Application.
   - Vehicle occupancy that was used in the analysis is consistent with values provided by *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated December 2018. The analysis assumed occupancy of 1.68 people per automobile and 1.00 people per truck. These values are from Federal Highway Administration Highway Statistics 2016, Table VM1.

6. **Safety Analysis:**

   The Highway 200 Project adds several safety improvements on TH 200 and Blair Road. The BCA used nine years of data from 2010 through 2018 as the crash analysis period for TH 200. Since Blair Road has substantially lower AADT than TH 200, a 13-year period from 2006 to 2018 was used to gather a larger sample of data. It should also be noted that the roadway geometry and traffic trends on Blair Road has not changed significantly over the 13-year crash analysis period. Crash data was provided from years 2009 to 2018 by the Minnesota

[2] https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/14091/benefit-cost-analysis-guidance-2018.pdf

Department of Public Safety. For crash data prior to year 2009, the Minnesota Crash Mapping Analysis Tool (MnCMAT) was used to identify crashes.

Existing crashes were disaggregated by location, crash type, and crash severity so that they could be later categorized with the appropriate project improvements. The various improvements assumed in the Build Scenario are listed below:

- Intersection lighting
- Shoulder widening
- Clear zone widening
- Flattening inslope
- Installing a right-turn lane
- Installing chevrons
- Improving pavement condition
- Installing advanced curve warning signs
- Resurfacing pavement and improving superelevation
- Installing wet-reflective pavement markings

Crash impacts associated with the Build Scenario improvements were obtained from: Crash Modification Factors Clearinghouse, the AASHTO *Highway Safety Manual* (2010), and the FHWA Desktop Reference for Crash Reduction Factors, last modified on April 1, 2019. Each crash adjustment factor was applied to appropriate crashes to determine crash reductions under the Build Alternative. The safety benefit was quantified for years 2016 and 2045 and interpolated based on an annual growth rate to determine total safety benefits for the period from year 2023 to 2042. Crash cost assumptions for the KABCO scale are consistent with values and methodologies published in the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated December 2018. More detail on specific crash modification factors and their sources can be found in the appended BCA Workbook.

7. **Environmental and Air Quality Impacts:**

Annual VMT change associated with the flood diversion is expected to reduce emissions. Emission rates per additional mile traveled for autos and trucks were obtained from the United States Environmental Protection Agency, *Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks* (October, 2008)[3]. Total change in emissions was valued in accordance to the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated December 2018.

8. **Rehabilitation and Maintenance Costs**:

Major rehabilitation activities over the BCA period were provided by MnDOT District 4 staff for Blair Road under the Build Scenario and a "do-minimum" (i.e. No Build) scenario. Rehab activities for the No Build assumed a chip seal would have to take place on a three-year cycle to keep the roadway serviceable and up to standards. Rehabilitation activities associated with the Build Scenario are expected to be less frequent and will result in a reduction of department expenditures over the project lifecycle. Major rehabilitation activities for TH 200 were assumed to be similar under the No Build and Build Scenarios.

[3] https://nepis.epa.gov/Exe/tiff2png.cgi/P100EVXS.PNG?-r+75+-g+7+D%3A%5CZYFILES%5CINDEX%20DATA%5C06THRU10%5CTIFF%5C00001432%5CP100EVXS.TIF

Existing annual maintenance costs for TH 200 and Blair Road were provided by MnDOT District 4 staff. Reductions in Build Alternative maintenance costs were quantified for TH 200 and Blair Road by obtaining annual maintenance costs for comparable corridors that underwent similar clearzone and pavement rehabilitation improvements.

9. **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 2017 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 based on service life into the following categories:

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

10. **Factors Not Quantified**: Some factors were not quantified as part of the analysis due to unavailability of data needed to sufficiently estimate benefits or because review of initial data indicated low potential to yield substantial benefit. These factors included the following:

    - Travel time savings associated with increased free-flow speeds due to enhanced pavement condition.
    - Safety savings associated with grading improvements near Goodwin Lake were not quantified.
    - Safety savings associated with the pedestrian path were not quantified since there were no pedestrian crashes in the existing data near the project area. However, this project is expected to reduce the risk of pedestrian crashes over the project life.

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 1 below. See Attachment B for the complete benefit-cost analysis workbook.

Table 1 - Results

	Capital Cost (2017 Dollars)	Project Benefits (2017 Dollars)	Benefit-Cost Ratio (7% Discount Rate)
No Build vs. Build	$17.3 million	$18.6 million	1.1

Attachment A

MnDOT D4 Shoulder Widening Study

Attachment B

Benefit-Cost Analysis Worksheet