Appendix 8

Crash Analysis Summary

Mainline Analysis

In March 2011, the Montana Department of Transportation provided crash data for the portion of the Interstate 90 (I-90) corridor from RP 433.0 to RP 457.0. Each crash incident is coded with an individual identification number, and may involve a single vehicle or multiple vehicles.

The portion of I-90 from RP 433.0 to RP 442.3 is defined as rural Interstate by MDT. The remainder of the corridor (RP 442.3 to RP 457.0) is classified as urban Interstate as this section is generally located within the urban limits of Billings[1]. This analysis compares the crash rate, severity index, and severity rate for the I-90 corridor with rural and urban statewide averages for similar facilities.

The crash rate is a measure of the number of crashes in a roadway corridor per million vehicle miles (MVM) travelled. Since a higher number of crashes can generally be expected on roadway corridors with higher traffic volumes, this measurement offers an objective way to compare crash statistics for roadways with varying traffic volumes (which is also described as vehicle exposure). MDT calculates the crash rate as follows:

$$\text{Crash Rate} = \frac{(\text{Total Number of Crashes})}{(\text{Traffic Volume})(\text{Analysis Time Period})(\text{Segment Length})/(1{,}000{,}000\ \text{vehicles})}$$

The severity index is a weighted measure of crashes occurring in a roadway corridor, with fatal crashes and crashes resulting in incapacitating injuries weighted more heavily (using a multiplier of 8) as compared to crashes resulting in less serious injuries (multiplier of 3) or property damage only (multiplier of 1). The severity index is calculated as follows:

$$\text{Severity Index} = \frac{8(\text{Fatal \& Incapacitating Injury}) + 3(\text{Other Injury}) + 1(\text{Property Damage})}{\text{Total Number of Crashes}}$$

Finally, the Severity Rate is a measure of the severity of crashes per million vehicle miles (MVM) travelled and is calculated as follows:

$$\text{Severity Rate} = (\text{Crash Rate})(\text{Severity Index})$$

MDT calculated these rates independently over the rural and urban portions of the corridor for the period from January 1, 2006 through December 31, 2010. Statewide average rates for rural and urban roadways during the period 2006 to 2010 were used as a baseline for this analysis.

[1] Note: Urban areas are defined as cities with a population greater than 5,000 at the time of the 2000 Census.

As shown in Table 1, the all-vehicle crash rate for the rural portion of the I-90 corridor (from RP 433.0 to RP 442.3) over the period January 1, 2006 through December 31, 2010 was approximately 3% less than the statewide average crash rate for rural Interstate system routes. Over this same period, the observed I-90 corridor all-vehicle severity index and severity rate were also lower than the statewide average for similar rural facilities by approximately 3% and 5%, respectively. A total of 329 crashes occurred within the rural portion of the I-90 corridor from 2006 to 2010. As a result of these crashes, 130 injuries and 1 fatality occurred in this portion of the corridor during the analysis period.

Table 1 Crash History Comparison
Rural Interstate Statewide Average vs. Rural Portion of I-90 Corridor

Criteria	Statewide Average for Rural Interstate (2006 – 2010)	I-90 Corridor RP 433.0 – 442.3 (2006 – 2010)	Comparison of I-90 Corridor to Statewide Average
Crash Rate (All Vehicles)	0.92	0.89	3% lower
Severity Index (All Vehicles)	1.86	1.81	3% lower
Severity Rate (All Vehicles)	1.70	1.61	5% lower

Source: Montana Department of Transportation, 2011.

MDT's 2010 Comprehensive Highway Safety Plan Annual Update identified the portion of I-90 from RP 426.9 to RP 445.5 as a Rural High Crash Severity Corridor (See Figure 1 at the end of this summary).

Table 2 presents data for the urban portion of the I-90 corridor. As shown in Table 2, the all-vehicle crash rate for the urban portion of the Interstate 90 (I-90) corridor (from RP 442.3 to RP 457.0) over the period January 1, 2006 through December 31, 2010 was 19% lower than the statewide average crash rate for urban Interstate system routes. Over this same period, the observed I-90 corridor all-vehicle severity index was approximately 6% higher than the statewide average, while the all-vehicle severity rate was approximately 14% lower than the statewide average. A total of 580 crashes occurred within the urban portion of the I-90 corridor from 2006 to 2010. As a result of these crashes, 221 injuries and 13 fatalities occurred in this portion of the corridor during the analysis period.

