HIGHWAY SAFETY IMPROVEMENT PROGRAM (HSIP)

Greater Minnesota Solicitation for District Projects for 2018, 2019, 2020 and 2021

September 2016
# Table of Contents

Introduction..................................................................................................................................................5
Timeline .....................................................................................................................................................6
Requirements ..............................................................................................................................................7
Criteria for Systemic Projects ...................................................................................................................9
Criteria for Reactive Projects ..................................................................................................................10
Submittal Instructions ................................................................................................................................11
Appendix A: Sample HSIP Worksheet ......................................................................................................13
Appendix B: Critical Crash Rates ............................................................................................................15
Appendix C: Recommended Service Life ..................................................................................................27
Appendix D: HSIP & Signals .......................................................................................................................29
Appendix E: Narrow Shoulder Paving Guidelines ....................................................................................31
INTRODUCTION
The Office of Traffic, Safety and Technology (OTST) is soliciting for approximately $12 million over four years of State projects for the Highway Safety Improvement Program (HSIP).

See below for approximate funds available by district. Funding in 2021 is estimated based on 2020 levels: more funds may be available during project selection.

<table>
<thead>
<tr>
<th>District</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>—</td>
<td>$255,000</td>
<td>$1,200,000</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>$600,000</td>
</tr>
<tr>
<td>3</td>
<td>—</td>
<td>—</td>
<td>$900,000</td>
<td>$1,800,000</td>
</tr>
<tr>
<td>4</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>$900,000</td>
</tr>
<tr>
<td>6</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>$1,400,000</td>
</tr>
<tr>
<td>7</td>
<td>—</td>
<td>—</td>
<td>$990,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>8</td>
<td>—</td>
<td>$1,000,000</td>
<td>—</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Total</td>
<td>$0</td>
<td>$1,255,000</td>
<td>$3,090,000</td>
<td>$7,900,000</td>
</tr>
</tbody>
</table>

OTST strongly encourages submitting more projects than the minimum targets listed above as more dollars may become available for quality projects. If 2018 and 2019 funds are left unallocated after this solicitation, then those funds will go to a project outside of this solicitation that can be delivered in the necessary timeframe.
**TIMELINE**

- **July-August**
  - Solicitation will be sent out to all eligible agencies

- **August-October**
  - Each eligible agency selects projects and compiles an application packet based on the criteria guidelines.

- **November 1**
  - Application packets should be submitted to MnDOT's Office of Traffic, Safety and Technology no later than November 10, 2015.

- **November-January**
  - MnDOT Office of Traffic, Safety and Technology will review each application packet for compliance with HSIP criteria guidelines.
  - A preliminary list of prioritized projects is developed.

- **January**
  - HSIP selection committee reviews and approves the list of prioritized projects.

- **February**
  - Notification is sent to applicants announcing selected projects.

- **March-April**
  - Selected projects are placed in the STIP.
REQUIREMENTS

The Highway Safety Improvement Plan (HSIP) selection committee will evaluate each application, prioritize and determine the best funding source for each. Independent of the source from which funding will be secured; certain requirements must be met to receive funding.

1. Applications must be received on or before November 10, 2015.

2. The District Safety Plan should be the starting point for selecting projects for this solicitation.

3. Projects that originate from a road safety plan will be given priority. The higher priority given to the project in the safety plan, the more points that project will receive during the selection process.

4. Only stand-alone projects will be considered. It is recognized that portions of larger projects have elements that improve the safety of an intersection or section of roadway. Safety features, such as guardrail, that are routinely provided as part of a broader project should be funded from the same source as the broader project. Proposals should be limited to those that can be considered legitimate stand-alone safety projects. In some instances, narrow shoulder paving in conjunction with resurfacing projects may be allowed. See Appendix E for these exceptions.

5. Applicants submitting systemic lane departure or intersection projects identified in a Safety Plan, need only fill out page 1 of the application and attach the appropriate pages from that plan. Reactive projects and projects not identified in the Safety Plan need to attach additional documentation as indicated on the application. Page 4 of the application applies only to Reactive/Spot location projects.

6. Applicants are strongly encouraged to coordinate with other jurisdictions and agencies affected by the project. A letter from each of these agencies is required stating that they are aware of the project and have no objections. These letters do not imply participation in funding. Any projects proposed on or adjacent to state roads should be discussed with the MnDOT District Traffic Engineer before the project is submitted.

7. Projects must indicate the roadway and specify both a beginning and an ending reference point. This is to expedite the environmental review and historical site evaluation process.

8. Applicants must agree to maintain any selected projects for the life of the project. (See Appendix C for FHWA Recommended Service Life Criteria.)

