MID-STATES CORRIDOR

APPENDIX V – LOCAL IMPROVEMENTS ANALYSIS

Mid-States Corridor
Tier 1 Environmental Impact Study

Prepared for

Indiana Department of Transportation

Mid-States Regional Development Authority

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LOCHMUELLER GROUP
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1. INTRODUCTION

This Appendix describes the process which identified local improvement components for all alternatives. After defining key terms, the steps which identified the local improvements are summarized in this **Introduction**. These steps are described in detail in the remainder of this document.

- **Hybrid alternative**. This is an alternative which combines new-terrain construction with upgrades of existing state-jurisdictional highways.
- **Local improvements.** Most of these are upgrades to existing local highways to add passing lanes and make other improvements to the typical cross-section of these highways. These are between about one and one-quarter and three and one-quarter miles in length. One local improvement consists of access management within Jasper which does not include any construction outside of existing right-of-way. These locations were identified by INDOT staff.
- **Local improvement alternative.** A preliminary alternative consisting only of local improvements at 18 locations within the Study Area.

Consideration of hybrid alternatives. As described in **Section 2.4.2.1** of Volume I, part of the alternative development process considered combining upgrades of some portions of existing state highways with the alternatives carried forward in the Screening of Alternatives. Three agencies (USEPA, IDNR and IDEM) requested alternatives which consisted largely or entirely of upgrades to existing highways. Existing state highways which could be upgraded as part of an alternative were identified for all alternatives. The ***most promising*** of these was a variation of **Alternative P** which combined a new-terrain route in Dubois County with an upgrade of US 231 in Martin, Daviess and Greene counties, but this alternative performed poorly on core goals. These included:

- **Goal 1 – Increase Accessibility to Major Business Markets**
- **Goal 2 – Provide More Efficient Truck/Freight Travel in Southern Indiana**
- **Goal 3 – Increase Access to Major Intermodal Centers**

Since hybrid alternatives did not perform well on core goals, they were not considered further.

Some local improvements in the hybrid alternatives supported secondary project goals. The local improvements also were evaluated on an individual basis for their performance on secondary project goals. These included local safety and travel time benefits. Noteworthy local benefits were identified for these local improvements. Similar benefits were also identified for local improvements for alternatives other than **Alternative P**. The local improvements for other alternatives also supported secondary goals.

Each alternative was modified to incorporate associated local improvements. The local improvements became part of each alternative. Each alternative is evaluated on the entire "package" of a new-terrain alignment and associated local improvements.

Consideration of a Study-Area wide local improvement alternative. To fully respond to the agency comments requesting consideration of existing highway upgrades, a "local improvements" alternative also was evaluated. The alternative included the 18 local improvements associated with the five alternatives carried forward. That alternative performed poorly on project core goals. It has only 6 to 15

percent of the labor force access benefits provided by Alternatives M, O and P (the higher performing alternatives). Likewise, it has only 3 to 8 percent of the truck hours saved provided by these three alternatives. See **Table 13** through **Table 16** for comparisons on all core goals.

2. DESCRIPTION OF HYBRID ALTERNATIVE

Hybrid alternatives are supported by several agency comments received early in the project. These requested that alternatives emphasize upgrades to existing facilities rather than new terrain alternatives. Comments included:

- USEPA's Sept. 12, 2019 comment letter suggested that the project "... add passing lanes, increase shoulder widths, add turn lanes and traffic lights at intersections."
- IDNR's March 27, 2020 comment letter stated, "It is strongly recommended that few new highways be created, while existing highways and major roads are enhanced."
- IDEM's September 12, 2019 comment letter stated, "IDEM prefers alternatives that restrict as much of the project as possible to existing road alignments as the best option for avoiding and minimizing impacts to waters."

The Screening of Alternatives Report (see **Appendix D**) considered one preliminary alternative (**Alternative R**) which was almost entirely an upgrade of an existing highway, US 231. **Alternative R** had high impacts to local communities such as Huntingburg, Jasper, and Loogootee. It also performed poorly on core goals. It provided only 15 to 20 percent of labor force access benefits of the three other North Central alternatives. Likewise, it provided only 4 to 6 percent of the truck hour savings as the three other North Central alternatives. See **Table 3-2** in the Screening of Alternatives Report. It was not identified as an alternative carried forward.

For the five alternatives carried forward, consideration was given to combining new terrain alignments in Dubois County with upgrades to existing highways between Dubois County and I-69/SR 37.

State highways proximate to each alternative were identified. **Figure 1** shows each of the alternatives carried forward along with parallel state-jurisdictional highways which were considered for upgrades.

A qualitative engineering feasibility analysis was made for the existing highways associated with each alternative. **Table 1** presents the results of this assessment.

Figure 1 – Comparison of Existing Highways in Relation to Alternatives

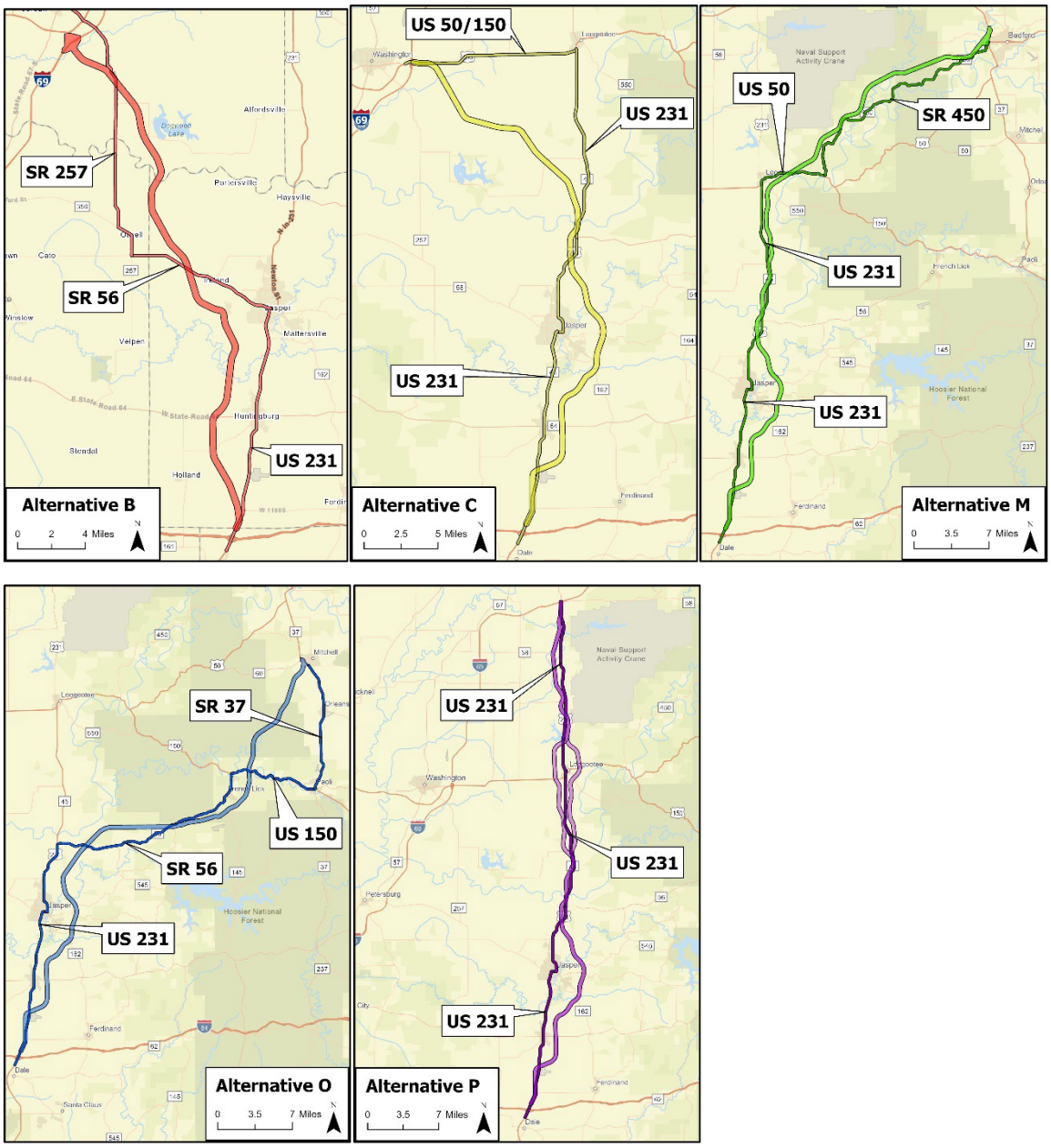


Table 1 – Engineering Assessment of Potential Local Highway Upgrades for Hybrid Alternatives

Alternatives	Mid-States Corridor Summary Assessment of Potential Existing Facility Upgrades in Section 3 for Routes B, C, M, O and P												
Rating	Category	Route B			Route C			Route M			Route O		Route P	
		New Alignmnt.	SR 56	SR 257	New Alignmnt.	US 231	US 50/150	New Alignmnt.	US 50	SR 450	New Alignmnt.	SR 56	New Alignmnt.	US 231
Engineering	End to End Segment Lengths in Section 2 and 3 (Miles)	32.9	35.2		40.4	45.8		62.3	65.6		53.2	53.4	53.6	52.1
	Percentage within Study Band	N/A	-1	-2	N/A	-2	-2	N/A	-1	-2	N/A	-1	N/A	2
	Functional Class Designation	N/A	Major Collector	Major Collector	N/A	Other Principal Arterial	Other Principal Arterial	N/A	Other Principal Arterial	Major Collector	N/A	Minor Arterial	N/A	Other Principal Arterial
	Overall Ease of Upgrade													
	Quality of Existing Pavement	N/A	0	1	N/A	2	2	N/A	1	0	N/A	1	N/A	2
	Existing Horizontal Alignment	N/A	1	1	N/A	1	1	N/A	-1	-2	N/A	-1	N/A	1
	Existing Vertical Alignment	N/A	1	-1	N/A	0	1	N/A	0	-2	N/A	-1	N/A	0
	Maintenance of Traffic, Utility Relocations, Constructability	N/A	0	0	N/A	-1	-2	N/A	-1	-2	N/A	-1	N/A	0
	Require bypasses of towns/communities	N/A	0	-1	N/A	-2	-1	N/A	0	-1	N/A	-2	N/A	-2
Selected Impacts	Residential/Business Relocation	N/A	-1	-1	N/A	-1	-1	N/A	-1	-2	N/A	-2	N/A	-1
	Local Access	N/A	-1	-1	-1			N/A	-1	-2	N/A	-2	N/A	-1
Construction Costs	Likelihood of Capital Cost Savings over New Terrain	N/A	0		N/A	-2		N/A	-2		N/A	-1	N/A	0

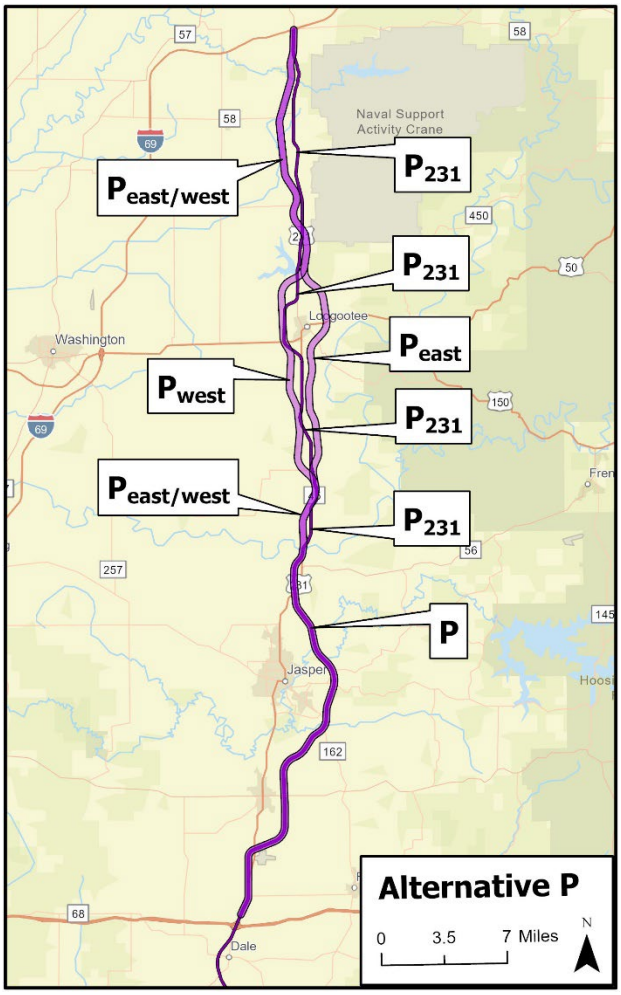
* Ratings are provided on a scale of -2 to +2 unless otherwise indicated.

**-2 and -1 indicate degrees of undesirable/unacceptable ratings, 0 indicates a neutral rating, +1 and +2 indicate degrees of desirable/acceptable ratings.

From this qualitative engineering assessment, US 231, evaluated in relation to **Alternative P**, was the only potential existing facility upgrade that resulted in an overall positive rating for potential feasibility. Based on this a hybrid version of **Alternative P** was selected for an evaluation of costs, impacts and benefits. This hybrid version of **Alternative P** was designated as the **P_{231}** variation. It combined a Super-2 facility type in Dubois County with upgrades of large portions of US 231 in Martin, Daviess and Greene counites.

The **P_{231}** variation did provide lower costs and impacts. However, its performance on core goals was much poorer than the Super-2 and expressway variations of **Alternative P**. It provided only 14 to 15 percent of the labor force access benefits of the Super-2 and expressway variations. It actually had ***negative*** benefits on the truck hour savings measure. See **Table 5**. The full comparison is provided in the following sections. **Figure 2** shows the variations of **Alternative P**. Alignments labeled "P" represent the Super-2 and expressway variations, and those labeled "P_{231}" are the **P_{231}** variation.

Figure 2 – Alternative P Variations, including P_{231} Variation



Cost, Impacts, Core Goal Performance

This cost, impact and benefit comparison was conducted in mid-2021. This comparison included only the costs, impacts and benefits of the new terrain and the hybrid variations. It does not reflect any of the Local Improvements described in **Section 3**. Due to minor refinements to **Alternative P** subsequent to this analysis, the costs, impacts and benefits may differ slightly from those shown elsewhere in this EIS. All costs and impacts assume a western bypass around the City of Loogootee.

Figure 2 shows the three variations of Alternative P.

The P_{231} variation has a significant cost advantage. Following are the construction costs for each. These costs were estimated using the methodology described in **Appendix E**. They were made using the working alignments under consideration in mid-2021.

- P_{231} variation - $381 million
- P Super-2 variation - $620 million
- P Expressway variation - $901 million

Table 2 compares impacts to key resources for the three variations of **Alternative P**.

Table 2 – Impact Comparison of Alternative P Variations

Impact	Comparison of Alternative P Variations		
	P_{231}	**P Super-2**	**P Expressway**
New Right-of-Way (acres)	1,433	2,105	2,759
Floodplains (acres)	150	150	195
Wetlands (acres)	40	49	67
Streams/Rivers (linear ft)	90,600	123,300	161,900
Managed Lands (acres)	18	45	55
Forests (acres)	332	583	743
Agricultural (acres)	706	1,301	1,743
Karst Areas (acres)	0	0	0
Relocations (number)	102	86	121

Table 3 through **Table 6** compares the performance of these variations on project core goals. Overall, the P_{231} variation performs poorly due to the absence of improved, higher-level facilities outside of Dubois County. The upgrades to US 231 for the P_{231} variation in Martin and Daviess counties offer on a very small increase in accessibility and decrease in travel time, compared to higher-level new terrain alignments for the Super-2 and Expressway variations.

Appendix A – Transportation Performance Measures provides details about each performance measure, including how they are calculated.