Table 2 Crash History Comparison
Urban Interstate Statewide Average vs. Urban Portion of I-90 Corridor

Criteria	Statewide Average for Urban Interstate (2006 – 2010)	I-90 Corridor RP 442.3 – 457.0 (2006 – 2010)	Comparison of I-90 Corridor to Statewide Average
Crash Rate (All Vehicles)	1.18	0.96	19% lower
Severity Index (All Vehicles)	1.79	1.90	6% higher
Severity Rate (All Vehicles)	2.11	1.82	14% lower

Source: Montana Department of Transportation, 2011.

Tables 6 to 14 at the end of this summary list characteristics of crashes occurring in the corridor. With regard to collision type, a majority of crashes in the corridor (508 out of 909 total crashes, or 56%) were classified as "other." Characteristics for crashes classified as "other" are listed in Tables 15 to 22 at the end of this summary. Based on these characteristics, it appears that crashes classified as "other" generally were single vehicle incidents occurring on the mainline during daylight conditions, with a sizeable number (43%) of these vehicles running off the road. Nearly half of the crashes classified as "other" occurred during poor road conditions (ice, snow or slush, or wet conditions).

The combined number of rear-end collisions and sideswipe collisions from the same direction accounted for 34% (312 out of 909) of all crashes in the corridor. Of the 90 sideswipe crashes in the same direction, 46 crashes (51%) occurred in the eastbound lanes and 41 crashes (46%) occurred in the westbound lanes; vehicle direction was not noted for the remaining 3 crashes in this category. Of the 222 rear-end crashes, 93 crashes (42%) occurred in the eastbound lanes and 129 crashes (58%) occurred in the westbound lanes.

Nearly half of all crashes in the corridor (48%, or 434 out of 909) occurred under clear conditions and 61% (or 555 out of 909) occurred under dry conditions. Speed was identified as a factor in 15% (135 out of 909) of all crashes in the analysis period in the corridor. The half-mile stretch with the highest percentage of speed-related crashes occurred from RP 455.0 to RP 455.5 located between the eastbound and westbound on/off ramps for the Johnson Lane Interchange, with 9 out of 19 crashes or 47% attributed to speed. The majority of all speed-related crashes within the study area (70%, or 97 out of 138) occurred just before or after interchanges.

The majority of crashes involving a fatality (13 out of 14, or 93%) occurred just before or after interchanges. The half-mile stretch with the highest number of fatal crashes (3 out of the 14 fatal crashes) occurred from RP 443.0 to RP 443.5 located just west of the eastbound off ramp and westbound on ramp at the Shiloh Road Interchange.

Segment Analysis

Table 3 presents the crash rate and severity rate for each corridor segment in comparison to statewide average and corridor-wide rates. As noted previously, MDT provided statewide average and corridor-wide crash rates and severity rates. Crash rates and severity rates for individual segments were calculated using traffic volumes published in MDT's Traffic by Sections (TBS) annual reports. For the purposes of this crash/severity rate analysis, segments were defined based on limits listed in the TBS reports. In some cases, these limits do not exactly match the segment definitions used in the remainder of the study.

The crash rate and severity rate for Segment 4 exceeded corridor-wide and statewide average rates; rates for all other segments fell below these thresholds.