9. Projects NOT eligible for funding:
   - road safety audits
   - overlays
   - guardrail updates
   - sign upgrades
   - “Force account” work - all projects must be done by a qualified contractor through the design-bid-build process
   - Maintenance
10. Edgeline restriping projects will be considered for 6” edgelines only. These projects will be selected based on risk as identified in the Safety Plans.

11. New or reconstructed signals will be considered if they meet the criteria contained in Appendix D.

12. Maximum Federal Funding is 90% of eligible total project costs. There is a minimum 10% match required. The match must be made in non-federal “hard dollars”. Soft matches (i.e. volunteer labor, donated materials, professional services) will not be included in the match.

13. Funds are not “capped.” Additional funds may be approved based on bid prices or other unforeseen circumstances. The selection committee must approve any increases in funding.
CRITERIA FOR SYSTEMIC PROJECT FUNDING

A minimum of 70% of the HSIP dollars that are awarded to each District will be systemic. The criteria that will be used to select these projects are detailed in this section of the document.

Proposed projects qualify for the Systemic Program by the following criteria:

- District agrees to maintain for the life of the project – see Appendix C

PRIORITIZATION

Projects will be prioritized using the following criteria:

- Part of a longer range plan (Road Safety Plan or Road Safety Audit Recommendations) – include an excerpt from the existing plan
  - Higher priority projects from the Road Safety Plan will receive more points during the selection process than lower priority projects.

- Cost/mile or Cost/intersection
CRITERIA FOR REACTIVE PROJECT FUNDING

A maximum of 30% of the projects awarded to each District will be reactive. Reactive projects must have a B/C greater than 1 to be considered for funding. The criteria that will be used to select these projects are detailed in this section of the document.

Proposed projects qualify for the Reactive Program by the following criteria:

- Locations must have a significant crash history that includes a fatal or serious injury crashes. Significant crash history can be determined in a number of ways, it is suggested that critical crash rates be used to assess significance. Details on calculating critical rates can be found in APPENDIX B. Contact OTST regarding the average crash rate by intersection type (see also Traffic Safety Fundamentals Handbook page B-8). Contact OTST if you are going to consider using another metric to address/quantify significant crash history.
  

- Must have a benefit/cost (B/C) ratio of 1.0 or greater.* (Note: The B/C ratio shall exclude right-of-way costs.)

  *Only crashes contained within the Minnesota Department of Transportation database can be used to determine the B/C for project submittals. If it is found that crashes have been omitted from MnDOT’s database, you will need to provide the crash report to have those crashes entered into the system.

- Agency agrees to maintain for the life of the project – see Appendix C.

REQUIRED MATERIAL & SPECIAL INSTRUCTIONS FOR REACTIVE PROJECTS

Following, is a list of material required to submit a project. Failure to provide this information will exclude the submission from consideration:

- Project plan or preliminary layout/scope of work proposed
- Calculations demonstrating a significant crash history (see Appendix B)
- HSIP Worksheet – A sample worksheet is included in Appendix A. An Excel version of the HSIP Worksheet is available at: www.mndot.gov/trafficeng/safety/index.html
- Crash data; include all crashes from the three most recent, complete calendar years. Only crashes contained within the Minnesota Department of Transportation’s database can be shown. This is to insure that all project proposals can be equally compared. All crash data must be obtained from MnCMAT.

Each submission should also include the following:

- Cover Letter – include submitting agency, project manager, description of project, Federal funds requested, local match and source.
- Location map.
- Letter from other entities involved in the project stating their awareness of the project and that they have no objections.
SUBMITTAL INSTRUCTIONS

Applications should be submitted electronically to the OTST office. Applications must be received in the office no later than the specified deadline.

Applications for all Districts are due in the OTST office on or before November 10, 2015.

An electronic version of this application can be found at: www.mndot.gov/trafficeng/safety/hsip.html

Electronic submittals must be in a pdf formatted document and be formatted to print no larger than 11x17. Each completed application and its supporting documents should be in ONE pdf file.

IE: If you are submitting three applications/projects, you will have 3 pdf files.