Table 3 – Performance on Goal 1 – Increase Accessibility to Major Business Markets

Origin-Destination Pair	2045 No-Build Travel Time (Min)	Travel Time Change (Minutes)		
		Expressway	Super-2	P_{231}
Jasper - Indianapolis	142.5	-5	-2	-1
Jasper - Chicago	271.5	-5	-2	-1
Jasper -Louisville	103	-3	-2	-2
Jasper - NSA Crane	47.6	-5	-3	-1
NSA Crane - Rockport	90	-15	-9	-8
NSA Crane - Louisville	131.4	-1	0	-1
Bedford - Louisville	87.5	0	0	0
Bedford - Rockport	114.3	-9	-9	-7
French Lick - Indianapolis	141.5	0	0	0
French Lick -Louisville	76.4	0	0	0
French Lick - Rockport	73.1	-4	-3	-3
Total - All Origin-Destination Pairs		-47	-30	-24
Source: Mid-States Corridor Regional Travel Demand Model				

Table 4 – Performance on Goal 1 – Increase Accessibility to Labor Force

Access From	2045 No-Build Labor Access within 30 Minute Travel Time (PM Peak)			
		P2E	P3E	P_{231}
Jasper	77,778	8,900	8,700	1,000
Crane	73,535	800	500	100
Washington	88,169	300	300	100
French Lick	64,637	1,000	900	200
Bedford	95,300	600	200	200
Total - All O/D Pairs		11,600	10,600	1,600
Source: Mid-States Corridor Regional Travel Demand Model				

Table 5 – Performance on Goal 2 – Provide More Efficient Freight/Truck Travel in Southern Indiana

2045 No-Build Annual VHT	Changes in Annual Truck VHT		
	P2E	P3E	P_{231}
3,565,800	-36,000	-7,900	7,800
Source: Mid-States Corridor Regional Travel Demand Model			

Table 6 – Performance on Goal 7 – Increase Access to Major Intermodal Centers

Origin-Destination Pair	2045 No-Build Travel Time (Min)	Travel Time Change (Minutes)		
		Expressway	Super-2	P_{231}
Jasper - CSX Avon Yard	145.3	-5	-4	-1
Jasper - Senate Ave Yard	140.3	-5	-4	-4
Jasper - Tell City River Port	53.8	-2	-1	-1
Jasper - Port of Indiana (Jeffersonville)	96	-2	-1	-1
Jasper - Louisville Int Airport	101.8	-5	-2	-2
Jasper - Indianapolis Int Airport	135	-5	-2	-1
NSA Crane - CSX Avon Yard	101.8	0	0	0
NSA Crane - Senate Ave Yard	96.7	0	0	0
NSA Crane - Tell City Port	97.3	-12	-8	-5
NSA Crane - Port of Indiana (Jeffersonville)	124.5	-1	-1	-1
NSA Crane - Indianapolis Int Airport	91.4	0	0	0
NSA Crane - Louisville Int Airport	130.2	-1	-1	-1
Total - All Origin-Destination Pairs		-38	-24	-17
Source: Mid-States Corridor Regional Travel Demand Model				

While the **P_{231}** variation generally has lower costs and impacts, it is a poor performer compared to the expressway and Super-2 variations. This comparative performance includes:

- **Increase Accessibility to Major Business Markets.** The **P_{231}** variation has only 51% of the performance of the expressway version and 80% of the performance of the Super-2 version.
- **Increase Accessibility to Labor Force.** The **P_{231}** variation has only 14% of the performance of the expressway version and 15% of the performance of the Super-2 version.
- **Provide More Efficient Freight/Truck Travel in Southern Indiana.** The **P_{231}** variation has ***negative*** performance in this goal. It results in an increase in annual truck VHT of 7,750 hours. By comparison, the expressway variation provides for an annual decrease in truck VHT of 36,000 hours, and the Super-2 variation provides for an annual decrease of truck VHT of 7,900 hours.
- **Increase Access to Major Intermodal Centers.** The **P_{231}** variation has only 47% of the performance of the expressway version and 73% of the performance of the Super-2 version.

The **P_{231}** variation has poor performance on core goals compared to the expressway and Super-2 variations. For one core goal (Truck VHT savings) it has negative performance. Based on this comparative poor performance on all core goals, the **P_{231}** variation was removed from consideration.

Secondary Goal Performance

The **P_{231}** variation considered upgrades to significant portions of US 231 in Martin, Daviess and Greene counties. This analysis identified that these improvements would offer significant benefits which would address regional safety needs (a secondary project goal). These improvements would complement the performance of new-terrain alternatives for project safety as well as accessibility goals.

In order to consider these local improvements as part of the Mid-States project, local highway improvements also were identified which could complement Alternatives B, C, M and O. These improvements were evaluated for the local highways identified in **Table 1**. **Section 3** provides the evaluation of the local improvements associated with all five alternatives (B, C, P, M and O). Based upon these evaluations, each alternative was modified to include these local improvements. The final cost, impact and performance evaluation of all alternatives includes these local improvements as part of each alternative.

It must be noted that the local improvements address secondary project goals. As such, their benefits should be viewed as "other desirable outcomes." In addition, these local improvements may be constructed, and offer benefits many years before the full new-terrain alternatives could be programmed and constructed.

Safety and Travel Time Methodology

The safety benefit calculations are documented in the Appendix to this document. Detailed Highway Safety Manual (HSM) analyses were used to estimate safety benefits. These analyses incorporated 18 variables and 13 crash modification factors. Key variables included AADT, lane width, shoulder width, driveway density and curve lengths/radii (if any). The Appendix also documents the travel time savings calculations.

Identification and Evaluation of Individual Components

Locations for proposed local improvements were identified through consultation with INDOT staff and a review of the safety analysis conducted for the Purpose and Need (see **Appendix CC – Purpose and Need, Section 4.1.1**). These locations are illustrative. A more precise location and length of each local improvement for the preferred alternative will be identified between the Tier 1 DEIS and FEIS as part of identifying the Refined Preferred Alternative in the FEIS. These local improvements will be finalized in Tier 2 NEPA studies.

Section 3 provides the costs, benefits, and impacts of local improvements which are part of each alternative.

3. OTHER LOCAL IMPROVEMENTS

Table 7 shows the local improvements and the alternatives in which each are included. **Figure 3** is a map showing all 18 local improvements. While the local improvements are described as they were evaluated for estimating cost, benefits, and impact, these improvements are illustrative for this Tier 1 analysis and will be further refined as described above.

Tables 8 through 12 show the benefits, costs, and impacts of the full set of local improvements associated with each alternative. These benefits, costs, and impacts are included in the analyses in **Chapter 2** and **Chapter 3** of this DEIS, in addition to the benefits, costs and impacts of the new alignment Super-2 and expressway variations. For both the Super-2 and expressway variations of each route, their total costs, benefits, and impacts are the sum of those for the mainline new terrain alignments and those for the local improvements which are part of that alternative.

Table 7 – Local Improvements

Local Improvement Number	Associated Route(s)	Existing Highway	Description
1	B, C, M, O, P	US 231	Approximately one mile of an added passing lane from near the Huntingburg Airport to CR 750 S in Dubois County, the primary benefits are safety and localized congestion. Anticipate only a southbound passing lane is necessary. Tier 2 studies would be necessary to determine optimal design.
2	B, C, M, O, P	US 231	Approximately three miles of added passing lanes between Huntingburg and Jasper in Dubois County, primary benefits are safety and localized congestion. Anticipate southbound and northbound passing lanes necessary. Tier 2 studies would be necessary to determine optimal design.
3	B, C, M, O, P	US 231	Approximately one and-a-half miles of added lanes from SR 162 to Indiana Street in Jasper, Dubois County. Primary benefits are safety and localized congestion. Added lane may be limited to shared center turn lanes to facilitate left turns, or combination of added through lanes with access control and/or added turn lanes. Tier 2 studies would be necessary to determine optimal design.
4	M, O, P	US 231	Approximately three miles of access management evaluation in Jasper, Dubois County, from Bartley Street to Common Drive. Primary benefits are safety and localized congestion. Tier 2 studies would be necessary to determine optimal design.
5	C, M, O, P	US 231	Approximately three miles of an added passing lane between Jasper and Haysville, Dubois County, from W 400 N to W 600 N. Primary benefit safety. Anticipate only a northbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
6	M, P	US 231	Approximately three miles of an added passing lane north of the White River near Alfordsville, Martin County, between CR 22 and CR 162. Primary benefit is safety. Anticipate only a northbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
7	M, P	US 231	Approximately two miles of an added passing lane south of Loogootee, Martin County, between CR 158 and US 50. Primary benefit is safety. Anticipate only a southbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.

App V – Local Improvements

Local Improvement Number	Associated Route(s)	Existing Highway	Description
8	P	US 231	Approximately one mile of an added passing lane north of Loogootee, Martin County, extending from Loogootee and tying into Route P. Primary benefit is safety. Anticipate only a northbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
9	P	US 231	Approximately two miles of an added passing lane south of the I-69 interchange, includes Greene and Martin counties. Primary benefit is safety. Anticipate only a southbound passing lane necessary. This would tie into Route P. The total length and location would be determined in Tier 2 studies for optimal design.
10	B	SR 56	Approximately two miles of an added passing lane west of Ireland, Dubois County. Primary benefit is safety. Anticipate only a westbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
11	B	SR 257	Approximately two miles of an added passing lane north of the intersection of SR 356 and SR 257, Pike County. Primary benefit is safety. Anticipate only a northbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
12	B	SR 257	Approximately one and-a-half miles of an added passing lane north of the intersection of CR 600 S, Daviess County. Primary benefit is safety. Anticipate only a southbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
13	M	SR 450	Approximately two miles of an added passing lane east of Dover Hill, Martin County. Primary benefit is safety. Anticipate only an eastbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
14	M	SR 450	Approximately one and-a-half miles of an added passing lane west of Bedford, Lawrence County. Primary benefits are safety. Anticipated only a westbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
15	O	SR 56	Approximately two miles of an added passing lane west of intersection of SR 56 and SR 545, Dubois County. Primary benefit is safety. Anticipate only an eastbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
16	O	SR 56	Approximately one mile of an added passing lane between Crystal and Cuzco Road, Dubois County. Primary benefit is safety. Anticipate only an eastbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
17	O	SR 145	Approximately two miles of an added passing lane south of French Lick, Orange County. Primary benefit is safety. Anticipate only a southbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.
18	O	US 150	Approximately one mile of an added passing lane east of West Baden, Orange County. Primary benefit is safety. Anticipate only an eastbound passing lane necessary. Tier 2 studies would be necessary to determine optimal design.

Figure 3 – Local Improvements

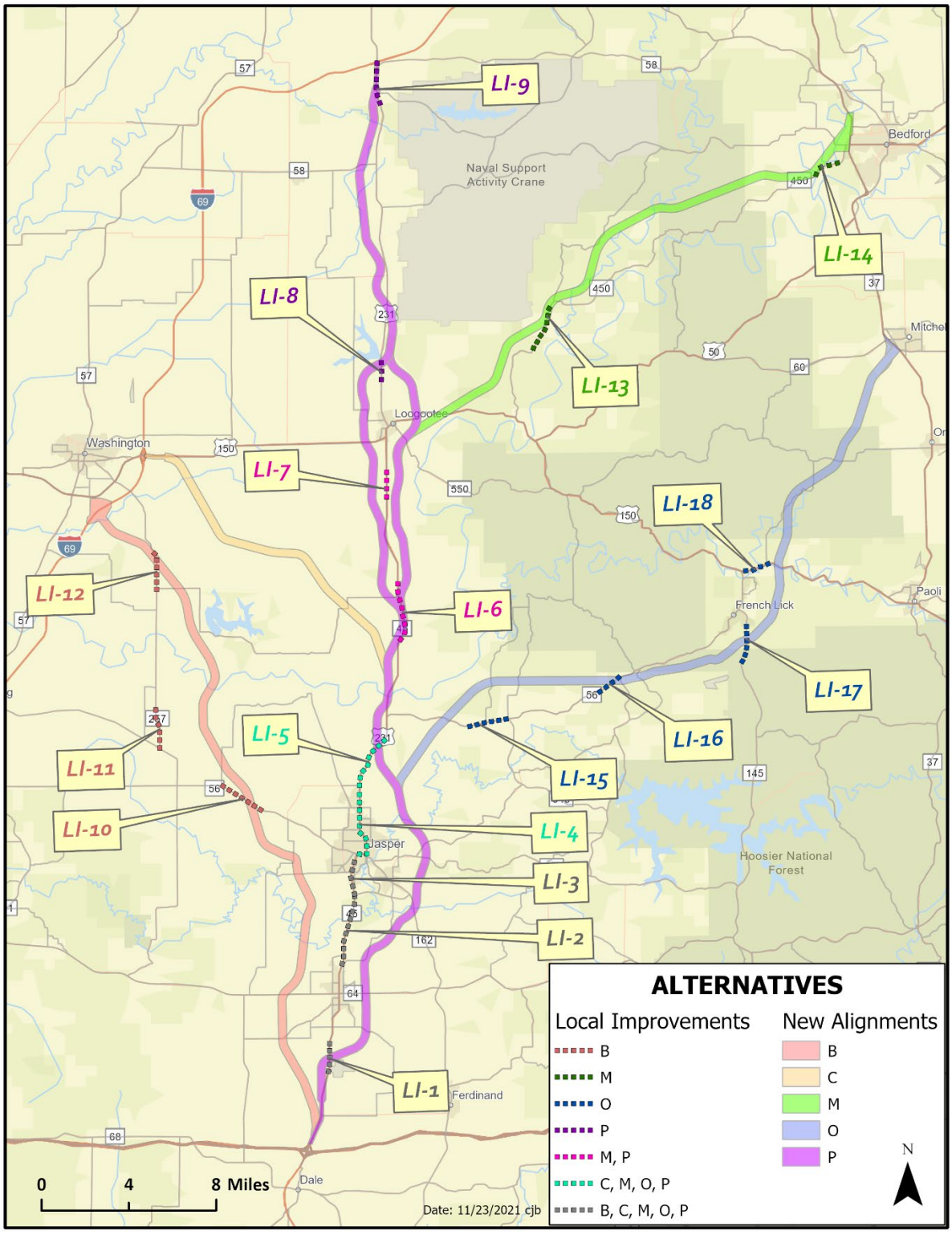


Table 8 – Costs, Benefits and Impacts of Local Improvements Which Are Part of Alternative B

Measure		Alternative B - Local Improvement Component						
		1	2	3	10	11	12	Total
Benefits	Annual Safety Benefit (dollars)	$771,000	$2,158,000	$1,233,000	$771,000	$154,000	$771,000	$5,858,000
	Annual Time Savings (hours)	4,700	14,100	7,100	5,600	700	3,300	35,500
Length/Cost	Length (miles)	1.27	3.16	1.50	2.04	1.78	1.66	11.41
	Construction Cost ($ millions)	$7.30	$31.70	$10.78	$10.42	$8.93	$11.53	$80.66
Impacts	New Right-of-Way[1] (acres)	13	20	0	19	20	12	84
	Floodplains [2] (acres)	5	53	13	0	0	8	79
	Wetlands[3] (acres)	0.1	12	0.001	0	0.2	0.4	12
	Streams/Rivers[4] (linear ft)	1,157	3,471	5,938	575	1,547	5,755	18,444
	Historic Site Parcels [5] (count)	0	0	0	0	0	0	0
	Managed Lands [6] (acres)	0	1.6	0	0	0	0	2
	Forests [7] (acres)	1	19	0.1	2	4	1	27
	Agricultural [7] (acres)	9	10	0.01	15	15	10	61
	Karst Areas [8] (acres)	0	0	0	0	0	0	0
	Parcels with Potential Relocations (count)	1	4	1	8	9	4	27

[1] Existing ROW layer was created from county parcel data layers and aerial photography. It was subtracted from the design ROW.

[2] IDNR Best Available Layer (06/2020). Acres include both the floodway and the floodplain fringe.

[3] USFWS National Wetland Inventory - Includes all wetland types except "riverine".

[4] USGS National Hydrography Dataset, Local Resolution -- Includes streams and rivers that have been given a classification.

[5] Impacts to parcels with a historic structure. The structure may not occur in the ROW. Data is from the Indiana SHAARD Historic Database and field windshield survey by professional historians.

[6] Managed Lands data is a compilation of layers (04/2020) from IDNR, NRCS, National Forests, GAP Program, land trusts, and local government.

[7] Forest (Deciduous, Evergreen, Mixed, and Wetlands) and Agriculture (Crops, Pasture) layers are subsets of the National Land Cover Dataset 2016. General land cover data classified from 30-meter

[8] IGS layer of sinkhole areas and sinking stream basins.

[9] Potential Relocations are a count of parcels containing one or more structures within 20 feet of the ROW. Isolated outbuildings were not included.