Table 3 Crash Rate and Severity Rate Comparison
Statewide Average and I-90 Corridor vs. I-90 Corridor Segments (2006 – 2010)

Segment [1]			Crash Rate		Severity Rate	
			Statewide Average (I-90 Corridor Average) [2]	I-90 Segment [1]	Statewide Average (I-90 Corridor Average) [2]	I-90 Segment [1]
Rural	1	**Laurel to Mossmain** (RP 434.0 to RP 437.5)	0.92 (0.89)	0.90	1.70 (1.61)	1.53
Rural	2	**Mossmain to Shiloh** (RP 437.5 to RP 442.2)		0.69		1.37
Urban	3	**Shiloh to West Billings** (RP 442.2 to RP 446.0)	1.18 (0.96)	0.70	2.11 (1.82)	1.38
Urban	4	**West Billings to South Billings Boulevard** (RP 446.0 to RP 447.2)		2.86		6.13
Urban	5	**South Billings Boulevard to 27th Street** (RP 447.2 to RP 450.1)		0.61		1.08
Urban	6	**27th Street to Lockwood** (RP 450.1 to RP 452.9)		1.13		1.93
Urban	7	**Lockwood to Johnson Lane** (RP 452.9 to 455.3)		0.58		1.08
Urban	8	**Johnson Lane to Pinehills** (RP 455.3 to 456.6)		0.72		1.31

Source: MDT, 2011; DOWL HKM, 2011.
Note: For the purpose of crash and severity rate calculations, AADT values were calculated using average of 2006 through 2009 TBS volumes weighted according to TBS segment length. 2010 TBS volumes were not available at the time of the analysis; accordingly, the 2009 volume was used twice in crash and severity rate calculations.
Shaded cell indicates segment exceeding statewide average and corridor-wide rates.
[1] For the crash and severity rate analysis, segments were defined using TBS limits; segment limits for crash/severity rate calculations do not exactly match segment definitions used in the remainder of the study.
[2] As defined by MDT in rural and urban rate calculation, rural portion of corridor extends from RP 433.0 to RP 442.3; urban portion of corridor extends from RP 442.3 to RP 457.0.

Figure 2 at the end of this summary illustrates the crash and severity rates for segments in the corridor, and Figures 3 and 4 illustrate the number of crashes per segment and the number of crashes per mile in each segment.

Half-Mile Analysis

In addition to crash rate and severity rate, this analysis also examined crash frequency (or the number of crashes occurring over a specified time period).

The average number of crashes within a half-mile stretch of the corridor over the five-year analysis period was 18.9, with a standard deviation of 16.9. The standard deviation is a measure

of the size of a typical difference between an observed outcome (i.e., the number of crashes in an individual half-mile stretch) and an expected value (i.e., the corridor average). A large standard deviation indicates that data points are spread out over a range of values, while a small standard deviation indicates that data points are close in value to the average. Some variation in data is common; notable data points generally fall more than 1 standard deviation outside the average.

As listed in Table 4, the 5 highest deviations from the corridor average are generally located just before and after interchanges. The relatively high number of crashes occurring around these interchanges may be attributed to higher turbulence from merging and diverging vehicles, which results from a higher rate of lane-changing than is normally present on ramp-free portions of Interstate.[2] The number of crashes in each of these lengths of the corridor is more than 1 standard deviation above the corridor average for a half-mile stretch. The half-mile stretch located in Segment 4 is the farthest outlier at more than 5 standard deviations above the corridor average. Within this half-mile stretch, 87 crashes occurred in a single discrete location (RP 446.0158); the number of crashes at this location alone is 4 standard deviations above the corridor average for a half-mile stretch. Under normal data distribution, approximately 99.7% of all data falls within 3 standard deviations from the average, suggesting that this location is experiencing a substantially higher than normal number of crashes when compared to the corridor overall.

Table 4 Highest Number of Crashes within Half-Mile Stretches

Segment	Half-Mile Stretch	Location in Relation to Interchange Within Half-Mile Stretch	Number of Crashes	Standard Deviations Above Corridor Average
1	RP 434.0 to RP 434.5	Between Laurel Interchange Eastbound and Westbound On/Off Ramps	51	1.90
4	RP 446.0 to RP 446.5	Between Eastbound On and Westbound Off Ramps at the West Billings Interchange	106	5.15
5	RP 447.0 to RP 447.5	Between South Billings Boulevard Interchange Eastbound and Westbound On/Off Ramps	44	1.49
6	RP 452.0 to RP 452.5	West of Eastbound Off and Westbound On Ramps at the Lockwood Interchange	38	1.13
6	RP 452.5 to RP 453.0	Between Lockwood Interchange Eastbound and Westbound On/Off Ramps	54	2.08

Source: MDT, 2011; DOWL HKM, 2011.