Contact electronic submittals to: SafetyProject.DOT@state.mn.us

Contacts

Applicants having questions or requiring assistance with this application should contact:

Eric DeVoe, OTST
651-234-7016
Eric.DeVoe@state.mn.us

Brad Estochen, OTST
651-234-7011
Bradley.Estochen@state.mn.us
### Appendix A – Sample HSIP Worksheet

#### HSIP Worksheet

<table>
<thead>
<tr>
<th>Control Section</th>
<th>T.H. / Roadway</th>
<th>Location</th>
<th>Beginning Ref. Pt.</th>
<th>Ending Ref. Pt.</th>
<th>State, County, City or Township</th>
<th>Study Period Begins</th>
<th>Study Period Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-494</td>
<td>Portland Ave to Nicollet Ave</td>
<td>3+00.848</td>
<td>4+00.357</td>
<td>Hennepin Co.</td>
<td>1/1/2012</td>
<td>12/31/2014</td>
<td></td>
</tr>
</tbody>
</table>

#### Description of Proposed Work
Construct Westbound auxiliary lane between Portland and Nicollet.

#### Accident Diagram Codes

<table>
<thead>
<tr>
<th>Type of Crash</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear End</td>
<td>Sideswipe Same Direction</td>
<td>1</td>
</tr>
<tr>
<td>1 Left Turn Main Line</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Right Angle</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Ran off Road</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Head On</td>
<td>8.9</td>
<td></td>
</tr>
<tr>
<td>Pedestrian</td>
<td>6, 90, 99</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8, 9</td>
<td></td>
</tr>
</tbody>
</table>

#### Study Period: Number of Crashes

<table>
<thead>
<tr>
<th>Percent Change in Crashes</th>
<th>Fatal</th>
<th>Personal Injury (PI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>Personal Injury (PI)</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>Percent Change in Crashes</td>
<td>-25%</td>
<td>-25%</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

#### Change in Crashes

<table>
<thead>
<tr>
<th>Percent Change in Crashes</th>
<th>Fatal</th>
<th>Personal Injury (PI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>Personal Injury (PI)</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>Percent Change in Crashes</td>
<td>-1.25</td>
<td>-2.50</td>
</tr>
</tbody>
</table>

#### Year (Safety Improvement Construction)
2018

<table>
<thead>
<tr>
<th>Project Cost (Exclude Right of Way)</th>
<th>$ 600,000</th>
<th>Type of Crash</th>
<th>Study Period: Change in Crashes</th>
<th>Annual Change in Crashes</th>
<th>Cost per Crash</th>
<th>Annual Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right of Way Costs (optional)</td>
<td>F</td>
<td>$ 1,140,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Growth Factor</td>
<td>0.5%</td>
<td>A</td>
<td>$ 570,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Recovery</td>
<td>B</td>
<td>$ 170,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount Rate</td>
<td>2%</td>
<td>C</td>
<td>-1.25</td>
<td>-0.42</td>
<td>$ 83,000</td>
<td>$ 34,583</td>
</tr>
<tr>
<td>Project Service Life (n)</td>
<td>30</td>
<td>PD</td>
<td>-2.50</td>
<td>-0.83</td>
<td>$ 7,600</td>
<td>$ 6,333</td>
</tr>
</tbody>
</table>

**B/C = 1.66**

Using present worth values,

**B = $ 998,370**

**C = $ 600,000**

See “Calculations” sheet for amortization.

Office of Traffic, Safety and Technology August 2015
Data for Calculating Benefit/Cost Ratio

The Recommended % Change in Crashes should be taken from the FHWA’s Crash Reduction Factors Clearinghouse. The clearinghouse can be located at: www.cmfclearinghouse.org

Include documentation on how the appropriate crash reduction factor was determined.

The proposal will have to demonstrate in logical fashion how each improvement will impact each type of crash. The MnDOT Selection Committee will review the documentation and estimates for accuracy. Some examples of acceptable estimates are listed below:

**Example 1:** A project is proposing closure of a median at an intersection. Logically, all left turning and cross street right angle crashes will be eliminated (100% reduction in these types of crashes).

**Example 2:** A project is proposing adding right turn lanes at a signal on two approaches. The clearinghouse (www.cmfclearinghouse.org) shows a 9% reduction (empirical Bayes analysis) in all crashes. 9% should be used.

The applicant can contact Julie Whitcher, 651-234-7019, to discuss crash reduction assumptions for each improvement project prior to submittal.

The most beneficial improvement included in the proposed project should be used to determine the crash reduction factor and the recommended service life (Appendix C).

In the interest of standardizing the calculation of an annual cost associated with a given type of highway safety improvement, the following inputs are used in all calculations for HSIP submissions:

- Discount = 2%
- Traffic Growth = 0.5% (The default value of 0.5% is a conservative statewide average. The use can input a different value with documentation.)
- Salvage Value of Right of Way and change in maintenance costs are negligible.