Table 9 – Costs, Benefits and Impacts of Local Improvements Which Are Part of Alternative C

Measure		Alternative C - Local Improvement Component					
		1	2	3	4	5	Total
Benefits	Annual Safety Benefit (dollars)	$167,000	$1,850,000	$1,079,000	$1,308,000	$1,542,000	$6.396,000
	Annual Time Savings (hours)	4,300	11,900	6,400	0	6,600	29,200
Length/Cost	Length (miles)	1.27	3.16	1.50	3.20	2.46	12
	Construction Cost ($ millions)	$7.30	$31.70	$10.78	$1.00	$19.09	$69.87
Impacts	New Right-of-Way[1] (acres)	13	20	0	0	23	56
	Floodplains [2] (acres)	5	53	13	0	3	75
	Wetlands[3] (acres)	0.1	12	0.001	0	0	12
	Streams/Rivers[4] (linear ft)	1,157	3,471	5,938	0	3,980	14,546
	Historic Site Parcels [5] (count)	0	0	0	7	0	7
	Managed Lands [6] (acres)	0	1.6	0	0.008	0	2
	Forests [7] (acres)	1	19	0.1	0.02	4	24
	Agricultural [7] (acres)	9	10	0.01	0	9	29
	Karst Areas [8] (acres)	0	0	0	0	0	0
	Parcels with Potential Relocations (count)	1	4	1	0	15	21

[1] Existing ROW layer was created from county parcel data layers and aerial photography. It was subtracted from the design ROW.

[2] IDNR Best Available Layer (06/2020). Acres include both the floodway and the floodplain fringe.

[3] USFWS National Wetland Inventory - Includes all wetland types except "riverine".

[4] USGS National Hydrography Dataset, Local Resolution -- Includes streams and rivers that have been given a classification.

[5] Impacts to parcels with a historic structure. The structure may not occur in the ROW. Data is from the Indiana SHAARD Historic Database and field windshield survey by professional historians.

[6] Managed Lands data is a compilation of layers (04/2020) from IDNR, NRCS, National Forests, GAP Program, land trusts, and local government.

[7] Forest (Deciduous, Evergreen, Mixed, and Wetlands) and Agriculture (Crops, Pasture) layers are subsets of the National Land Cover Dataset 2016. General land cover data classified from 30-meter satellite imagery.

[8] IGS layer of sinkhole areas and sinking stream basins.

[9] Potential Relocations are a count of parcels containing one or more structures within 20 feet of the ROW. Isolated outbuildings were not included.

Table 10 – Costs, Benefits and Impacts of Local Improvements Which Are Part of Alternative M

Measure		Alternative M - Local Improvement Component									
		1	2	3	4	5	6	7	13	14	Total
Benefits	Annual Safety Benefit (dollars)	$617,000	$1,696,000	$1,079,000	$1,263,000	$1,388,000	$154,000	$308,000	$154,000	$463,000	$7,122,000
	Annual Time Savings (hours)	4,200	10,800	6,000	0	5,900	900	1,800	700	2,700	33,000
Length/Cost	Length (miles)	1.27	3.16	1.50	3.20	2.46	2.65	1.13	1.99	1.17	19
	Construction Cost ($ millions)	$7.30	$31.70	$10.78	$1.00	$19.09	$18.47	$11.95	$14.72	$18.47	$82.70
Impacts	New Right-of-Way[1] (acres)	13	20	0	0	23	49	8	39	20	172
	Floodplains [2] (acres)	5	53	13	0	3	10	6	7	7	106
	Wetlands[3] (acres)	0.1	12	0.001	0	0	1	0.003	0.2	0	13
	Streams/Rivers[4] (linear ft)	1,157	3,471	5,938	0	3,980	5,044	1,964	3,049	340	24,943
	Historic Site Parcels [5] (count)	0	0	0	7	0	0	0	0	0	7
	Managed Lands [6] (acres)	0	1.6	0	0.008	0	0	0	0	0	2
	Forests [7] (acres)	1	19	0.1	0.02	4	28	2	23	18	97
	Agricultural [7] (acres)	9	10	0.01	0	9	17	11	15	2	73
	Karst Areas [8] (acres)	0	0	0	0	0	0	0	0	12	12
	Parcels with Potential Relocations (count)	1	4	1	0	15	3	2	4	4	34

[1] Existing ROW layer was created from county parcel data layers and aerial photography. It was subtracted from the design ROW.

[2] IDNR Best Available Layer (06/2020). Acres include both the floodway and the floodplain fringe.

[3] USFWS National Wetland Inventory - Includes all wetland types except "riverine".

[4] USGS National Hydrography Dataset, Local Resolution -- Includes streams and rivers that have been given a classification.

[5] Impacts to parcels with a historic structure. The structure may not occur in the ROW. Data is from the Indiana SHAARD Historic Database and field windshield survey by professional historians.

[6] Managed Lands data is a compilation of layers (04/2020) from IDNR, NRCS, National Forests, GAP Program, land trusts, and local government.

[7] Forest (Deciduous, Evergreen, Mixed, and Wetlands) and Agriculture (Crops, Pasture) layers are subsets of National Land Cover Dataset 2016. General land cover data classified from 30-meter satellite imagery.

[8] IGS layer of sinkhole areas and sinking stream basins.

[9] Potential Relocations are a count of parcels containing one or more structures within 20 feet of the ROW. Isolated outbuildings were not included.

Table 11 – Costs, Benefits and Impacts of Local Improvements Which Are Part of Alternative O

Measure		Alternative O - Local Improvement Component									
		1	2	3	4	5	15	16	17	18	Total
Benefits	Annual Safety Benefit (dollars)	$771,000	$1,696,000	$1,079,000	$1,263,000	$1,696,000	$308,000	$154,000	$771,000	$925,000	$8,663,000
	Annual Time Savings (hours)	4,400	11,400	6,100	0	7,800	2,100	1,000	5,000	5,300	43,100
Length/Cost	Length (miles)	1.27	3.16	1.50	3.20	2.46	1.69	1.07	1.42	1.08	17
	Construction Cost ($ millions)	$7.30	$31.70	$10.78	$1.00	$19.09	$10.83	$8.49	$10.04	$11.50	$110.73
Impacts	New Right-of-Way[1] (acres)	13	20	0	0	23	28	17	7	8	116
	Floodplains [2] (acres)	5	53	13	0	3	0	10	29	22	136
	Wetlands[3] (acres)	0.1	12	0.001	0	0	0.05	0.01	0.3	1	13
	Streams/Rivers[4] (linear ft)	1,157	3,471	5,938	0	3,980	984	3,878	3,134	2,583	25,126
	Historic Site Parcels [5] (count)	0	0	0	7	0	1	0	0	0	8
	Managed Lands [6] (acres)	0	1.6	0	0.008	0	0	0	0	0	2
	Forests [7] (acres)	1	19	0.1	0.02	4	9	8	5	2	50
	Agricultural [7] (acres)	9	10	0.01	0	9	17	7	5	4	61
	Karst Areas [8] (acres)	0	0	0	0	0	0	0	0	0.4	0
	Parcels with Potential Relocations (count)	1	4	1	0	15	6	3	1	1	32

[1] Existing ROW layer was created from county parcel data layers and aerial photography. It was subtracted from the design ROW.

[2] IDNR Best Available Layer (06/2020). Acres include both the floodway and the floodplain fringe.

[3] USFWS National Wetland Inventory - Includes all wetland types except "riverine".

[4] USGS National Hydrography Dataset, Local Resolution -- Includes streams and rivers that have been given a classification.

[5] Impacts to parcels with a historic structure. The structure may not occur in the ROW. Data is from the Indiana SHAARD Historic Database and field windshield survey by professional historians.

[6] Managed Lands data is a compilation of layers (04/2020) from IDNR, NRCS, National Forests, GAP Program, land trusts, and local government.

[7] Forest (Deciduous, Evergreen, Mixed, and Wetlands) and Agriculture (Crops, Pasture) layers are subsets of the National Land Cover Dataset 2016. General land cover data classified from 30-meter satellite imagery.

[8] IGS layer of sinkhole areas and sinking stream basins.

[9] Potential Relocations are a count of parcels containing one or more structures within 20 feet of the ROW. Isolated outbuildings were not included.

Table 12 – Costs, Benefits and Impacts of Local Improvements Which Are Part of Alternative P

Measure		Alternative P - Local Improvement Component									
		1	2	3	4	5	6	7	8	9	Total
Benefits	Annual Safety Benefit (dollars)	$617,000	$1,696,000	$1,079,000	$1,263,000	$1,388,000	$308,000	$308,000	$308,000	$1,388,000	$8,355,000
	Annual Time Savings (hours)	3,700	11,300	6,500	0	6,100	1,800	1,700	2,800	10,300	44,200
Length/Cost	Length (miles)	1.27	3.16	1.50	3.20	2.46	2.65	1.13	0.78	1.85	18.01
	Construction Cost ($ millions)	$7.30	$31.70	$10.78	$1.00	$19.09	$18.47	$11.95	$6.38	$8.69	$115.36
Impacts	New Right-of-Way[1] (acres)	13	20	0	0	23	49	8	6	8	127
	Floodplains [2] (acres)	5	53	13	0	3	10	6	0.002	0	91
	Wetlands[3] (acres)	0.1	12	0.001	0	0	1	0.003	0	0	13
	Streams/Rivers[4] (linear ft)	1,157	3,471	5,938	0	3,980	5,044	1,964	1,012	243	22,810
	Historic Site Parcels [5] (count)	0	0	0	7	0	0	0	0	0	7
	Managed Lands [6] (acres)	0	1.6	0	0.008	0	0	0	0	0	2
	Forests [7] (acres)	1	19	0.1	0.02	4	28	2	2	3	59
	Agricultural [7] (acres)	9	10	0.01	0	9	17	11	7	16	79
	Karst Areas [8] (acres)	0	0	0	0	0	0	0	0	0	0
	Parcels with Potential Relocations (count)	1	4	1	0	15	3	2	1	1	28

[1] Existing ROW layer was created from county parcel data layers and aerial photography. It was subtracted from the design ROW.

[2] IDNR Best Available Layer (06/2020). Acres include both the floodway and the floodplain fringe.

[3] USFWS National Wetland Inventory - Includes all wetland types except "riverine".

[4] USGS National Hydrography Dataset, Local Resolution -- Includes streams and rivers that have been given a classification.

[5] Impacts to parcels with a historic structure. The structure may not occur in the ROW. Data is from the Indiana SHAARD Historic Database and field windshield survey by professional historians.

[6] Managed Lands data is a compilation of layers (04/2020) from IDNR, NRCS, National Forests, GAP Program, land trusts, and local government.

[7] Forest (Deciduous, Evergreen, Mixed, and Wetlands) and Agriculture (Crops, Pasture) layers are subsets of the National Land Cover Dataset 2016. General land cover data classified from 30-meter satellite imagery.

[8] IGS layer of sinkhole areas and sinking stream basins.

[9] Potential Relocations are a count of parcels containing one or more structures within 20 feet of the ROW. Isolated outbuildings were not included.

4. EVALUATION OF LOCAL IMPROVEMENTS – ALL ROUTES

Multiple agency requests asked that an alternative be considered which consisted largely or entirely of improvements to existing highways. This request was made by the following agencies.

- **USEPA's Sept. 12, 2019 comment letter** suggested that the project "... add passing lanes, increase shoulder widths, add turn lanes and traffic lights at intersections."
- **IDNR's March 27, 2020 comment letter stated**, "It is strongly recommended that few new highways be created, while existing highways and major roads are enhanced."
- I**DEM's September 12, 2019 comment letter stated**, "IDEM prefers alternatives that restrict as much of the project as possible to existing road alignments as the best option for avoiding and minimizing impacts to waters."

To consider these comments, an alternative (designated the Upgrade Alternative) was identified which consisted of all 18 local improvements identified in the previous section. A forecast year (2045) traffic assignment was provided for which the Upgrade Alternative was the Build Alternative. **Tables 13 through 16** compare the performance of the Upgrade Alternative on the project core goals with the performance of the Super-2[1] variations of Alternative B, C, P, M and O. These local improvements are described in **Table 7** and depicted in **Figure 3**.

The performance measures in **Tables 3** through **6** were calculated earlier in the project. Since that time, refinements have been made to **Alternative P**. Accordingly, the performance measures shown in the following tables may not coincide exactly with those shown in **Tables 3 through 6**.

[1] The expressway variations typically have much higher performance than Super-2 variations. This comparison is provided to Super-2 variations to compare the Upgrade Alternative to less expensive, lower-level variation with lower performance than expressway variations.

Table 13 – Performance on Goal 1 – Increase Accessibility to Major Business Markets

Origin-Destination Pair	2045 No-Build Travel Time (Min)	Travel Time Change (Minutes)					
		Alt. B	Alt. C	Alt. M	Alt. O	Alt. P	Upgrade Alternative
Jasper - Indianapolis	145.3	-1	-1	-1	0	-2	-2
Jasper - Chicago	140.3	-1	-1	-2	0	-2	-2
Jasper -Louisville	53.8	-2	-1	-2	-3	-2	-1
Jasper - NSA Crane	96	-1	-1	-1	-2	-3	-2
NSA Crane - Rockport	101.8	-2	-6	-11	-7	-9	-3
NSA Crane - Louisville	135	-1	0	0	0	0	0
Bedford - Louisville	101.8	0	0	0	0	0	0
Bedford - Rockport	96.7	0	-3	-9	-3	-4	-1
French Lick - Indianapolis	97.3	0	0	0	-1	0	0
French Lick -Louisville	124.5	0	0	0	0	0	0
French Lick - Rockport	91.4	0	-3	-4	-5	-3	0
Total - All Origin-Destination Pairs		-8	-16	-30	-21	-25	-11

Source: Mid-States Corridor Regional Travel Demand Model

Travel Time Changes for Alternatives B, C, P, M and O are for the Super-2 Variations

Table 14 – Performance on Goal 1 – Increase Accessibility to Labor Force

Access From	2045 No-Build Labor Force Access within 30 Minute Travel Time (PM Peak)	Added Access to Labor Force (Persons)					
		Alt. B	Alt. C	Alt. M	Alt. O	Alt. P	Upgrade Alt.
Jasper	77,800	2,100	1,700	7,600	8,400	8,700	600
Crane	73,500	300	0	100	0	500	200
Washington	88,200	12,900	2,000	0	0	300	100
French Lick	64,600	0	800	600	17,000	900	500
Bedford	95,300	0	0	1,900	900	0	200
Total - All O/D Pairs		15,300	4,500	10,200	26,300	10,400	1,600

Source: Mid-States Corridor Regional Travel Demand Model
"Labor Force" defined as residents at least 16 years of age.

Labor Force Access Increases for Alternatives B, C, P, M and O are for the Super-2 Variations

Table 15 – Performance on Goal 2 – Provide More Efficient Freight/Truck Travel in Southern Indiana

2045 No-Build Annual VHT	Changes in Annual Truck VHT					
	Alternative B	Alternative C	Alternative M	Alternative O	Alternative P	Upgrade Alternative
3,565,700	11,100	-1,800	-7,800	3,000	-8,400	-300

Source: Mid-States Corridor Regional Travel Demand Model
Negative Numbers Indicate Reductions in Truck VHT (Travel Time Savings)
Truck Hour Savings for Alternatives B, C, P, M and O are for the Super-2 Variations

Table 16 – Performance on Goal 7 – Increase Access to Major Intermodal Centers

Origin-Destination Pair	2045 No-Build Travel Time (Min)	Travel Time Change (Minutes)					
		Alternative B	Alternative C	Alternative M	Alternative O	Alternative P	Upgrade Alternative
Jasper - CSX Avon Yard	145.3	-1	-1	-1	0	-4	-2
Jasper - Senate Ave Yard	140.3	0	0	-1	0	-4	-2
Jasper - Tell City River Port	53.8	0	0	-2	-2	-1	-1
Jasper - Port of Indiana (Jeffersonville)	96	0	0	-2	-2	-1	-1
Jasper - Louisville Int Airport	101.8	0	0	-2	-2	-2	-1
Jasper - Indianapolis Int Airport	135	-1	0	-1	0	-2	-2
NSA Crane - CSX Avon Yard	101.8	0	0	0	0	0	0
NSA Crane - Senate Ave Yard	96.7	0	0	0	1	0	0
NSA Crane - Tell City Port	97.3	-1	-2	-8	-4	-8	-3
NSA Crane - Port of Indiana (Jeffersonville)	124.5	-1	0	0	0	-1	0
NSA Crane - Indianapolis Int Airport	91.4	0	0	0	0	0	0
NSA Crane - Louisville Int Airport	130.2	0	0	0	0	0	0
Total - All Origin-Destination Pairs		-4	-3	-17	-9	-23	-12

Source: Mid-States Corridor Regional Travel Demand Model
Travel Time Changes for Alternatives B, C, P, M and O are for the Super-2 Variations

Costs, Impacts and Benefits

The Upgrade Alternative is not a truly low-cost alternative. Its total cost is $170 million.