Table 4 and Figure 5 (at the end of this summary) present the five half-mile stretches with the highest number of crashes in the corridor.

[2] Highway Capacity Manual 2010, page 13-3.

The half-mile stretch from RP 446.0 to 446.5 contains the highest number of crashes in the corridor and is also located in the segment with the highest crash rate and severity rate in the corridor. This half-mile stretch was further analyzed to identify trends in types of accidents and contributing factors.

Segment 4: RP 446.0 to RP 446.5

A total of 106 crashes were reported over the half-mile stretch from RP 446.0 to RP 446.5 located between the eastbound on and westbound off ramps at the West Billings Interchange, representing more than 5 standard deviations above the average number of crashes for a half-mile stretch in this corridor. The relatively high number of crashes in this half-mile stretch could be associated with of the complexity of this interchange in comparison to other interchanges in the corridor. The West Billings Interchange has a total of 4 freeway on/off ramps and 6 minor internal ramps, while all other interchanges in the corridor are less complex with a total of 4 ramps. The higher number of ramps at the West Billings Interchange adds to the complexity of the weaving and merging patterns that occur over this half-mile stretch, which may influence the number of crashes in this location.

Characteristics for crashes in this half-mile stretch are listed in Tables 23 to 31 at the end of this summary. Based on these characteristics, it appears that most crashes in the half-mile stretch from RP 446.0 to RP 446.5 generally were incidents involving two vehicles that occurred on the roadway during dry, clear, daylight conditions in or near an intersection or interchange.

The majority of crashes in this half-mile stretch (58 of 106, or 55%) were classified as rear-end collisions. As noted previously, a higher percentage of rear-end collisions may be related to the complexity of the West Billings Interchange and the associated weaving and merging maneuvers. Vehicles approaching an exit or entering the Interstate often do so at speeds lower than the flow of traffic, which coupled with inattentive drivers or vehicles traveling too closely to other vehicles may lead to higher frequency of rear-end collisions than would otherwise occur over uninterrupted stretches of the Interstate.

Animal-Vehicle Conflicts

Over the five-year analysis period from 2006 to 2010, a total of 43 crashes within the study corridor involved wild animals (approximately two per mile or nine per year). Crashes involving wild animals were distributed relatively evenly throughout the corridor, ranging from zero to four crashes per half-mile stretch. No single location had a substantially higher concentration of crashes involving wild animals as compared to the corridor overall.

Laurel Interchange Analysis – Ramp Intersections

The types of collisions occurring at the two Laurel Interchange ramp intersections were analyzed to identify trends in these locations and to supplement the *Billings I-90 Interchanges Project* report completed in 2006. As noted in Table 5, rear-end collisions occurred most frequently (5

out of 13, or 38% of all crashes). The westbound off ramp termini and the westbound on ramp entrance is a signalized intersection. The relatively high number of right angle and left turn crashes may indicate that signal phasing modifications or other mitigation measures may be needed at this intersection.

Table 5 Laurel Interchange Intersections

Collision Type	Number of Crashes	Percentage of Total Crashes in Half-Mile Stretch
Left Turn, Opposite Direction	2	15%
Rear-End	5	38%
Right Angle	4	31%
Sideswipe, Same Direction	1	8%
Other	1	8%
Total	13	100%

Source: MDT, 2011; DOWL HKM, 2011.

Mossmain Interchange Analysis – Ramp Intersections

Only 1 crash was reported at the four Mossmain Interchange ramp intersections; all other crashes occurring near the Mossmain Interchange during the analysis period were coded as occurring on the I-90 mainline. Accordingly, no trends were identified at these intersections.