<table>
<thead>
<tr>
<th>Type of Crash</th>
<th>Crash Severity</th>
<th>Crash Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>K</td>
<td>$ 1,140,000</td>
</tr>
<tr>
<td>Personal Injury</td>
<td>A – incapacitating</td>
<td>$ 570,000</td>
</tr>
<tr>
<td></td>
<td>B – non-incapacitating</td>
<td>$ 170,000</td>
</tr>
<tr>
<td></td>
<td>C – possible</td>
<td>$84,000</td>
</tr>
<tr>
<td>Property Damage</td>
<td>PDO or N</td>
<td>$ 7,600</td>
</tr>
</tbody>
</table>

Appendix B

Critical Crash Rates

A Planner’s Guide to Sustained Crash Location Selection – Greater MN Local and District Solicitations

Every year in Minnesota, there are around 75,000 crashes involving motor vehicles. The vast majorities of these crashes (98%) are minor injury or only result in property damage. When looking at all crashes, there is rarely a location or segment that has not had some kind of crash within a given window of time (typically 3, 5 or 10 years of data). Knowing this, it has been difficult to assign where an at-risk location is using solely crash data. Since nearly all segments and intersections have some crashes, it has been possible to establish average crash rates for a given type of intersection of segment. Due to the random nature of crashes, OTST has decided to use a statistical evaluation to determine which locations are below the average crash rate, performing near the average crash rate, those that are above the average crash rate, and those that are statistically significant (i.e. critical) above the crash rate. Using a critical crash helps to ensure that locations being selected are actually having something significant happening, and are not just a result of the random nature of crashes. The Critical Crash Rate helps to filter out areas with low Average Daily Traffic, or evaluated over a short time period.


Calculating the Critical Crash Rate

The Office of Traffic, Safety, and Technology (OTST) evaluates crash data on a routine basis to help monitor trends, track crashes, and establish average crash rates. This data is collected, organized and released in the yearly Toolkit. A new feature to the 2011 Toolkit is the use of the critical crash rate index.

This index is calculated by taking the existing crash rate, and dividing it by the critical crash rate. Any index with a number greater than 1.0 will be considered as having a critical crash rate.

Critical Rate Equation:

\[ R_C = R_A + K \times \left( \frac{R_A}{m} \right)^{1/2} + 0.5/m \]

- \( R_C \) = Critical Crash Rate
- \( R_A \) = System Wide Average Crash Rate
- \( K \) = Confidence Interval
- \( m \) = Vehicle Exposure (for sections this is Vehicle Miles Traveled (VMT), for intersections this is Entering Vehicles)

OTST has established the following confidence intervals for each type of crash rate:

- Crash Rate will be 99.5% Confidence; \( K = 2.756 \)
- Severity Rate will be 99.5% Confidence; \( K = 2.756 \)
- Fatal Rate will be 90% Confidence; \( K = 1.282 \)
- Fatal and Serious (A) Rate will be 90% Confidence; \( K = 1.282 \)
To understand the toolkit, we have included two examples to understand the process OTST will use for location selection and project evaluation. These examples were developed using the 2011 Toolkit. The most current toolkit can be found at: http://ihub/trafficeng/crash_data.html

EXAMPLE 1

Minnesota Trunk Highway 66 is a four lane expressway in rural Minnesota that has a need to be evaluated by the District Engineer. Here are the facts:

- Segment Length = 10.5 miles
- Average Daily Traffic = 33,711
- Crash History (3 years) = 93 crashes total:
  - 1 Fatal, 2 A Injury, 7 B Injury, 20 C Injury, and 63 Property Damage

Calculating the Rates

Crash Rate = \( \frac{(\text{total crashes})\times 1,000,000}{(\text{Length} \times \text{ADT} \times \text{Years} \times 365 \text{ Days/ Year})} \)

Crash Rate = \( \frac{93\times1,000,000}{10.5 \times 33,711 \times 3 \times 365} \)

- **Crash Rate = 0.24**

Severity Rate is a weighted number, which gives more severe crashes a higher score:

K=5 points, A = 4 points, B = 3 points, C = 2 points, PDO = 1 point

Severity Rate = \( \frac{(5\times K + 4\times A + 3\times B + 2\times C + \text{PDO}) \times 1,000,000}{(\text{Length} \times \text{ADT} \times \text{Years} \times 365)} \)

Severity Rate = \( \frac{(5\times 1 + 4\times 2 + 3\times 7 + 2\times 20 + 63)\times 1,000,000}{(10.5 \times 33,711 \times 3 \times 365)} \)

- **Severity Rate = 0.35**

Fatal Rate looks only at fatal crashes.

Fatal Rate = \( \frac{K \times 100,000,000}{(\text{Length} \times \text{ADT} \times \text{Years} \times 365)} \)

Fatal Rate = \( \frac{1\times 100,000,000}{(10.5 \times 33,711 \times 3 \times 365)} \)

- **Fatal Rate = 0.26**

FA Rate is a rate looking only at Fatal and Serious (A) Injury Crashes. This is the current performance measure that OTST uses.