The Upgrade Alternative also has noteworthy impacts. **Table 17** compares its costs and impacts with the P_{231} hybrid alternative (see **Section 2**) considered earlier. The P_{231} Alternative also included significant upgrades to existing highways. **Table 17** also includes the comparison provided in **Table 2** of the Super-2 and Expressway variations of **Alternative P.**

The performance of the Upgrade Alternative is poorer than Super-2 alternatives. The following points compare its performance to the three higher-performing Super-2 alternatives (Alternatives M, O and P).

- **Increased accessibility to major business markets** – 11 minutes saved, versus 21 to 30 minutes saved for Alternatives M, O and P.
- **Increased accessibility to labor force** – 1,600 added workers, versus 10,200 to 26,300 added workers for Alternatives M, O and P.
- **Annual truck hours saved** – 300 truck hours saved, versus 3,000 hours increase to 8,400 hours saved for Alternatives M, O and P.
- **Increased access to intermodal centers** – 12 minutes saved, versus 9 to 23 minutes saved for Alternatives M, O and P.

Based upon its poorer performance on core goals compared to lower-level variations of other alternatives, the Upgrade Alternative was removed from further consideration.

Table 17 – Comparative Impacts of Local Improvement Alternatives with Variations of Alternative P

Impact	Comparison of Alternative P Variations and Local Improvement Alternative			
	P_{231}	P Super-2	P Expressway	Local Improvements
New Right-of-Way (acres)	1,433	2,105	2,759	297
Floodplains (acres)	150	150	195	174
Wetlands (acres)	40	49	67	15
Streams/Rivers (linear ft)	90,600	123,300	161,900	44,700
Forests (acres)	332	583	743	133
Agricultural (acres)	706	1,301	1,743	170
Karst Areas (acres)	0	0	0	0
Relocations (number)	102	86	121	68
Cost ($millions)	$381	$620	$901	$170

APPENDIX

Highway Safety Manual 1st Edition, Volume 2, Chapter 10 -- Predictive Method for Rural Tw

Overview

This spreadsheet has been developed to demonstrate the predictive models for rural two-lane highways as contained in the new Highway Safety Manual. The content was developed for training purposes and all users should verify that the answers they obtain with these worksheets correctly represent their target analysis.

The page tabs shown at the bottom of this file represent the various analyses that can be performed using this spreadsheet tool and the HSM predictive methods. A user can evaluate an individual road segment or intersection as well as analyze multiple road segments and intersections. If more than one segment type requires analysis, the user should create a blank worksheet and then copy the contents of the segment worksheet into the blank sheet and name the worksheet accordingly.

The current contents of this spreadsheet include the following:

Worksheet Name	Contents
Instructions	Current worksheet displaying overview, summary of spreadsheet worksheets, and description of color coding included in the worksheets.
Segment 1	Analysis for the rural 2-lane segments that uses lookup tables from exhibits included in the worksheet "Segment Tables." The associated HSM worksheets are 1A, 1B, 1C, 1D, and 1E.
Segment 2	Duplicate segment worksheet for additional highway segments.
Segment Tables	Includes segment tables used for analysis of HSM-provided crash trends as well as locally-derived crash information. These are HSM Tables 10-3, 10-4, and 10-12. This worksheet also includes tables used for CMF calculations. These tables include Table 10-8, 10-9, and 10-10.
Intersection 1	Analysis for the rural 2-lane intersections that uses lookup tables from exhibits included in the worksheet "Intersection Tables." The associated HSM worksheets are 2A, 2B, 2C, 2D, and 2E.
Intersection 2	Duplicate intersection worksheet for additional highway segments.
Intersection Tables	Includes intersection tables used for analysis of HSM-

	provided crash trends as well as locally-derived crash information. These are HSM Tables 10-5, 10-6, and 10-15. This worksheet also includes tables used for CMF calculations. These tables include Tables 10-13 and 10-14.
Rural 2-lane Site Total	Analysis for site-specific EB analysis using results from the rural 2-lane segment as well as rural 2-lane intersection worksheets. This analysis can be performed if the analyst knows the exact location of historic crashes within the study limits. The associated HSM worksheets are 3A and 3B.
Rural 2-lane Project Total	Analysis for project-specific EB analysis using results from the rural 2-lane segment as well as rural 2-lane intersection worksheets. This analysis can be performed if the analyst has historic crash data, but does not know the exact location within the project limits at which the crashes occurred. The associated HSM worksheets are Worksheets 4A and 4B.
Construction -- Do Not Delete	Data in this worksheet has been used to help define the pull-down options in the analysis worksheets. There is no need for a user to work within this worksheet, but the worksheet should be retained so that the other worksheets can continue to use the options included in this sheet.

/o-Lane, Two-Way Roads -- Analysis Spreadsheet Summary

Color Coding in the Worksheets

The worksheets include three specific color options to help users identify locations where input data is required. In some cases, the shaded cells require the user to input specific numbers. In other cases the input is restricted to a select set of options included in pull-down lists. The respective color coding is as follows:

Color Used	Type of Information Required from User
	Required input information as identified in the HSM.
	Input data required from the user but restricted to options provided in pull-down boxes.
	Optional input information that can be used to supplement the analysis if this information is available. This optional input information is reserved for locally-derived crash information. If the analyst elects to use this option so as to improve analysis for local crash distribution trends, each of the Exhibits with the locally-derived input also includes a pull-down box where the analyst should indicate they are using locally derive crash information. The worksheets will then use the local values instead of the HSM default values.

Spreadsheet developed by:

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B2 Operational Benefits

Local Improvement	Length	Description	2045 Daily Volumes	Travel Time Savings (Hr)	Annual Travel Time Savings (Hr)
1	1.27	Southbound Passing - Three	9,000	15.8	4,748
2	3.16	North/South passing lane-three	13,000	47.0	14,085
3	1.5	Additional lanes - Four-lane	15,500	23.7	7,104
10	2	Westbound passing lane	8,200	18.8	5,644
11	2	Northbound Pasing Lane Three-L	1,000	2.3	688
12	1.5	Southbound Passing - Three	6,000	11.0	3,312
Daily Travel Time Savings (Hrs)				119	
Annual Travel Time Savings (Hrs)				35,582	
Annual Operational Cost Savings				$711,636	

C2 Operational Benefits

Local Improvement	Length	Description	2045 Daily Volumes	Travel Time Savings (Hr)	Annual Travel Time Savings (Hr)
1	1.27	Southbound Passing - Three	8,200	14.4	4,326
2	3.16	North/South passing lane-three	11,000	39.7	11,918
3	1.5	Additional lanes - Four-lane	14,000	21.4	6,417
5	2.5	Norhbound Passing Lane	8,000	22.0	6,597
Daily Travel Time Savings (Hrs)				98	
Annual Travel Time Savings (Hrs)				29,259	
Annual Operational Cost Savings				$585,170	

M2 Operational Benefits

Local Improvement	Length	Description	2045 Daily Volumes	Travel Time Savings (Hr)	Annual Travel Time Savings (Hr)
1	1.27	Southbound Passing - Three	8,000	14.1	4,221
2	3.16	North/South passing lane-three	10,000	36.1	10,835
3	1.5	Additional lanes - Four-lane	13,000	19.9	5,958
5	2.5	Northbound Passing Lane	7,100	19.5	5,855
6	3	Westbound passing lane	1,000	3.1	927
7	2	Southbound Passing Lane	2,700	6.1	1,825
13	2	Eastbound Passing Lane	1,000	2.3	701
14	1.5	Westbound passing lane	4,400	8.9	2,671
Daily Travel Time Savings (Hrs)				110	
Annual Travel Time Savings (Hrs)				32,994	
Annual Operational Cost Savings				$659,881	

O2 Operational Benefits

Local Improvement	Length	Description	2045 Daily Volumes	Travel Time Savings (Hr)	Annual Travel Time Savings (Hr)
1	1.27	Southbound Passing - Three	8,300	14.6	4,379
2	3.16	North/South passing lane-three	10,500	37.9	11,376
3	1.5	Additional lanes - Four-lane	13,400	20.5	6,142
5	2.5	Northbound Passing Lane	9,500	26.1	7,834
15	3	Eastbound passing lane	3,000	6.9	2,065
16	2	Eastbound passing lane	2,400	3.3	997
17	2	Southbound Passing Lane	7,300	16.7	5,025
18	1.5	Eastbound passing lane	11,500	17.5	5,257
Daily Travel Time Savings (Hrs)				144	
Annual Travel Time Savings (Hrs)				43,076	
Annual Operational Cost Savings				$861,514	

P2 Operational Benefits

Local Improvement	Length	Description	2045 Daily Volumes	Travel Time Savings (Hr)	Annual Travel Time Savings (Hr)
1	1.27	Southbound Passing - Three	8,000	12.3	3,700
2	3.16	North/South passing lane-three	10,400	37.5	11,250
3	1.5	Additional lanes - Four-lane	14,000	21.7	6,500
5	2.5	Northbound Passing Lane	7,400	20.3	6,100
6	3	Northbound Pasing Lane	1,900	5.8	1,750
7	2	Southbound Passing Lane	2,500	5.7	1,700
8	1	Northbound Passing Lane	6,700	9.4	2,825
9	2	Southbound Passing Lane	13,600	34.3	10,275
Daily Travel Time Savings (Hrs)				147	
Annual Travel Time Savings (Hrs)				44,100	
Annual Operational Cost Savings				$882,000	

All Local Improvements Operations Benefits

Local Improvement	Length	Description	2045 Daily Volumes	Travel Time Savings (Hr)	Annual Travel Time Savings (Hr)
1	1.27	Southbound Passing - Three	11,000	19.3	5,804
2	3.16	North/South passing lane-three	15,000	54.2	16,252
3	1.5	Additional lanes - Four-lane	18,000	27.5	8,250
5	2.5	Northbound Passing Lane	11,400	31.3	9,401
6	3	Northbound Pasing Lane	7,900	24.4	7,326
7	2	Southbound Passing Lane	7,700	17.4	5,205
8	1	Northbound Passing Lane	8,200	11.6	3,471
9	2	Southbound Passing Lane	11,000	27.8	8,329
10	2	Westbound Passing	10,300	23.6	7,090
11	2	Northbound Passing Lane	3,600	8.3	2,478
12	1.5	Southbound Passing Lane	3,700	6.8	2,042
13	2	Eastbound passing lane	1,000	2.3	701
14	1.5	Westbound Pasing Lane	4,400	8.9	2,671
15	2	Eastbound passing lane	4,600	10.6	3,166
16	1	Eastbound passing lane	4,900	6.8	2,036
17	2	Southbound Passing - Three	7,400	17.0	5,094
18	1	Eastbound passing lane	11,600	17.7	5,303
Daily Travel Time Savings (Hrs)				315	
Annual Travel Time Savings (Hrs)				94,619	
Annual Operational Cost Savings				**$1,892,375**	

B2 Safety Benefits

				Before						After						
Option	Length	Improvements	2045 Daily Volumes	Crashes/Year	Fatal Injury	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	PDO	Crashes/ Year	Fatal Injury	Incapacitating	Non-Incapacit	Possible Injury	PDO	Safety Benefit
1	1.27	Southbound Passing - Three Lane	9,000	5	0.04	0.73	0.45	0.20	3.60	4	0.02	0.42	0.26	0.12	2.70	$424,172
2	3.16	North/South passing lane-three	13,000	14	0.10	2.03	1.26	0.56	10.08	10	0.06	1.18	0.73	0.32	7.56	$1,187,682
3	1.5	Additional lanes - Four-lane	15,500	8	0.06	1.16	0.72	0.32	5.76	6	0.03	0.67	0.42	0.19	4.32	$678,676
10	2	Westbound passing lanes	8,200	5	0.04	0.73	0.45	0.20	3.60	4	0.02	0.42	0.26	0.12	2.70	$424,172
11	2	Northbound Pasing Lane Three-	1,000	1	0.01	0.15	0.09	0.04	0.72	1	0.00	0.08	0.05	0.02	0.54	$84,834
12	1.5	Southbound Passing - Three Lane S	6,000	5	0.04	0.73	0.45	0.20	3.60	4	0.02	0.42	0.26	0.12	2.70	$424,172
Total				38	0.27	5.51	3.42	1.52	27.36	26.74	0.15	3.20	1.98	0.88	20.52	

Scenario	Fatal Cost	Incapacitating Cost	Non-Incapacitati	Possible Injury	PDO Cost	Total
Before	$3,004,576	$3,609,050	$677,160	$190,912	$325,584	$7,807,282
After	$1,742,654	$2,093,249	$392,753	$110,729	$244,188	$4,583,573
Safety Benefits						$3,223,709

C2 Safety Benefits

				Before						After						
Option	Length	Improvements	2045 Daily Volumes	Crashes/Year	Fatal Injury	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	PDO	Crashes/ Year	Fatal Injury	Incapacitating	Non-Incapacit	Possible Injury	PDO	Safety Benefit
1	1.27	Southbound Passing - Three Lane	8,200	4	0.03	0.58	0.36	0.16	2.88	3	0.02	0.34	0.21	0.09	2.16	$339,338
2	3.16	North/South passing lane-three	11,000	12	0.08	1.74	1.08	0.48	8.64	8	0.05	1.01	0.63	0.28	6.48	$1,018,013
3	1.5	Additional lanes - Four-lane	14,000	7	0.05	1.02	0.63	0.28	5.04	5	0.03	0.59	0.37	0.16	3.78	$593,841
4	3.2	Access Management	28,400	58	0.41	8.41	5.22	2.32	41.76	55	0.38	7.91	4.91	2.18	39.25	$714,983
5	2.5	Northbound Passing Lane Three-	8,000	10	0.07	1.45	0.90	0.40	7.20	7	0.04	0.84	0.52	0.23	5.40	$848,345
Total				91	0.64	13.20	8.19	3.64	65.52	77.85	0.52	10.68	6.63	2.95	57.07	

Scenario	Fatal Cost	Incapacitating Cost	Non-Incapacitati	Possible Injury	PDO Cost	Total
Before	$7,195,170	$8,642,725	$1,621,620	$457,184	$779,688	$18,696,387
After	$5,824,134	$6,995,859	$1,312,621	$370,068	$679,185	$15,181,867
Safety Benefits						$3,514,520

M2 Safety Benefits

				Before						After						
Option	Length	Improvements	2045 Daily Volumes	Crashes/Year	Fatal Injury	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	PDO	Crashes/ Year	Fatal Injury	Incapacitating	Non-Incapacit	Possible Injury	PDO	Safety Benefit
1	1.27	Southbound Passing - Three Lane	8,000	4	0.03	0.58	0.36	0.16	2.88	3	0.02	0.34	0.21	0.09	2.16	$339,338
2	3.16	North/South passing lane-three	10,000	11	0.08	1.60	0.99	0.44	7.92	8	0.04	0.93	0.57	0.26	5.94	$933,179
3	1.5	Additional lanes - Four-lane	13,000	7	0.05	1.02	0.63	0.28	5.04	5	0.03	0.59	0.37	0.16	3.78	$593,841
4	3.2	Access Management	26,500	56	0.39	8.12	5.04	2.24	40.32	53	0.37	7.63	4.74	2.11	37.90	$690,328
5	2.5	Northbound Passing Lane Three-	7100	9	0.06	1.31	0.81	0.36	6.48	6	0.04	0.76	0.47	0.21	4.86	$763,510
6	3	Northbound Passing Lane Three-La	1000	1	0.01	0.15	0.09	0.04	0.72	1	0.00	0.08	0.05	0.02	0.54	$84,834
7	2	Southbound Passing - Three Lane	2700	2	0.01	0.29	0.18	0.08	1.44	1	0.01	0.17	0.10	0.05	1.08	$169,669
13	2	Eastbound passing lane	1000	1	0.01	0.15	0.09	0.04	0.72	1	0.00	0.08	0.05	0.02	0.54	$84,834
14	1.5	Westbound passing lane	4400	3	0.02	0.44	0.27	0.12	2.16	2	0.01	0.25	0.16	0.07	1.62	$254,503
Total				94	0.66	13.63	8.46	3.76	67.68	79.48	0.52	10.83	6.72	2.99	58.42	

Scenario	Fatal Cost	Incapacitating Cost	Non-Incapacitati	Possible Injury	PDO Cost	Total
Before	$7,432,373	$8,927,650	$1,675,080	$472,256	$805,392	$19,312,751
After	$5,904,783	$7,092,733	$1,330,798	$375,192	$695,208	$15,398,714
Safety Benefits						$3,914,037

O2 Safety Benefits

				Before						After						
Option	Length	Improvements	2045 Daily Volumes	Crashes/Year	Fatal Injury	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	PDO	Crashes/ Year	Fatal Injury	Incapacitating	Non-Incapacit	Possible Injury	PDO	Safety Benefit
1	1.27	Southbound Passing - Three Lane	8,300	5	0.04	0.73	0.45	0.20	3.60	4	0.02	0.42	0.26	0.12	2.70	$424,172
2	3.16	North/South passing lane-three	10,500	11	0.08	1.60	0.99	0.44	7.92	8	0.04	0.93	0.57	0.26	5.94	$933,179
3	1.5	Additional lanes - Four-lane	13,400	7	0.05	1.02	0.63	0.28	5.04	5	0.03	0.59	0.37	0.16	3.78	$593,841
4	3.2	Access Management	26,500	56	0.39	8.12	5.04	2.24	40.32	53	0.37	7.63	4.74	2.11	37.90	$690,328
5	2.5	Northbound Passing Lane Three-	9500	11	0.08	1.60	0.99	0.44	7.92	8	0.04	0.93	0.57	0.26	5.94	$933,179
15	2	Eastbound passing lane	3000	2	0.01	0.29	0.18	0.08	1.44	1	0.01	0.17	0.10	0.05	1.08	$169,669
16	1	Eastbound passing lane	2400	1	0.01	0.15	0.09	0.04	0.72	1	0.00	0.08	0.05	0.02	0.54	$84,834
17	2	Southbound Passing - Three Lane	7300	5	0.04	0.73	0.45	0.20	3.60	4	0.02	0.42	0.26	0.12	2.70	$424,172
18	1	Eastbound passing lane	11500	6	0.04	0.87	0.54	0.24	4.32	4	0.02	0.50	0.31	0.14	3.24	$509,007
Total				104	0.73	15.08	9.36	4.16	74.88	86.52	0.56	11.67	7.24	3.22	63.82	

Scenario	Fatal Cost	Incapacitating Cost	Non-Incapacitati	Possible Injury	PDO Cost	Total
Before	$8,223,051	$9,877,400	$1,853,280	$522,496	$891,072	$21,367,299
After	$6,363,377	$7,643,588	$1,434,154	$404,332	$759,468	$16,604,917
Safety Benefits						$4,762,382

P2 Safety Benefits

				Before						After						
Option	Length	Improvements	2045 Daily Volumes	Crashes/Year	Fatal Injury	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	PDO	Crashes/ Year	Fatal Injury	Incapacitating	Non-Incapacit	Possible Injury	PDO	Safety Benefit
1	1.27	Southbound Passing - Three Lane	8,000	4	0.03	0.58	0.36	0.16	2.88	3	0.02	0.34	0.21	0.09	2.16	$339,338
2	3.16	North/South passing lane-three	10,400	11	0.08	1.60	0.99	0.44	7.92	8	0.04	0.93	0.57	0.26	5.94	$933,179
3	1.5	Additional lanes - Four-lane	14,000	7	0.05	1.02	0.63	0.28	5.04	5	0.03	0.59	0.37	0.16	3.78	$593,841
4	3.2	Access Management	26,500	56	0.39	8.12	5.04	2.24	40.32	53	0.37	7.63	4.74	2.11	37.90	$690,328
5	2.5	Northbound Passing Lane Three-	7,400	9	0.06	1.31	0.81	0.36	6.48	6	0.04	0.76	0.47	0.21	4.86	$763,510
6	3	Northbound Pasing Lane Three-Lar	1,900	2	0.01	0.29	0.18	0.08	1.44	1	0.01	0.17	0.10	0.05	1.08	$169,669
7	2	Southbound Passing - Three Lane	2,500	2	0.01	0.29	0.18	0.08	1.44	1	0.01	0.17	0.10	0.05	1.08	$169,669
8	1	Northbound Passing Lane Three-	6,700	2	0.01	0.29	0.18	0.08	1.44	1	0.01	0.17	0.10	0.05	1.08	$169,669
9	2	Southbound Passing - Three Lane	13,600	9	0.06	1.31	0.81	0.36	6.48	6	0.04	0.76	0.47	0.21	4.86	$763,510
Total				102	0.71	14.79	9.18	4.08	73.44	85.11	0.56	11.50	7.14	3.17	62.74	

Scenario	Fatal Cost	Incapacitating Cost	Non-Incapacitati	Possible Injury	PDO Cost	Total
Before	$8,064,916	$9,687,450	$1,817,640	$512,448	$873,936	$20,956,390
After	$6,271,658	$7,533,417	$1,413,482	$398,504	$746,616	$16,363,676
Safety Benefits						$4,592,713

All Local Improvements Safety Benefits

				Before						After						
Option	Length	Improvements	2045 Daily Volumes	Crashes/Year	Fatal Injury	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	PDO	Crashes/ Year	Fatal Injury	Incapacitating	Non-Incapacit	Possible Injury	PDO	Safety Benefit
1	1.27	Southbound Passing - Three Lane	11,000	6	0.04	0.87	0.54	0.24	4.32	4	0.02	0.50	0.31	0.14	3.24	$509,007
2	3.16	North/South passing lane-three	15,000	15	0.11	2.18	1.35	0.60	10.80	11	0.06	1.26	0.78	0.35	8.10	$1,272,517
3	1.5	Additional lanes - Four-lane	18,000	9	0.06	1.31	0.81	0.36	6.48	6	0.04	0.76	0.47	0.21	4.86	$763,510
4	3.2	Access Management	35,700	63	0.44	9.14	5.67	2.52	45.36	60	0.42	8.68	5.39	2.39	43.09	$647,183
5	2.5	Northbound Passing Lane Three-	11,400	13	0.09	1.89	1.17	0.52	9.36	9	0.05	1.09	0.68	0.30	7.02	$1,102,848
6	3	Northbound Pasing Lane Three-Lar	7,900	7	0.05	1.02	0.63	0.28	5.04	5	0.03	0.59	0.37	0.16	3.78	$593,841
7	2	Southbound Passing - Three Lane	7,700	5	0.04	0.73	0.45	0.20	3.60	4	0.02	0.42	0.26	0.12	2.70	$424,172
8	1	Northbound Passing Lane Three-	8,200	3	0.02	0.44	0.27	0.12	2.16	2	0.01	0.25	0.16	0.07	1.62	$254,503
9	2	Southbound Passing - Three Lane	11,000	8	0.06	1.16	0.72	0.32	5.76	6	0.03	0.67	0.42	0.19	4.32	$678,676
10	2	Westbound Passing	10,300	6	0.04	0.87	0.54	0.24	4.32	4	0.02	0.50	0.31	0.14	3.24	$509,007
11	2	Northbound Passing Lane Three-La	3,600	3	0.02	0.44	0.27	0.12	2.16	2	0.01	0.25	0.16	0.07	1.62	$254,503
12	1.5	Southbound Passing Lane	3,700	3	0.02	0.44	0.27	0.12	2.16	2	0.01	0.25	0.16	0.07	1.62	$254,503
13	2	Eastbound passing lane	1,000	1	0.01	0.15	0.09	0.04	0.72	1	0.00	0.08	0.05	0.02	0.54	$84,834
14	1.5	Westbound Pasing Lane	4,400	3	0.02	0.44	0.27	0.12	2.16	2	0.01	0.25	0.16	0.07	1.62	$254,503
15	2	Eastbound passing lane	4,600	3	0.02	0.44	0.27	0.12	2.16	2	0.01	0.25	0.16	0.07	1.62	$254,503
16	1	Eastbound passing lane	4,900	2	0.01	0.29	0.18	0.08	1.44	1	0.01	0.17	0.10	0.05	1.08	$169,669
17	2	Southbound Passing - Three Lane S	7,400	5	0.04	0.73	0.45	0.20	3.60	4	0.02	0.42	0.26	0.12	2.70	$424,172
18	1	Eastbound passing lane	11,600	6	0.04	0.87	0.54	0.24	4.32	4	0.02	0.50	0.31	0.14	3.24	$509,007
Total				161	1.13	23.35	14.49	6.44	115.92	128.92	0.82	16.92	10.50	4.67	96.01	

Scenario	Fatal Cost	Incapacitating Cost	Non-Incapacitati	Possible Injury	PDO Cost	Total
Before	$12,729,916	$15,290,975	$2,869,020	$808,864	$1,379,448	$33,078,223
After	$9,226,422	$11,082,633	$2,079,416	$586,251	$1,142,543	$24,117,263
Safety Benefits						$8,960,959

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 1
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	1.27			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	11,000			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0	0.1			
Radius of curvature (ft)		0	1600			**Radius Value OK**
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5	6			
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.32	1.00	1.00	1.01	1.00	1.00	1.00	1.07	1.00	1.00	1.323

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1) Crash Severity Level	(2) N spf rs	(3) Overdispersion Parameter, k	(4) Crash Severity Distribution	(5) N spf rs by Severity Distribution	(6) Combined CMFs	(7) Calibration Factor, Cr	(8) Predicted average crash frequency, N
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	3.732	0.19	1.000	3.732	1.32	1.10	5.430
Fatal and Injury (FI)	--	--	0.321	1.198	1.32	1.10	1.743
Property Damage Only (PDO)	--	--	0.679	2.534	1.32	1.10	3.687

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1) Collision Type	(2) Proportion of Collision Type(TOTAL)	(3) $N_{predicted\ rs\ (TOTAL)}$ (crashes/year)	(4) Proportion of Collision Type(FI)	(5) $N_{predicted\ rs\ (FI)}$ (crashes/year)	(6) Proportion of Collision Type(PDO)	(7) $N_{predicted\ rs\ (PDO)}$ (crashes/year)
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	5.430	1.000	1.743	1.000	3.687
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.657	0.038	0.066	0.184	0.678
Collision with bicycle	0.002	0.011	0.004	0.007	0.001	0.004
Collision with pedestrian	0.003	0.016	0.007	0.012	0.001	0.004
Overturned	0.025	0.136	0.037	0.064	0.015	0.055
Ran off road	0.521	2.829	0.545	0.950	0.505	1.862
Other single-vehicle collision	0.021	0.114	0.007	0.012	0.029	0.107
Total single-vehicle crashes	0.693	3.763	0.638	1.112	0.735	2.710
MULTIPLE-VEHICLE						
Angle collision	0.085	0.462	0.100	0.174	0.072	0.265
Head-on collision	0.016	0.087	0.034	0.059	0.003	0.011
Rear-end collision	0.142	0.771	0.164	0.286	0.122	0.450
Sideswipe collision	0.037	0.201	0.038	0.066	0.038	0.140
Other multiple-vehicle collision	0.027	0.147	0.026	0.045	0.030	0.111
Total multiple-vehicle crashes	0.307	1.667	0.362	0.631	0.265	0.977

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1) Crash severity level	(2) Crash Severity Distribution (proportion)	(3) Predicted average crash frequency (crashes/year)	(4) Roadway segment length (mi)	(5) Crash rate (crashes/mi/year)
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	5.4	1.27	4.3
Fatal and Injury (FI)	0.321	1.7	1.27	1.4
Property Damage Only (PDO)	0.679	3.7	1.27	2.9

5.43026

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	1600
Adjusted Curve Length (if less than 100 ft):	0.1
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.323
Adjusted Horizontal Curve CMF:	1.323

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rlr})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	4.03	1.50
9.5	1.04	3.45	1.40
10	1.02	2.88	1.30
10.5	1.02	2.08	1.18
11	1.01	1.28	1.05
11.5	1.01	1.14	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	3.75	1.50
1	1.09	3.17	1.40
2	1.07	2.59	1.30
3	1.05	2.23	1.23
4	1.02	1.88	1.15
5	1.01	1.44	1.08
6	1.00	1.00	1.00
7	0.99	0.63	0.94
8	0.98	0.25	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 2
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	3.16			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	15,000			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0	0.2			
Radius of curvature (ft)		0	3000			**Radius Value OK**
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5	6			
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.09	1.00	1.00	1.01	1.00	1.00	1.00	1.07	1.00	1.00	1.081

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	12.664	0.07	1.000	12.664	1.08	1.10	15.057
Fatal and Injury (FI)	--	--	0.321	4.065	1.08	1.10	4.833
Property Damage Only (PDO)	--	--	0.679	8.599	1.08	1.10	10.223

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	15.057	1.000	4.833	1.000	10.223
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	1.822	0.038	0.184	0.184	1.881
Collision with bicycle	0.002	0.030	0.004	0.019	0.001	0.010
Collision with pedestrian	0.003	0.045	0.007	0.034	0.001	0.010
Overturned	0.025	0.376	0.037	0.179	0.015	0.153
Ran off road	0.521	7.845	0.545	2.634	0.505	5.163
Other single-vehicle collision	0.021	0.316	0.007	0.034	0.029	0.296
Total single-vehicle crashes	0.693	10.434	0.638	3.084	0.735	7.514
MULTIPLE-VEHICLE						
Angle collision	0.085	1.280	0.100	0.483	0.072	0.736
Head-on collision	0.016	0.241	0.034	0.164	0.003	0.031
Rear-end collision	0.142	2.138	0.164	0.793	0.122	1.247
Sideswipe collision	0.037	0.557	0.038	0.184	0.038	0.388
Other multiple-vehicle collision	0.027	0.407	0.026	0.126	0.030	0.307
Total multiple-vehicle crashes	0.307	4.622	0.362	1.750	0.265	2.709

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	15.1	3.16	4.8
Fatal and Injury (FI)	0.321	4.8	3.16	1.5
Property Damage Only (PDO)	0.679	10.2	3.16	3.2

15.0566

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wla}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tla}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2l} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	3000
Adjusted Curve Length (if less than 100 ft):	0.2
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.086
Adjusted Horizontal Curve CMF:	1.086

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	5.15	1.50
9.5	1.04	4.36	1.40
10	1.02	3.58	1.30
10.5	1.02	2.48	1.18
11	1.01	1.38	1.05
11.5	1.01	1.19	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	4.75	1.50
1	1.09	3.95	1.40
2	1.07	3.16	1.30
3	1.05	2.68	1.23
4	1.02	2.21	1.15
5	1.01	1.60	1.08
6	1.00	1.00	1.00
7	0.99	0.49	0.94
8	0.98	-0.02	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 3
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	1.5				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	17,800				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.2				
Radius of curvature (ft)		0	3000				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5	5				
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.09	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.075

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	7.134	0.16	1.000	7.134	1.07	1.10	8.432
Fatal and Injury (FI)	--	--	0.321	2.290	1.07	1.10	2.707
Property Damage Only (PDO)	--	--	0.679	4.844	1.07	1.10	5.726

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	8.432	1.000	2.707	1.000	5.726
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	1.020	0.038	0.103	0.184	1.054
Collision with bicycle	0.002	0.017	0.004	0.011	0.001	0.006
Collision with pedestrian	0.003	0.025	0.007	0.019	0.001	0.006
Overturned	0.025	0.211	0.037	0.100	0.015	0.086
Ran off road	0.521	4.393	0.545	1.475	0.505	2.891
Other single-vehicle collision	0.021	0.177	0.007	0.019	0.029	0.166
Total single-vehicle crashes	0.693	5.844	0.638	1.727	0.735	4.208
MULTIPLE-VEHICLE						
Angle collision	0.085	0.717	0.100	0.271	0.072	0.412
Head-on collision	0.016	0.135	0.034	0.092	0.003	0.017
Rear-end collision	0.142	1.197	0.164	0.444	0.122	0.699
Sideswipe collision	0.037	0.312	0.038	0.103	0.038	0.218
Other multiple-vehicle collision	0.027	0.228	0.026	0.070	0.030	0.172
Total multiple-vehicle crashes	0.307	2.589	0.362	0.980	0.265	1.517

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	8.4	1.5	5.6
Fatal and Injury (FI)	0.321	2.7	1.5	1.8
Property Damage Only (PDO)	0.679	5.7	1.5	3.8