FA Rate = \( \frac{(K+A) \times 100,000,000}{(\text{Length} \times \text{ADT} \times \text{Years} \times 365)} \)

FA Rate = \( \frac{(1+2)\times 100,000,000}{(10.5 \times 33,711 \times 3 \times 365)} \)

- **FA Rate = 0.77**
Comparison

We will need the average crash rates for each of the categories. This is available from the 2011 section toolkit.

For a 4-Lane Rural Expressway, the average rates are:

- Crash Rate = 0.34
- Severity Rate = 0.51
- Fatal Rate = 0.33
- FA Rate = 0.74

Looking at our calculated rates on Page 2, we can see that Crash Rate (0.25), Severity Rate (0.37), and Fatal (0.27) are all below the average rate. This segment of roadway is performing safely compared to similar types of segments.

The FA rate, however, is above the average and will need some evaluation.

Calculating the FA Rate

\[
R_C = R_A + K \times (R_A/m)^{1/2} + 0.5/m
\]

\(R_C\) = Critical Crash Rate

\(R_A\) = System Wide Average Crash Rate (FA Rate = 0.74, from 2011 Toolkit)

\(K\) = Confidence Interval: Fatal and Serious (A) Rate will be 90% Confidence; \(K = 1.282\)

\(m\) = Vehicle Exposure (10.5 miles * 33,711 ADT * 3 years * 365 days/year) = 387.6 Million Vehicle Miles

\(R_C = 0.74 + 1.282 \times (0.74/387.6)^{1/2} + 0.5/387.6\)

\(0.80\) (critical) > \(0.77\) (actual)

FA Index = Actual / Critical = 0.77 / 0.80 = 0.96

- This segment does not meet the critical crash rate criteria.
EXAMPLE 2

An intersection on US TH 202 (a divided expressway) has need for review. Here are the facts:

- Three Legged intersection with MN TH 93 - Unsignalized
- Entering/Approach Volume = 12,300
- Crash History (10 years) = 67 crashes total:
  - 4 Fatal, 5 A Injury, 11 B Injury, 12 C Injury, and 35 Property Damage

Calculating the Rates

Crash Rate = (total crashes) * 1,000,000 / (Entering ADT * Years * 365 Days/Year)
Crash Rate = 67*1,000,000 / 12,300 * 10 years * 365 Days / Year

- Crash Rate = 1.49

Severity Rate is a weighted number, which gives more severe crashes a higher score:
K=5 points, A = 4 points, B = 3 points, C = 2 points, PDO = 1 point
Severity Rate = (5*K + 4*A + 3*B + 2*C + PDO) * 1,000,000 / (Entering ADT * Years * 365)
Severity Rate = (5*4+4*5+3*11+2*12+35)*1,000,000 / (12,300*10*365)

- Severity Rate = 2.94

Fatal Rate looks only at fatal crashes.
Fatal Rate = K * 100,000,000 / (Entering ADT * Years * 365)
Fatal Rate = 4*100,000,000 / (12,300*10*365)

- Fatal Rate = 8.91

FA Rate is a rate looking only at Fatal and Serious (A) Injury Crashes.
FA Rate = (K+A) * 100,000,000 / (Entering ADT * Years * 365)
FA Rate = (4+5)*100,000,000 / (12,300*3*365)

- FA Rate = 20.1

We will need the average crash rates for each of the categories. This is available from the 2011 section toolkit.
For an unsignalized rural thru-stop, the average rates are:

- Crash Rate = 0.29
- Severity Rate = 0.48
- Fatal Rate = 0.50
- FA Rate = 1.38
All of our calculated rates are above the average crash rate. We will use the critical crash equation to find if they are statistically significant.

\[ R_C = R_A + K \cdot \left( \frac{R_A}{m} \right)^{1/2} + 0.5/m \]

- **RC** = Critical Crash Rate
- **RA** = System Wide Average Crash Rate (FA Rate = 0.74, from 2011 Toolkit)
- **K** = Confidence Interval: OTST has established the following confidence intervals for each type of crash rate
  - Crash Rate will be 99.5% Confidence; K = 2.756
  - Severity Rate will be 99.5% Confidence; K = 2.756
  - Fatal Rate will be 90% Confidence; K = 1.282
  - Fatal and Serious (A) Rate will be 90% Confidence; K = 1.282
- **m** = Vehicle Exposure (12,300 ADT * 10 years * 365 days/year) = 44.90 Million Entering Vehicles (MEV)

**Crash Rate**

\[ R_C = 0.29 + 2.756 \cdot \left( \frac{0.29}{44.90} \right)^{1/2} + 0.5/44.90 \]

\[ R_C = 0.52 \text{ (critical)} > 1.49 \text{ (actual)} \]

Crash Rate Index = Actual / Critical = 1.49 / 0.52 = 2.9

- **This segment meets the critical crash rate criteria.**

**Severity Rate**

\[ R_C = 0.48 + 2.756 \cdot \left( \frac{0.48}{44.90} \right)^{1/2} + 0.5/44.90 \]

\[ R_C = 0.78 \text{ (critical)} > 2.94 \text{ (actual)} \]

Severity Index = 2.94 / 0.78 = 3.8

- **This segment meets the critical severity crash rate criteria.**

**Fatal Rate**

\[ R_C = 0.50 + 1.282 \cdot \left( \frac{0.50}{44.90} \right)^{1/2} + 0.5/44.90 \]

\[ R_C = 0.65 \text{ (critical)} > 8.91 \text{ (actual)} \]

Fatal Index = 8.91 / 0.65 = 13.7

- **This segment meets the critical severity crash rate criteria.**
Fatal and Serious Rate

\[ R_C = 1.38 + 1.282 \times (1.38/44.90)^{1/2} + .5/44.90 \]

\[ R_C = 1.62 \text{ (critical)} > 20.1 \text{ (actual)} \]

Fatal and Serious Index = 20.1 / 1.62 = 12.4

- This segment meets the critical severity crash rate criteria.
Understanding the Crashes

After having run the critical rate calculations, we can see there is clearly a sustained crash problem at this location. There is also a problem with fatal and serious injury type crashes.

Comparing this intersection to other intersections in Minnesota, it appears that right angle crashes are over represented at TH 202 and TH 93. When possible, obtaining intersection collision diagrams can also be insightful into understanding the problem.
The collision diagram for this intersection shows a large number of crashes (and especially severe crashes) are occurring on the near side of the intersection. If the goal is to make this intersection safer, this crash type should be our target to eliminate.

**Eliminating the Target Crash Type**

The crash diagram is suggesting that people heading south are pulling out while attempting to turn left, and getting hit by vehicles on the US 202 mainline heading west. Basically, we need to make drivers aware of approaching vehicles, control the intersection and assign right of way, eliminate the ability for people to pull out, or separate the existing conflict points.

The projects that we could implement are the following:

1. Install a Traffic Signal (control the intersection)
2. Install a Reduced Conflict Intersection (RCI) (eliminate the ability to pull out)
3. Construct a grade separated interchange (separate existing conflict points)
Each of the options have pro’s and con’s. The table below shows a simple look at some of these concerns.

<table>
<thead>
<tr>
<th>Description</th>
<th>Time to implement</th>
<th>Cost</th>
<th>Safety Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install a Traffic Signal</td>
<td>Medium</td>
<td>Medium</td>
<td>Signals tend to lower severe crashes moderately, but other crash types typically increase (ie Rear End)</td>
</tr>
<tr>
<td>Reduced Conflict Intersection</td>
<td>Short to Medium</td>
<td>Medium</td>
<td>Medium to High</td>
</tr>
<tr>
<td>Grade Separated Interchange</td>
<td>Long</td>
<td>Long</td>
<td>High</td>
</tr>
</tbody>
</table>

The crash costs that are currently used to establish a benefit/cost ratio are:

<table>
<thead>
<tr>
<th>Type of Crash</th>
<th>Crash Severity</th>
<th>Crash Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>K</td>
<td>$1,140,000</td>
</tr>
<tr>
<td>Personal Injury</td>
<td>A – incapacitating</td>
<td>$570,000</td>
</tr>
<tr>
<td></td>
<td>B – non-incapacitating</td>
<td>$170,000</td>
</tr>
<tr>
<td></td>
<td>C – possible</td>
<td>$84,000</td>
</tr>
<tr>
<td>Property Damage</td>
<td>PDO or N</td>
<td>$7,600</td>
</tr>
</tbody>
</table>

MnDOT – Transportation System Management, [www.mndot.gov/planning/program/appendix_a.html](http://www.mndot.gov/planning/program/appendix_a.html)
Installing a Traffic Signal

Estimated Cost: $300,000

Project Life: 20 years

Typical Crash Reductions:

Fatal and Severe: -30%

Minor Injury: -30%

Property Damage: +60%

<table>
<thead>
<tr>
<th>Crash Severity</th>
<th>Number of Crashes</th>
<th>Crash Cost</th>
<th>Crash Reduction</th>
<th>Crash Cost Savings/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal and Serious</td>
<td>9</td>
<td>$5,460,000</td>
<td>-30%</td>
<td>$163,800</td>
</tr>
<tr>
<td>Minor Injury</td>
<td>23</td>
<td>$2,622,000</td>
<td>-30%</td>
<td>$78,660</td>
</tr>
<tr>
<td>Property Damage</td>
<td>35</td>
<td>$420,000</td>
<td>+60%</td>
<td>-$25,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Yearly Savings</td>
</tr>
</tbody>
</table>