8.43242

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	3000
Adjusted Curve Length (if less than 100 ft):	0.2
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.086
Adjusted Horizontal Curve CMF:	1.086

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	5.94	1.50
9.5	1.04	5.00	1.40
10	1.02	4.07	1.30
10.5	1.02	2.76	1.18
11	1.01	1.45	1.05
11.5	1.01	1.22	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	5.45	1.50
1	1.09	4.50	1.40
2	1.07	3.56	1.30
3	1.05	3.00	1.23
4	1.02	2.43	1.15
5	1.01	1.72	1.08
6	1.00	1.00	1.00
7	0.99	0.39	0.94
8	0.98	-0.22	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 5
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data	Base Conditions	Site Conditions				
Length of segment, L (mi)	--	2.5				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	11,400			AADT OK
Lane width (ft)	12	12				
Shoulder width (ft)	6	Right Shld:	8	Left Shld:	8	
Shoulder type	Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)	0	0.1				
Radius of curvature (ft)	0	980				Radius Value OK
Spiral transition curve (present/not present)	Not Present	Not Present				
Superelevation variance (ft/ft)	< 0.01	0				
Grade (%)	0	2				
Driveway density (driveways/mile)	5	6				
Centerline rumble strips (present/not present)	Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]	Not Present	Not Present				
Two-way left-turn lane (present/not present)	Not Present	Not Present				
Roadside hazard rating (1-7 scale)	3	4				
Segment lighting (present/not present)	Not Present	Not Present				
Auto speed enforcement (present/not present)	Not Present	Not Present				
Calibration Factor, Cr	1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x...x(11)x(12)
1.00	0.93	1.53	1.00	1.00	1.01	1.00	1.00	1.00	1.07	1.00	1.00	1.526

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1) Crash Severity Level	(2) N spf rs	(3) Overdispersion Parameter, k	(4) Crash Severity Distribution	(5) N spf rs by Severity Distribution	(6) Combined CMFs	(7) Calibration Factor, Cr	(8) Predicted average crash frequency, N
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	7.614	0.09	1.000	7.614	1.53	1.10	12.785
Fatal and Injury (FI)	--	--	0.321	2.444	1.53	1.10	4.104
Property Damage Only (PDO)	--	--	0.679	5.170	1.53	1.10	8.681

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1) Collision Type	(2) Proportion of Collision Type(TOTAL)	(3) N predicted rs (TOTAL) (crashes/year)	(4) Proportion of Collision Type(FI)	(5) N predicted rs (FI) (crashes/year)	(6) Proportion of Collision Type(PDO)	(7) N predicted rs (PDO) (crashes/year)
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	12.785	1.000	4.104	1.000	8.681
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	1.547	0.038	0.156	0.184	1.597
Collision with bicycle	0.002	0.026	0.004	0.016	0.001	0.009
Collision with pedestrian	0.003	0.038	0.007	0.029	0.001	0.009
Overturned	0.025	0.320	0.037	0.152	0.015	0.130
Ran off road	0.521	6.661	0.545	2.237	0.505	4.384
Other single-vehicle collision	0.021	0.268	0.007	0.029	0.029	0.252
Total single-vehicle crashes	0.693	8.860	0.638	2.618	0.735	6.380
MULTIPLE-VEHICLE						
Angle collision	0.085	1.087	0.100	0.410	0.072	0.625
Head-on collision	0.016	0.205	0.034	0.140	0.003	0.026
Rear-end collision	0.142	1.815	0.164	0.673	0.122	1.059
Sideswipe collision	0.037	0.473	0.038	0.156	0.038	0.330
Other multiple-vehicle collision	0.027	0.345	0.026	0.107	0.030	0.260
Total multiple-vehicle crashes	0.307	3.925	0.362	1.486	0.265	2.300

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1) Crash severity level	(2) Crash Severity Distribution (proportion)	(3) Predicted average crash frequency (crashes/year)	(4) Roadway segment length (mi)	(5) Crash rate (crashes/mi/year)
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	12.8	2.5	5.1
Fatal and Injury (FI)	0.321	4.1	2.5	1.6
Property Damage Only (PDO)	0.679	8.7	2.5	3.5

12.7845

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	980
Adjusted Curve Length (if less than 100 ft):	0.1
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.528
Adjusted Horizontal Curve CMF:	1.528

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	< 400	400 to 2000	> 2000
9	1.05	4.14	1.50
9.5	1.04	3.54	1.40
10	1.02	2.95	1.30
10.5	1.02	2.12	1.18
11	1.01	1.29	1.05
11.5	1.01	1.14	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	< 400	400 to 2000	> 2000
0	1.10	3.85	1.50
1	1.09	3.25	1.40
2	1.07	2.64	1.30
3	1.05	2.28	1.23
4	1.02	1.91	1.15
5	1.01	1.46	1.08
6	1.00	1.00	1.00
7	0.99	0.61	0.94
8	0.98	0.22	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 6
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	3			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	7,900			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0				
Radius of curvature (ft)		0				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5	5			
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	0.989

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	6.332	0.08	1.000	6.332	0.99	1.10	6.891
Fatal and Injury (FI)	--	--	0.321	2.033	0.99	1.10	2.212
Property Damage Only (PDO)	--	--	0.679	4.299	0.99	1.10	4.679

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	6.891	1.000	2.212	1.000	4.679
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.834	0.038	0.084	0.184	0.861
Collision with bicycle	0.002	0.014	0.004	0.009	0.001	0.005
Collision with pedestrian	0.003	0.021	0.007	0.015	0.001	0.005
Overturned	0.025	0.172	0.037	0.082	0.015	0.070
Ran off road	0.521	3.590	0.545	1.205	0.505	2.363
Other single-vehicle collision	0.021	0.145	0.007	0.015	0.029	0.136
Total single-vehicle crashes	0.693	4.775	0.638	1.411	0.735	3.439
MULTIPLE-VEHICLE						
Angle collision	0.085	0.586	0.100	0.221	0.072	0.337
Head-on collision	0.016	0.110	0.034	0.075	0.003	0.014
Rear-end collision	0.142	0.978	0.164	0.363	0.122	0.571
Sideswipe collision	0.037	0.255	0.038	0.084	0.038	0.178
Other multiple-vehicle collision	0.027	0.186	0.026	0.058	0.030	0.140
Total multiple-vehicle crashes	0.307	2.115	0.362	0.801	0.265	1.240

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	6.9	3	2.3
Fatal and Injury (FI)	0.321	2.2	3	0.7
Property Damage Only (PDO)	0.679	4.7	3	1.6

6.89073

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	0
Adjusted Curve Length (if less than 100 ft):	0
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.000
Adjusted Horizontal Curve CMF:	1.000

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rlw})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	3.16	1.50
9.5	1.04	2.75	1.40
10	1.02	2.33	1.30
10.5	1.02	1.77	1.18
11	1.01	1.20	1.05
11.5	1.01	1.10	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{rsw})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	2.98	1.50
1	1.09	2.56	1.40
2	1.07	2.14	1.30
3	1.05	1.89	1.23
4	1.02	1.63	1.15
5	1.01	1.31	1.08
6	1.00	1.00	1.00
7	0.99	0.73	0.94
8	0.98	0.46	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 7
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	2			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	7,700			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0				
Radius of curvature (ft)		0				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5	8			
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.00	1.00	1.00	1.05	1.00	1.00	1.00	1.07	1.00	1.00	1.034

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1) Crash Severity Level	(2) N spf rs	(3) Overdispersion Parameter, k	(4) Crash Severity Distribution	(5) N spf rs by Severity Distribution	(6) Combined CMFs	(7) Calibration Factor, Cr	(8) Predicted average crash frequency, N
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	4.114	0.12	1.000	4.114	1.03	1.10	4.680
Fatal and Injury (FI)	--	--	0.321	1.321	1.03	1.10	1.502
Property Damage Only (PDO)	--	--	0.679	2.794	1.03	1.10	3.178

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1) Collision Type	(2) Proportion of Collision Type(TOTAL)	(3) $N_{predicted\ rs\ (TOTAL)}$ (crashes/year)	(4) Proportion of Collision Type(FI)	(5) $N_{predicted\ rs\ (FI)}$ (crashes/year)	(6) Proportion of Collision Type(PDO)	(7) $N_{predicted\ rs\ (PDO)}$ (crashes/year)
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	4.680	1.000	1.502	1.000	3.178
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.566	0.038	0.057	0.184	0.585
Collision with bicycle	0.002	0.009	0.004	0.006	0.001	0.003
Collision with pedestrian	0.003	0.014	0.007	0.011	0.001	0.003
Overturned	0.025	0.117	0.037	0.056	0.015	0.048
Ran off road	0.521	2.438	0.545	0.819	0.505	1.605
Other single-vehicle collision	0.021	0.098	0.007	0.011	0.029	0.092
Total single-vehicle crashes	0.693	3.243	0.638	0.958	0.735	2.336
MULTIPLE-VEHICLE						
Angle collision	0.085	0.398	0.100	0.150	0.072	0.229
Head-on collision	0.016	0.075	0.034	0.051	0.003	0.010
Rear-end collision	0.142	0.665	0.164	0.246	0.122	0.388
Sideswipe collision	0.037	0.173	0.038	0.057	0.038	0.121
Other multiple-vehicle collision	0.027	0.126	0.026	0.039	0.030	0.095
Total multiple-vehicle crashes	0.307	1.437	0.362	0.544	0.265	0.842

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1) Crash severity level	(2) Crash Severity Distribution (proportion)	(3) Predicted average crash frequency (crashes/year)	(4) Roadway segment length (mi)	(5) Crash rate (crashes/mi/year)
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	4.7	2	2.3
Fatal and Injury (FI)	0.321	1.5	2	0.8
Property Damage Only (PDO)	0.679	3.2	2	1.6

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	0
Adjusted Curve Length (if less than 100 ft):	0
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.000
Adjusted Horizontal Curve CMF:	1.000

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rla})

	AADT (veh/day)		
Lane Width (ft)	< 400	400 to 2000	> 2000
9	1.05	3.10	1.50
9.5	1.04	2.70	1.40
10	1.02	2.30	1.30
10.5	1.02	1.75	1.18
11	1.01	1.19	1.05
11.5	1.01	1.10	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	< 400	400 to 2000	> 2000
0	1.10	2.93	1.50
1	1.09	2.52	1.40
2	1.07	2.11	1.30
3	1.05	1.86	1.23
4	1.02	1.61	1.15
5	1.01	1.31	1.08
6	1.00	1.00	1.00
7	0.99	0.74	0.94
8	0.98	0.48	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

4.6802

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 8
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	1				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	8,200				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.6				
Radius of curvature (ft)		0	47400				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5	9				
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.00	1.00	1.00	1.06	1.00	1.00	1.00	1.07	1.00	1.00	1.048

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	2.191	0.24	1.000	2.191	1.05	1.10	2.525
Fatal and Injury (FI)	--	--	0.321	0.703	1.05	1.10	0.810
Property Damage Only (PDO)	--	--	0.679	1.488	1.05	1.10	1.714

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	2.525	1.000	0.810	1.000	1.714
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.305	0.038	0.031	0.184	0.315
Collision with bicycle	0.002	0.005	0.004	0.003	0.001	0.002
Collision with pedestrian	0.003	0.008	0.007	0.006	0.001	0.002
Overturned	0.025	0.063	0.037	0.030	0.015	0.026
Ran off road	0.521	1.315	0.545	0.442	0.505	0.866
Other single-vehicle collision	0.021	0.053	0.007	0.006	0.029	0.050
Total single-vehicle crashes	0.693	1.750	0.638	0.517	0.735	1.260
MULTIPLE-VEHICLE						
Angle collision	0.085	0.215	0.100	0.081	0.072	0.123
Head-on collision	0.016	0.040	0.034	0.028	0.003	0.005
Rear-end collision	0.142	0.358	0.164	0.133	0.122	0.209
Sideswipe collision	0.037	0.093	0.038	0.031	0.038	0.065
Other multiple-vehicle collision	0.027	0.068	0.026	0.021	0.030	0.051
Total multiple-vehicle crashes	0.307	0.775	0.362	0.293	0.265	0.454

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	2.5	1	2.5
Fatal and Injury (FI)	0.321	0.8	1	0.8
Property Damage Only (PDO)	0.679	1.7	1	1.7

2.52461

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wla}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tla}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2l} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	47400
Adjusted Curve Length (if less than 100 ft):	0.6
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.002
Adjusted Horizontal Curve CMF:	1.002

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rlw})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	3.24	1.50
9.5	1.04	2.81	1.40
10	1.02	2.39	1.30
10.5	1.02	1.80	1.18
11	1.01	1.21	1.05
11.5	1.01	1.10	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{rwra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	3.05	1.50
1	1.09	2.62	1.40
2	1.07	2.19	1.30
3	1.05	1.92	1.23
4	1.02	1.65	1.15
5	1.01	1.33	1.08
6	1.00	1.00	1.00
7	0.99	0.72	0.94
8	0.98	0.44	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 9
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	2				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	11,000				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.3				
Radius of curvature (ft)		0	2000				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5	7				
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.09	1.00	1.00	1.02	1.00	1.00	1.00	1.07	1.00	1.00	1.097

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	$(2)_{TOTAL}$ x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	5.878	0.12	1.000	5.878	1.10	1.10	7.090
Fatal and Injury (FI)	--	--	0.321	1.887	1.10	1.10	2.276
Property Damage Only (PDO)	--	--	0.679	3.991	1.10	1.10	4.814

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type$_{(TOTAL)}$**	**N $_{predicted\ rs\ (TOTAL)}$ (crashes/year)**	**Proportion of Collision Type$_{(FI)}$**	**N $_{predicted\ rs\ (FI)}$ (crashes/year)**	**Proportion of Collision Type$_{(PDO)}$**	**N $_{predicted\ rs\ (PDO)}$ (crashes/year)**
	from Table 10-4	$(8)_{TOTAL}$ from Worksheet 1C	from Table 10-4	$(8)_{FI}$ from Worksheet 1C	from Table 10-4	$(8)_{PDO}$ from Worksheet 1C
Total	1.000	7.090	1.000	2.276	1.000	4.814
		$(2)x(3)_{TOTAL}$		$(4)x(5)_{FI}$		$(6)x(7)_{PDO}$
SINGLE-VEHICLE						
Collision with animal	0.121	0.858	0.038	0.086	0.184	0.886
Collision with bicycle	0.002	0.014	0.004	0.009	0.001	0.005
Collision with pedestrian	0.003	0.021	0.007	0.016	0.001	0.005
Overturned	0.025	0.177	0.037	0.084	0.015	0.072
Ran off road	0.521	3.694	0.545	1.240	0.505	2.431
Other single-vehicle collision	0.021	0.149	0.007	0.016	0.029	0.140
Total single-vehicle crashes	0.693	4.914	0.638	1.452	0.735	3.538
MULTIPLE-VEHICLE						
Angle collision	0.085	0.603	0.100	0.228	0.072	0.347
Head-on collision	0.016	0.113	0.034	0.077	0.003	0.014
Rear-end collision	0.142	1.007	0.164	0.373	0.122	0.587
Sideswipe collision	0.037	0.262	0.038	0.086	0.038	0.183
Other multiple-vehicle collision	0.027	0.191	0.026	0.059	0.030	0.144
Total multiple-vehicle crashes	0.307	2.177	0.362	0.824	0.265	1.276

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	7.1	2	3.5
Fatal and Injury (FI)	0.321	2.3	2	1.1
Property Damage Only (PDO)	0.679	4.8	2	2.4

7.09022

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	2000
Adjusted Curve Length (if less than 100 ft):	0.3
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.086
Adjusted Horizontal Curve CMF:	1.086

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rlr})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	4.03	1.50
9.5	1.04	3.45	1.40
10	1.02	2.88	1.30
10.5	1.02	2.08	1.18
11	1.01	1.28	1.05
11.5	1.01	1.14	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	3.75	1.50
1	1.09	3.17	1.40
2	1.07	2.59	1.30
3	1.05	2.23	1.23
4	1.02	1.88	1.15
5	1.01	1.44	1.08
6	1.00	1.00	1.00
7	0.99	0.63	0.94
8	0.98	0.25	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 10
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	2			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	10,300			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0				
Radius of curvature (ft)		0				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5				
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	0.989

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	5.504	0.12	1.000	5.504	0.99	1.10	5.989
Fatal and Injury (FI)	--	--	0.321	1.767	0.99	1.10	1.923
Property Damage Only (PDO)	--	--	0.679	3.737	0.99	1.10	4.067