Crash Benefit = $217,260 * 20 years = $4,345,200

Projects Costs + Operations and Maintenance = $300,000 + 10% per year ($30,000*20 year)

Cost = $900,000

Benefit/ Cost = $4,345,200 / $900,000 = 4.8
Installing a Reduced Conflict Intersection

Estimated Cost: $750,000

Project Life: 35 years

Typical Crash Reductions:

Fatal and Severe: -70%

Minor Injury: -40%

Property Damage: - 35%

<table>
<thead>
<tr>
<th>Crash Severity</th>
<th>Number of Crashes</th>
<th>Crash Cost</th>
<th>Crash Reduction</th>
<th>Crash Cost Savings/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal and Serious</td>
<td>9</td>
<td>$5,460,000</td>
<td>-70%</td>
<td>$382,200</td>
</tr>
<tr>
<td>Minor Injury</td>
<td>23</td>
<td>$2,622,000</td>
<td>-40%</td>
<td>$104,880</td>
</tr>
<tr>
<td>Property Damage</td>
<td>35</td>
<td>$420,000</td>
<td>-35%</td>
<td>$14,700</td>
</tr>
</tbody>
</table>

Total Yearly Savings $501,780

Crash Benefit = $501,780 * 35 years = $17,562,300

Projects Costs + Operations and Maintenance = $750,000 + 5% per year ($37,500*35 year)

Cost = $2,062,500

Benefit/ Cost = $17,562,300/ $2,062,500= 8.5
Constructing a Grade Separated Interchange

Estimated Cost: $5,000,000

Project Life: 50 years

Typical Crash Reductions:

Fatal and Severe: -75%
Minor Injury: -60%
Property Damage: -35%

<table>
<thead>
<tr>
<th>Crash Severity</th>
<th>Number of Crashes</th>
<th>Crash Cost</th>
<th>Crash Reduction</th>
<th>Crash Cost Savings/ Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal and Serious</td>
<td>9</td>
<td>$5,460,000</td>
<td>-90%</td>
<td>$491,400</td>
</tr>
<tr>
<td>Minor Injury</td>
<td>23</td>
<td>$2,622,000</td>
<td>-60%</td>
<td>$157,320</td>
</tr>
<tr>
<td>Property Damage</td>
<td>35</td>
<td>$420,000</td>
<td>-35%</td>
<td>$14,700</td>
</tr>
<tr>
<td><strong>Total Yearly Savings</strong></td>
<td></td>
<td><strong>$581,520</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Crash Benefit = $663,420 * 50 years = $33,171,000

Projects Costs + Operations and Maintenance = $5,000,000 + 2% per year ($100,000*50 year)

Cost = $10,000,000

Benefit/ Cost = $33,171,000 / $10,000,000 = 3.3

Benefit/ Cost Analysis

After reviewing the three alternatives, it appears that the reduced conflict intersection gives us the best return on investment, with a BC of 8.5. However, the interchange gives us the most crash savings over the life of the project, but at the highest level of investment.

It is important to remember that many factors go into selecting a project. Cost is one consideration, but one of several. Other factors to remember are mobility, capacity, right of way acquisition, current funds, access management, public feedback, political, social, demographic, and others.

For investments on intersections, an Intersection Control Evaluation (ICE) should be conducted, especially for larger projects.
## Appendix C - Recommended Service Life

<table>
<thead>
<tr>
<th>Description</th>
<th>Service Life</th>
<th>Description</th>
<th>Service Life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intersection &amp; Traffic Control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct Turning Lanes</td>
<td>20</td>
<td>Widen Traveled Way (no lanes added)</td>
<td>20</td>
</tr>
<tr>
<td>Provide Traffic Channelization</td>
<td>20</td>
<td>Add Lane(s) to Traveled Way</td>
<td>20</td>
</tr>
<tr>
<td>Improve Sight Distance</td>
<td>20</td>
<td>Construct Median for Traffic Separation</td>
<td>20</td>
</tr>
<tr>
<td>Install Traffic Signs</td>
<td>10</td>
<td>Wide or Improve Shoulder</td>
<td>20</td>
</tr>
<tr>
<td>Install Pavement Marking</td>
<td>2</td>
<td>Realign Roadway (except at railroads)</td>
<td>20</td>
</tr>
<tr>
<td>Install Delineators</td>
<td>10</td>
<td>Overlay for Skid Treatment</td>
<td>10</td>
</tr>
<tr>
<td>Install Illumination</td>
<td>20</td>
<td>Groove Pavement for Skid Treatment</td>
<td>10</td>
</tr>
<tr>
<td>Upgrade Traffic Signals</td>
<td>20</td>
<td>Install Breakaway Sign Supports</td>
<td>10</td>
</tr>
<tr>
<td>Install New Traffic Signals</td>
<td>20</td>
<td>Install Breakaway Utility Poles</td>
<td>10</td>
</tr>
<tr>
<td>Retime Coordinated System</td>
<td>5</td>
<td>Relocate Utility Poles</td>
<td>20</td>
</tr>
<tr>
<td>Construct Roundabout</td>
<td>20</td>
<td>Install Guardrail End Treatment</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upgrade Guardrail</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upgrade or Install Concrete Median Barrier</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upgrade or Install Cable Median Barrier</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install Impact Attenuators</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flatten or Re-grade Side Slopes</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install Bridge Approach Guardrail Transition</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove Obstacles</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install Edge Treatments</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install Centerline Rumble Strips</td>
<td>7</td>
</tr>
<tr>
<td><strong>Pedestrian &amp; Bicycle Safety</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct sidewalk</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct Pedestrian &amp; Bicycle</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overpass/Underpass</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Install Fencing &amp; Pedestrian Barrier</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct Bikeway</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Structures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Widen or Modify Bridge for Safety</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace Bridge for Safety</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct New Bridge for Safety</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace/Improve Minor Structure for Safety</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upgrade Bridge Rail</td>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Federal Highway Administration (FHWA)
Appendix D: HSIP and Signals

(Revised 10/10/2012)

In most cases, traffic signals are not safety control devices. They assign right of way for vehicles and are necessary for operational purposes. However, in some cases they can improve safety. The objective of the Highway Safety Improvement Program (HSIP) is to “reduce the occurrence of and the potential for fatalities and serious injuries resulting from crashes on all public roads” (23 CRF 924.5). Signal projects will be considered for funding provided they meet the following criteria.

1. New Signals

   - Warrant 7, Crash Experience from the MMUTCD must be met. Specifically, “Five or more reported crashes, of the types susceptible to correction by a traffic control signal, have occurred within a 12-month period”. Exceptions to meeting this warrant may be made if an adequate case is made on how the new signal will reduce the number of, or potential for, fatalities and serious injuries.

     Section 4 of the Minnesota Manual on Uniform Traffic Control Devices can be found at the link below:


   - All new signals shall meet current MnDOT design standards. If exceptions to incorporating these standards are necessary due to site specific conditions, explanation should be included with the application.

   - Installation of red light running (enforcement) lights is strongly encouraged. Installation costs are low when installed with new signals and they provide the benefit of red light running enforcement to be accomplished by one law enforcement officer, instead of two.

   - Documentation should be provided confirming that other intersection types were considered but are not feasible. Those considered should include intersection types that reduce the probability of severe right-angle crashes. Roundabouts restricted crossing u-turn (RCUT) intersections, and some other alternative intersection types fall into this category.

2. Existing Signals

   - Rebuilding an existing signal system is only eligible for HSIP funding if it is necessary for implementation of a geometric improvement (constructing new lanes). The signal system is incidental to the primary safety improvement on these projects, which is geometric.

3. Retiming of signal systems

   - The development and implementation of new signal timing plans for a series of signals, a corridor or the entire system is eligible.
Appendix E – Narrow Shoulder Paving Guidelines

Under certain circumstances it makes sense to pave narrow shoulders in conjunction with a resurfacing project, rather than as a separate, stand-alone project.

The County Road Safety Plans (CRSPs) have identified **6 miles per county per year** for narrow shoulder paving. This work involves the paving of existing aggregate or turf shoulders with 1 to 2 feet of pavement and the addition of a safety edge and a shoulder rumble strip or edge line rumble stripe. The following guidelines are proposed for the selection of future HSIP projects on the local system:

- Narrow shoulder paving can be done in conjunction with resurfacing if the project is along one of the segments specifically identified in the CRSP for this type of work.

- The project can be at a different location than those identified in the CRSP if it is along a higher-risk segment, as identified in the CRSP. The CRSP assigns a risk rating to highway segments based on the following criteria: traffic volume, rate and density of road departure crashes, curve density and edge assessment. The risk rating ranges from 0 (lower risk) to 5 (higher risk). **If the proposed project is along a highway segment with a rating of 4 or 5, then it can be done in conjunction with a resurfacing project.** This process ensures that narrow shoulder paving is being done at locations of higher risk rather than being driven by the schedule of pavement rehabilitation projects.

- The shoulder paving must include a safety edge and either shoulder or edge line rumble strips.

- The Applicant should use regular construction dollars to upgrade guardrail and other safety hardware as part of the resurfacing project.