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	5.989	1.000	1.923	1.000	4.067
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.725	0.038	0.073	0.184	0.748
Collision with bicycle	0.002	0.012	0.004	0.008	0.001	0.004
Collision with pedestrian	0.003	0.018	0.007	0.013	0.001	0.004
Overturned	0.025	0.150	0.037	0.071	0.015	0.061
Ran off road	0.521	3.120	0.545	1.048	0.505	2.054
Other single-vehicle collision	0.021	0.126	0.007	0.013	0.029	0.118
Total single-vehicle crashes	0.693	4.151	0.638	1.227	0.735	2.989
MULTIPLE-VEHICLE						
Angle collision	0.085	0.509	0.100	0.192	0.072	0.293
Head-on collision	0.016	0.096	0.034	0.065	0.003	0.012
Rear-end collision	0.142	0.850	0.164	0.315	0.122	0.496
Sideswipe collision	0.037	0.222	0.038	0.073	0.038	0.155
Other multiple-vehicle collision	0.027	0.162	0.026	0.050	0.030	0.122
Total multiple-vehicle crashes	0.307	1.839	0.362	0.696	0.265	1.078

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	6.0	2	3.0
Fatal and Injury (FI)	0.321	1.9	2	1.0
Property Damage Only (PDO)	0.679	4.1	2	2.0

5.98941

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	0
Adjusted Curve Length (if less than 100 ft):	0
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.000
Adjusted Horizontal Curve CMF:	1.000

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rla})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	3.83	1.50
9.5	1.04	3.29	1.40
10	1.02	2.75	1.30
10.5	1.02	2.01	1.18
11	1.01	1.26	1.05
11.5	1.01	1.13	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	3.58	1.50
1	1.09	3.03	1.40
2	1.07	2.49	1.30
3	1.05	2.16	1.23
4	1.02	1.82	1.15
5	1.01	1.41	1.08
6	1.00	1.00	1.00
7	0.99	0.65	0.94
8	0.98	0.30	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 11
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	2			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	3,600			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0	0.2			
Radius of curvature (ft)		0	1400			**Radius Value OK**
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5				
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.18	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.172

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	1.924	0.12	1.000	1.924	1.17	1.10	2.480
Fatal and Injury (FI)	--	--	0.321	0.617	1.17	1.10	0.796
Property Damage Only (PDO)	--	--	0.679	1.306	1.17	1.10	1.684

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	2.480	1.000	0.796	1.000	1.684
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.300	0.038	0.030	0.184	0.310
Collision with bicycle	0.002	0.005	0.004	0.003	0.001	0.002
Collision with pedestrian	0.003	0.007	0.007	0.006	0.001	0.002
Overturned	0.025	0.062	0.037	0.029	0.015	0.025
Ran off road	0.521	1.292	0.545	0.434	0.505	0.850
Other single-vehicle collision	0.021	0.052	0.007	0.006	0.029	0.049
Total single-vehicle crashes	0.693	1.719	0.638	0.508	0.735	1.238
MULTIPLE-VEHICLE						
Angle collision	0.085	0.211	0.100	0.080	0.072	0.121
Head-on collision	0.016	0.040	0.034	0.027	0.003	0.005
Rear-end collision	0.142	0.352	0.164	0.131	0.122	0.205
Sideswipe collision	0.037	0.092	0.038	0.030	0.038	0.064
Other multiple-vehicle collision	0.027	0.067	0.026	0.021	0.030	0.051
Total multiple-vehicle crashes	0.307	0.761	0.362	0.288	0.265	0.446

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	2.5	2	1.2
Fatal and Injury (FI)	0.321	0.8	2	0.4
Property Damage Only (PDO)	0.679	1.7	2	0.8

2.48023

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	1400
Adjusted Curve Length (if less than 100 ft):	0.2
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.185
Adjusted Horizontal Curve CMF:	1.185

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	1.95	1.50
9.5	1.04	1.76	1.40
10	1.02	1.58	1.30
10.5	1.02	1.34	1.18
11	1.01	1.09	1.05
11.5	1.01	1.05	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	1.90	1.50
1	1.09	1.71	1.40
2	1.07	1.53	1.30
3	1.05	1.40	1.23
4	1.02	1.28	1.15
5	1.01	1.14	1.08
6	1.00	1.00	1.00
7	0.99	0.88	0.94
8	0.98	0.76	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 12
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	1.5			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	3,700			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0	0.1			
Radius of curvature (ft)		0	700			Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5				
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.74	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.721

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	1.483	0.16	1.000	1.483	1.72	1.10	2.806
Fatal and Injury (FI)	--	--	0.321	0.476	1.72	1.10	0.901
Property Damage Only (PDO)	--	--	0.679	1.007	1.72	1.10	1.906

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	2.806	1.000	0.901	1.000	1.906
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.340	0.038	0.034	0.184	0.351
Collision with bicycle	0.002	0.006	0.004	0.004	0.001	0.002
Collision with pedestrian	0.003	0.008	0.007	0.006	0.001	0.002
Overturned	0.025	0.070	0.037	0.033	0.015	0.029
Ran off road	0.521	1.462	0.545	0.491	0.505	0.962
Other single-vehicle collision	0.021	0.059	0.007	0.006	0.029	0.055
Total single-vehicle crashes	0.693	1.945	0.638	0.575	0.735	1.401
MULTIPLE-VEHICLE						
Angle collision	0.085	0.239	0.100	0.090	0.072	0.137
Head-on collision	0.016	0.045	0.034	0.031	0.003	0.006
Rear-end collision	0.142	0.399	0.164	0.148	0.122	0.232
Sideswipe collision	0.037	0.104	0.038	0.034	0.038	0.072
Other multiple-vehicle collision	0.027	0.076	0.026	0.023	0.030	0.057
Total multiple-vehicle crashes	0.307	0.862	0.362	0.326	0.265	0.505

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	2.8	1.5	1.9
Fatal and Injury (FI)	0.321	0.9	1.5	0.6
Property Damage Only (PDO)	0.679	1.9	1.5	1.3

2.80641

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2l} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	700
Adjusted Curve Length (if less than 100 ft):	0.1
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.739
Adjusted Horizontal Curve CMF:	1.739

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rlw})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	1.98	1.50
9.5	1.04	1.79	1.40
10	1.02	1.60	1.30
10.5	1.02	1.35	1.18
11	1.01	1.09	1.05
11.5	1.01	1.05	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	1.93	1.50
1	1.09	1.73	1.40
2	1.07	1.54	1.30
3	1.05	1.42	1.23
4	1.02	1.29	1.15
5	1.01	1.14	1.08
6	1.00	1.00	1.00
7	0.99	0.88	0.94
8	0.98	0.75	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 13
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	2				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	1,000				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.1				
Radius of curvature (ft)		0	1250				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5					
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x...x(11)x(12)
1.00	0.96	1.41	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.458

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1) Crash Severity Level	(2) N spf rs	(3) Overdispersion Parameter, k	(4) Crash Severity Distribution	(5) N spf rs by Severity Distribution	(6) Combined CMFs	(7) Calibration Factor, Cr	(8) Predicted average crash frequency, N
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	0.534	0.12	1.000	0.534	1.46	1.10	0.857
Fatal and Injury (FI)	--	--	0.321	0.172	1.46	1.10	0.275
Property Damage Only (PDO)	--	--	0.679	0.363	1.46	1.10	0.582

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1) Collision Type	(2) Proportion of Collision Type(TOTAL)	(3) N predicted rs (TOTAL) (crashes/year)	(4) Proportion of Collision Type(FI)	(5) N predicted rs (FI) (crashes/year)	(6) Proportion of Collision Type(PDO)	(7) N predicted rs (PDO) (crashes/year)
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	0.857	1.000	0.275	1.000	0.582
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.104	0.038	0.010	0.184	0.107
Collision with bicycle	0.002	0.002	0.004	0.001	0.001	0.001
Collision with pedestrian	0.003	0.003	0.007	0.002	0.001	0.001
Overturned	0.025	0.021	0.037	0.010	0.015	0.009
Ran off road	0.521	0.447	0.545	0.150	0.505	0.294
Other single-vehicle collision	0.021	0.018	0.007	0.002	0.029	0.017
Total single-vehicle crashes	0.693	0.594	0.638	0.176	0.735	0.428
MULTIPLE-VEHICLE						
Angle collision	0.085	0.073	0.100	0.028	0.072	0.042
Head-on collision	0.016	0.014	0.034	0.009	0.003	0.002
Rear-end collision	0.142	0.122	0.164	0.045	0.122	0.071
Sideswipe collision	0.037	0.032	0.038	0.010	0.038	0.022
Other multiple-vehicle collision	0.027	0.023	0.026	0.007	0.030	0.017
Total multiple-vehicle crashes	0.307	0.263	0.362	0.100	0.265	0.154

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1) Crash severity level	(2) Crash Severity Distribution (proportion)	(3) Predicted average crash frequency (crashes/year)	(4) Roadway segment length (mi)	(5) Crash rate (crashes/mi/year)
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	0.9	2	0.4
Fatal and Injury (FI)	0.321	0.3	2	0.1
Property Damage Only (PDO)	0.679	0.6	2	0.3

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.94	Calculated Left Shoulder Width (CMF_{wra}) :	0.94
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.96	Computed Left Shoulder CMF_{2l} :	0.96

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	1250
Adjusted Curve Length (if less than 100 ft):	0.1
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.414
Adjusted Horizontal Curve CMF:	1.414

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	< 400	400 to 2000	> 2000
9	1.05	1.22	1.50
9.5	1.04	1.17	1.40
10	1.02	1.13	1.30
10.5	1.02	1.08	1.18
11	1.01	1.03	1.05
11.5	1.01	1.01	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	< 400	400 to 2000	> 2000
0	1.10	1.25	1.50
1	1.09	1.20	1.40
2	1.07	1.16	1.30
3	1.05	1.11	1.23
4	1.02	1.07	1.15
5	1.01	1.03	1.08
6	1.00	1.00	1.00
7	0.99	0.97	0.94
8	0.98	0.94	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

0.85726

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 14
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	1.5				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	4,400				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.3				
Radius of curvature (ft)		0	1750				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5					
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.10	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.087

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1) Crash Severity Level	(2) N spf rs	(3) Overdispersion Parameter, k	(4) Crash Severity Distribution	(5) N spf rs by Severity Distribution	(6) Combined CMFs	(7) Calibration Factor, Cr	(8) Predicted average crash frequency, N
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	$(2)_{TOTAL}$ x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	1.763	0.16	1.000	1.763	1.09	1.10	2.108
Fatal and Injury (FI)	--	--	0.321	0.566	1.09	1.10	0.677
Property Damage Only (PDO)	--	--	0.679	1.197	1.09	1.10	1.431

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1) Collision Type	(2) Proportion of Collision Type$_{(TOTAL)}$	(3) N predicted rs (TOTAL) (crashes/year)	(4) Proportion of Collision Type$_{(FI)}$	(5) N predicted rs (FI) (crashes/year)	(6) Proportion of Collision Type$_{(PDO)}$	(7) N predicted rs (PDO) (crashes/year)
	from Table 10-4	$(8)_{TOTAL}$ from Worksheet 1C	from Table 10-4	$(8)_{FI}$ from Worksheet 1C	from Table 10-4	$(8)_{PDO}$ from Worksheet 1C
Total	1.000	2.108	1.000	0.677	1.000	1.431
		$(2)x(3)_{TOTAL}$		$(4)x(5)_{FI}$		$(6)x(7)_{PDO}$
SINGLE-VEHICLE						
Collision with animal	0.121	0.255	0.038	0.026	0.184	0.263
Collision with bicycle	0.002	0.004	0.004	0.003	0.001	0.001
Collision with pedestrian	0.003	0.006	0.007	0.005	0.001	0.001
Overturned	0.025	0.053	0.037	0.025	0.015	0.021
Ran off road	0.521	1.098	0.545	0.369	0.505	0.723
Other single-vehicle collision	0.021	0.044	0.007	0.005	0.029	0.042
Total single-vehicle crashes	0.693	1.461	0.638	0.432	0.735	1.052
MULTIPLE-VEHICLE						
Angle collision	0.085	0.179	0.100	0.068	0.072	0.103
Head-on collision	0.016	0.034	0.034	0.023	0.003	0.004
Rear-end collision	0.142	0.299	0.164	0.111	0.122	0.175
Sideswipe collision	0.037	0.078	0.038	0.026	0.038	0.054
Other multiple-vehicle collision	0.027	0.057	0.026	0.018	0.030	0.043
Total multiple-vehicle crashes	0.307	0.647	0.362	0.245	0.265	0.379

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1) Crash severity level	(2) Crash Severity Distribution (proportion)	(3) Predicted average crash frequency (crashes/year)	(4) Roadway segment length (mi)	(5) Crash rate (crashes/mi/year)
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	2.1	1.5	1.4
Fatal and Injury (FI)	0.321	0.7	1.5	0.5
Property Damage Only (PDO)	0.679	1.4	1.5	1.0

2.10806

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	1750
Adjusted Curve Length (if less than 100 ft):	0.3
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.099
Adjusted Horizontal Curve CMF:	1.099

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	< 400	400 to 2000	> 2000
9	1.05	2.17	1.50
9.5	1.04	1.95	1.40
10	1.02	1.72	1.30
10.5	1.02	1.42	1.18
11	1.01	1.11	1.05
11.5	1.01	1.06	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	< 400	400 to 2000	> 2000
0	1.10	2.10	1.50
1	1.09	1.87	1.40
2	1.07	1.64	1.30
3	1.05	1.49	1.23
4	1.02	1.35	1.15
5	1.01	1.17	1.08
6	1.00	1.00	1.00
7	0.99	0.85	0.94
8	0.98	0.71	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 15
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions			
Length of segment, L (mi)		--	2			
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	4,600			AADT OK
Lane width (ft)		12	12			
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved
Length of horizontal curve (mi)		0	0.1			
Radius of curvature (ft)		0	7500			Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present			
Superelevation variance (ft/ft)		< 0.01	0			
Grade (%)		0	2			
Driveway density (driveways/mile)		5				
Centerline rumble strips (present/not present)		Not Present	Not Present			
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present			
Two-way left-turn lane (present/not present)		Not Present	Not Present			
Roadside hazard rating (1-7 scale)		3	4			
Segment lighting (present/not present)		Not Present	Not Present			
Auto speed enforcement (present/not present)		Not Present	Not Present			
Calibration Factor, Cr		1	1.10			

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.07	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.058

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	2.458	0.12	1.000	2.458	1.06	1.10	2.859
Fatal and Injury (FI)	--	--	0.321	0.789	1.06	1.10	0.918
Property Damage Only (PDO)	--	--	0.679	1.669	1.06	1.10	1.942

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type(TOTAL)**	**N predicted rs (TOTAL) (crashes/year)**	**Proportion of Collision Type(FI)**	**N predicted rs (FI) (crashes/year)**	**Proportion of Collision Type(PDO)**	**N predicted rs (PDO) (crashes/year)**
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	2.859	1.000	0.918	1.000	1.942
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.346	0.038	0.035	0.184	0.357
Collision with bicycle	0.002	0.006	0.004	0.004	0.001	0.002
Collision with pedestrian	0.003	0.009	0.007	0.006	0.001	0.002
Overturned	0.025	0.071	0.037	0.034	0.015	0.029
Ran off road	0.521	1.490	0.545	0.500	0.505	0.980
Other single-vehicle collision	0.021	0.060	0.007	0.006	0.029	0.056
Total single-vehicle crashes	0.693	1.982	0.638	0.586	0.735	1.427
MULTIPLE-VEHICLE						
Angle collision	0.085	0.243	0.100	0.092	0.072	0.140
Head-on collision	0.016	0.046	0.034	0.031	0.003	0.006
Rear-end collision	0.142	0.406	0.164	0.151	0.122	0.237
Sideswipe collision	0.037	0.106	0.038	0.035	0.038	0.074
Other multiple-vehicle collision	0.027	0.077	0.026	0.024	0.030	0.058
Total multiple-vehicle crashes	0.307	0.878	0.362	0.332	0.265	0.515

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	2.9	2	1.4
Fatal and Injury (FI)	0.321	0.9	2	0.5
Property Damage Only (PDO)	0.679	1.9	2	1.0

2.85942

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2l} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	7500
Adjusted Curve Length (if less than 100 ft):	0.1
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.069
Adjusted Horizontal Curve CMF:	1.069

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	2.23	1.50
9.5	1.04	1.99	1.40
10	1.02	1.76	1.30
10.5	1.02	1.44	1.18
11	1.01	1.12	1.05
11.5	1.01	1.06	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	2.15	1.50
1	1.09	1.91	1.40
2	1.07	1.67	1.30
3	1.05	1.52	1.23
4	1.02	1.36	1.15
5	1.01	1.18	1.08
6	1.00	1.00	1.00
7	0.99	0.85	0.94
8	0.98	0.69	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 16
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	1				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	4,900				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.1				
Radius of curvature (ft)		0	2500				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5					
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.21	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.194

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	$(2)_{TOTAL}$ x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	1.309	0.24	1.000	1.309	1.19	1.10	1.720
Fatal and Injury (FI)	--	--	0.321	0.420	1.19	1.10	0.552
Property Damage Only (PDO)	--	--	0.679	0.889	1.19	1.10	1.168

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type$_{(TOTAL)}$**	**N $_{predicted\ rs\ (TOTAL)}$ (crashes/year)**	**Proportion of Collision Type$_{(FI)}$**	**N $_{predicted\ rs\ (FI)}$ (crashes/year)**	**Proportion of Collision Type$_{(PDO)}$**	**N $_{predicted\ rs\ (PDO)}$ (crashes/year)**
	from Table 10-4	$(8)_{TOTAL}$ from Worksheet 1C	from Table 10-4	$(8)_{FI}$ from Worksheet 1C	from Table 10-4	$(8)_{PDO}$ from Worksheet 1C
Total	1.000	1.720	1.000	0.552	1.000	1.168
		$(2)x(3)_{TOTAL}$		$(4)x(5)_{FI}$		$(6)x(7)_{PDO}$
SINGLE-VEHICLE						
Collision with animal	0.121	0.208	0.038	0.021	0.184	0.215
Collision with bicycle	0.002	0.003	0.004	0.002	0.001	0.001
Collision with pedestrian	0.003	0.005	0.007	0.004	0.001	0.001
Overturned	0.025	0.043	0.037	0.020	0.015	0.018
Ran off road	0.521	0.896	0.545	0.301	0.505	0.590
Other single-vehicle collision	0.021	0.036	0.007	0.004	0.029	0.034
Total single-vehicle crashes	0.693	1.192	0.638	0.352	0.735	0.858
MULTIPLE-VEHICLE						
Angle collision	0.085	0.146	0.100	0.055	0.072	0.084
Head-on collision	0.016	0.028	0.034	0.019	0.003	0.004
Rear-end collision	0.142	0.244	0.164	0.091	0.122	0.142
Sideswipe collision	0.037	0.064	0.038	0.021	0.038	0.044
Other multiple-vehicle collision	0.027	0.046	0.026	0.014	0.030	0.035
Total multiple-vehicle crashes	0.307	0.528	0.362	0.200	0.265	0.309

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	1.7	1	1.7
Fatal and Injury (FI)	0.321	0.6	1	0.6
Property Damage Only (PDO)	0.679	1.2	1	1.2

1.71952

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	2500
Adjusted Curve Length (if less than 100 ft):	0.1
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.207
Adjusted Horizontal Curve CMF:	1.207

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rb})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	2.31	1.50
9.5	1.04	2.06	1.40
10	1.02	1.81	1.30
10.5	1.02	1.47	1.18
11	1.01	1.12	1.05
11.5	1.01	1.06	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	2.23	1.50
1	1.09	1.97	1.40
2	1.07	1.71	1.30
3	1.05	1.55	1.23
4	1.02	1.39	1.15
5	1.01	1.19	1.08
6	1.00	1.00	1.00
7	0.99	0.84	0.94
8	0.98	0.67	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 17
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	2				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	7,400				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.2				
Radius of curvature (ft)		0	4000				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5					
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.06	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.053

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	**N spf rs**	**Overdispersion Parameter, k**	**Crash Severity Distribution**	**N spf rs by Severity Distribution**	**Combined CMFs**	**Calibration Factor, Cr**	**Predicted average crash frequency, N**
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	$(2)_{TOTAL}$ x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	3.954	0.12	1.000	3.954	1.05	1.10	4.581
Fatal and Injury (FI)	--	--	0.321	1.269	1.05	1.10	1.471
Property Damage Only (PDO)	--	--	0.679	2.685	1.05	1.10	3.111

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	**Proportion of Collision Type$_{(TOTAL)}$**	**N $_{predicted\ rs\ (TOTAL)}$ (crashes/year)**	**Proportion of Collision Type$_{(FI)}$**	**N $_{predicted\ rs\ (FI)}$ (crashes/year)**	**Proportion of Collision Type$_{(PDO)}$**	**N $_{predicted\ rs\ (PDO)}$ (crashes/year)**
	from Table 10-4	$(8)_{TOTAL}$ from Worksheet 1C	from Table 10-4	$(8)_{FI}$ from Worksheet 1C	from Table 10-4	$(8)_{PDO}$ from Worksheet 1C
Total	1.000	4.581	1.000	1.471	1.000	3.111
		$(2)x(3)_{TOTAL}$		$(4)x(5)_{FI}$		$(6)x(7)_{PDO}$
SINGLE-VEHICLE						
Collision with animal	0.121	0.554	0.038	0.056	0.184	0.572
Collision with bicycle	0.002	0.009	0.004	0.006	0.001	0.003
Collision with pedestrian	0.003	0.014	0.007	0.010	0.001	0.003
Overturned	0.025	0.115	0.037	0.054	0.015	0.047
Ran off road	0.521	2.387	0.545	0.801	0.505	1.571
Other single-vehicle collision	0.021	0.096	0.007	0.010	0.029	0.090
Total single-vehicle crashes	0.693	3.175	0.638	0.938	0.735	2.286
MULTIPLE-VEHICLE						
Angle collision	0.085	0.389	0.100	0.147	0.072	0.224
Head-on collision	0.016	0.073	0.034	0.050	0.003	0.009
Rear-end collision	0.142	0.651	0.164	0.241	0.122	0.380
Sideswipe collision	0.037	0.170	0.038	0.056	0.038	0.118
Other multiple-vehicle collision	0.027	0.124	0.026	0.038	0.030	0.093
Total multiple-vehicle crashes	0.307	1.406	0.362	0.532	0.265	0.824

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)
Crash severity level	**Crash Severity Distribution (proportion)**	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	4.6	2	2.3
Fatal and Injury (FI)	0.321	1.5	2	0.7
Property Damage Only (PDO)	0.679	3.1	2	1.6

4.58138

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	4000
Adjusted Curve Length (if less than 100 ft):	0.2
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.065
Adjusted Horizontal Curve CMF:	1.065

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rlr})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	3.02	1.50
9.5	1.04	2.63	1.40
10	1.02	2.25	1.30
10.5	1.02	1.72	1.18
11	1.01	1.19	1.05
11.5	1.01	1.09	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	2.85	1.50
1	1.09	2.46	1.40
2	1.07	2.07	1.30
3	1.05	1.83	1.23
4	1.02	1.59	1.15
5	1.01	1.29	1.08
6	1.00	1.00	1.00
7	0.99	0.75	0.94
8	0.98	0.50	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Analyst	Peter	Roadway	Local Improvements (LI)
Agency or Company	Lochmueller	Roadway Section	Option 18
Date Performed	10/202021	Jurisdiction	Anywhere, USA
		Analysis Year	2045

Input Data		Base Conditions	Site Conditions				
Length of segment, L (mi)		--	1				
AADT (veh/day)	$AADT_{MAX}$ = 17,800 (veh/day)	--	11,600				AADT OK
Lane width (ft)		12	12				
Shoulder width (ft)		6	Right Shld:	8	Left Shld:	8	
Shoulder type		Paved	Right Shld:	Paved	Left Shld:	Paved	
Length of horizontal curve (mi)		0	0.1				
Radius of curvature (ft)		0	1000				Radius Value OK
Spiral transition curve (present/not present)		Not Present	Not Present				
Superelevation variance (ft/ft)		< 0.01	0				
Grade (%)		0	2				
Driveway density (driveways/mile)		5					
Centerline rumble strips (present/not present)		Not Present	Not Present				
Passing lanes [present (1 lane) /present (2 lane) / not present)]		Not Present	Not Present				
Two-way left-turn lane (present/not present)		Not Present	Not Present				
Roadside hazard rating (1-7 scale)		3	4				
Segment lighting (present/not present)		Not Present	Not Present				
Auto speed enforcement (present/not present)		Not Present	Not Present				
Calibration Factor, Cr		1	1.10				

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	0.93	1.52	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.501

Worksheet 1C -- Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments

(1) Crash Severity Level	(2) N spf rs	(3) Overdispersion Parameter, k	(4) Crash Severity Distribution	(5) N spf rs by Severity Distribution	(6) Combined CMFs	(7) Calibration Factor, Cr	(8) Predicted average crash frequency, N
	from Equation 10-6	from Equation 10-7	from Table 10-3 (proportion)	(2)TOTAL x (4)	(13) from Worksheet 1B		(5)x(6)x(7)
Total	3.099	0.24	1.000	3.099	1.50	1.10	5.118
Fatal and Injury (FI)	--	--	0.321	0.995	1.50	1.10	1.643
Property Damage Only (PDO)	--	--	0.679	2.104	1.50	1.10	3.475

Worksheet 1D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Roadway Segments

(1) Collision Type	(2) Proportion of Collision Type(TOTAL)	(3) N predicted rs (TOTAL) (crashes/year)	(4) Proportion of Collision Type(FI)	(5) N predicted rs (FI) (crashes/year)	(6) Proportion of Collision Type(PDO)	(7) N predicted rs (PDO) (crashes/year)
	from Table 10-4	(8)TOTAL from Worksheet 1C	from Table 10-4	(8)FI from Worksheet 1C	from Table 10-4	(8)PDO from Worksheet 1C
Total	1.000	5.118	1.000	1.643	1.000	3.475
		(2)x(3)TOTAL		(4)x(5)FI		(6)x(7)PDO
SINGLE-VEHICLE						
Collision with animal	0.121	0.619	0.038	0.062	0.184	0.639
Collision with bicycle	0.002	0.010	0.004	0.007	0.001	0.003
Collision with pedestrian	0.003	0.015	0.007	0.011	0.001	0.003
Overturned	0.025	0.128	0.037	0.061	0.015	0.052
Ran off road	0.521	2.666	0.545	0.895	0.505	1.755
Other single-vehicle collision	0.021	0.107	0.007	0.011	0.029	0.101
Total single-vehicle crashes	0.693	3.547	0.638	1.048	0.735	2.554
MULTIPLE-VEHICLE						
Angle collision	0.085	0.435	0.100	0.164	0.072	0.250
Head-on collision	0.016	0.082	0.034	0.056	0.003	0.010
Rear-end collision	0.142	0.727	0.164	0.269	0.122	0.424
Sideswipe collision	0.037	0.189	0.038	0.062	0.038	0.132
Other multiple-vehicle collision	0.027	0.138	0.026	0.043	0.030	0.104
Total multiple-vehicle crashes	0.307	1.571	0.362	0.595	0.265	0.921

Worksheet 1E -- Summary Results for Rural Two-Lane Two-Way Roadway Segments

(1) Crash severity level	(2) Crash Severity Distribution (proportion)	(3) Predicted average crash frequency (crashes/year)	(4) Roadway segment length (mi)	(5) Crash rate (crashes/mi/year)
	(4) from Worksheet 1C	(8) from Worksheet 1C		(3)/(4)
Total	1.000	5.1	1	5.1
Fatal and Injury (FI)	0.321	1.6	1	1.6
Property Damage Only (PDO)	0.679	3.5	1	3.5

5.11776

Supplemental CMF Calculations for Shoulders:

Calculated Right Shoulder Width (CMF_{wra}) :	0.87	Calculated Left Shoulder Width (CMF_{wra}) :	0.87
Calculated Right Shoulder Type (CMF_{tra}) :	1.00	Calculated Left Shoulder Type (CMF_{tra}) :	1.00
Computed Right Shoulder CMF_{2r} :	0.93	Computed Left Shoulder CMF_{2r} :	0.93

Supplemental CMF Calculations for Horizontal Curves:

Adjusted Curve Radius (if less than 100 ft):	1000
Adjusted Curve Length (if less than 100 ft):	0.1
Numeric Value for S:	0
Calculated Horizonatal Curve CMF:	1.517
Adjusted Horizontal Curve CMF:	1.517

Tables Affiliated with Crash Modification Factors:

Table 10-8: CMF for Lane Width on Roadway Segments (CMF_{rd})

	AADT (veh/day)		
Lane Width (ft)	**< 400**	**400 to 2000**	**> 2000**
9	1.05	4.20	1.50
9.5	1.04	3.59	1.40
10	1.02	2.98	1.30
10.5	1.02	2.14	1.18
11	1.01	1.29	1.05
11.5	1.01	1.15	1.03
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Table 10-9: CMF for Shoulder Width on Roadway Segments (CMF_{wra})

	AADT (veh/day)		
Shoulder Width (ft)	**< 400**	**400 to 2000**	**> 2000**
0	1.10	3.90	1.50
1	1.09	3.29	1.40
2	1.07	2.67	1.30
3	1.05	2.30	1.23
4	1.02	1.93	1.15
5	1.01	1.47	1.08
6	1.00	1.00	1.00
7	0.99	0.61	0.94
8	0.98	0.21	0.87

Note: The collision types related to shoulder width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

Local Improvement	Length	Improvements	2045 Daily Volumes	Peak Hour Volume	Peak Dr Volume
1	1.27	Southbound Passing - Three Lane Section	11,000	1,320	726
2	3.16	North/South passing lane-three lane section	15,000	1,800	990
3	1.5	Additional lanes - Four-lane section	18,000	2,160	1,188
5	2.5	Northbound Passing Lane Three-Lane	11,400	1,368	752
6	3	Northbound Pasing Lane Three-Lane	7,900	948	521
7	2	Southbound Passing - Three Lane Section	7,700	924	508
8	1	Northbound Passing Lane Three-Lane	8,200	984	541
9	2	Southbound Passing - Three Lane Section	11,000	1,320	726
10	2	Westbound Passing	10,300	1,236	680
11	2	Northbound Passing Lane Three-Lane	3,600	432	238
12	1.5	Southbound Passing - Three Lane Section	3,700	444	244
13	2	Eastbound passing lane	1,000	120	66
14	1.5	Westbound Pasing Lane	4,400	528	290
15	2	Eastbound passing lane	4,600	552	304
16	1	Eastbound passing lane	4,900	588	323
17	2	Southbound Passing - Three Lane Section	7,400	888	488
18	1	Eastbound passing lane	11,600	1,392	766

am Influence Length	Upstream ATS (mph)	within the Passing Lane Zone	Downstream Influence Area (mph)	Before Travel Time (sec)	After Travel Time (sec)	Delay Reduction (sec)	Time Savings (sec/veh)	Daily TT Savings (hrs)
1.7	51	56.1	53.55	89.65	81.50	3.36	11.51	2.32
1.7	51	56.1	53.55	223.06	202.78	3.36	23.64	6.50
1.7	40	44	42	135.00	122.73	0.00	12.27	4.05
1.7	55	60.5	57.75	163.64	148.76	3.12	17.99	3.76
1.7	57	62.7	59.85	189.47	172.25	3.01	20.23	2.93
1.7	56	61.6	58.8	128.57	116.88	3.06	14.75	2.08
1.7	54	59.4	56.7	66.67	60.61	3.17	9.24	1.39
1.7	50	55	52.5	144.00	130.91	3.43	16.52	3.33
1.7	55	60.5	57.75	130.91	119.01	3.12	15.02	2.84
1.7	55	60.5	57.75	130.91	119.01	3.12	15.02	0.99
1.7	55	60.5	57.75	98.18	89.26	3.12	12.04	0.82
1.7	54	59.4	56.7	133.33	121.21	3.17	15.30	0.28
1.7	50	55	52.5	108.00	98.18	3.43	13.25	1.07
1.7	55	60.5	57.75	130.91	119.01	3.12	15.02	1.27
1.7	55	60.5	57.75	65.45	59.50	3.12	9.07	0.81
1.7	55	60.5	57.75	130.91	119.01	3.12	15.02	2.04
1.7	50	55	52.5	72.00	65.45	3.43	9.97	2.12