Characteristics of Corridor Crashes (RP 433.0 to RP 457.0)

Table 6 Collision Type

Collision Type	Number of Crashes	Percent of Total Crashes
Head On	9	1%
Left Turn, Opposite Direction	14	2%
Left Turn, Same Direction	1	0%
Other	508	56%
Not Classified	3	0%
Rear-End	222	24%
Right Angle	55	6%
Right Turn, Same Direction	1	0%
Sideswipe, Opposite Direction	6	0%
Sideswipe, Same Direction	90	10%
Total	909	100%

Table 7 Roadway Relation

Roadway Relation	Number of Crashes	Percent of Total Crashes
Gore	12	13%
Median	53	6%
Off Roadway – Location Unknown	2	0%
On Roadway	508	56%
Outside Shoulder - Left	30	6%
Outside Shoulder - Right	98	19%
Shoulder	52	6%
Unknown	154	17%
Total	909	100%

Table 8 Number of Vehicles

Number of Vehicles Involved in Crash	Number of Crashes	Percent of Total Crashes
1	493	54%
2	377	42%
3	32	4%
4	6	0%
5	1	0%
Total	909	100%

Table 9 Junction Relation

Junction Relation	Number of Crashes	Percent of Total Crashes
In Driveway Access	1	0%
In Intersection	59	7%
Interchange (in or related)	142	16%
Intersection Related	76	8%
Non Junction	631	69%
Total	909	100%

Table 10 Weather Condition

Weather Condition	Number of Crashes	Percent of Total Crashes
Blowing Snow	22	2%
Clear	434	48%
Cloudy	272	30%
Rain	20	2%
Sleet/Hail/Freezing Rain/Drizzle	18	2%
Snow	142	16%
Unknown	1	0%
Total	909	100%

Table 11 Road Condition

Road Condition	Number of Crashes	Percent of Total Crashes
Dry	555	61%
Ice	192	21%
Loose Gravel	1	0%
Other / Unknown	3	0%
Sand / Mud / Dirt / Oil	1	0%
Snow / Slush	104	11%
Wet	53	6%
Total	909	100%

Table 12 Light Condition

Light Condition	Number of Crashes	Percent of Total Crashes
Dark – Lighted	81	9%
Dark – Not Lighted	182	20%
Dawn	13	1%
Daylight	619	68%
Dusk	14	2%
Total	909	100%

Table 13 Contributing Circumstances

Contributing Circumstance	Number of Crashes	Percent of Total Crashes
Speed Related	135	15%
Weather Related	107	12%
Alcohol / Drug Influence	63	7%
Careless / Inattentive Driving	295	32%
Total	NA*	NA*

*More than one contributing circumstance per crash.

Table 14 Direction

Direction	Number of Crashes	Percent of Total Crashes
EB	426	47%
WB	468	52%
Unknown	15	17%
Total	909	100%

Characteristics of Crashes Classified as "Other" (RP 433.0 to RP 457.0)

Table 15 Roadway Relation

Roadway Relation		Number of Crashes		Percent of Total Crashes	
Gore		12		2%	
On Roadway		176		35%	
Unknown		100		20%	
"Run-off-the-Road"	**Median**	51	220	10%	43%
	Outside Shoulder - Left	29		6%	
	Outside Shoulder - Right	93		18%	
	Shoulder	45		9%	
	Off Roadway – Location Unknown	2		0%	
Total		508		100%	

Table 16 Direction

Direction	Number of Crashes	Percent of Total Crashes
EB	242	48%
WB	257	51%
Unknown	9	2%
Total	508	100%

Table 17 Number of Vehicles

Number of Vehicles Involved in Crash	Number of Crashes	Percent of Total Crashes
1	487	96%
2	20	4%
3	1	0%
Total	508	100%

Table 18 Junction Relation

Junction Relation	Number of Crashes	Percent of Total Crashes
In Intersection	6	1%
Interchange (in or related)	44	9%
Intersection Related	13	3%
Non Junction	444	87
In Driveway Access	1	0%
Total	508	100%

Table 19 Weather Condition

Weather Condition		Number of Crashes		Percent of Total Crashes	
Clear		211		42%	
Unknown		1		0%	
Cloudy		159		31%	
Poor Weather Conditions	**Rain**	9	137	2%	27%
	Sleet/Hail/Freezing Rain/Drizzle	7		1%	
	Blowing Snow or Snow	121		24%	
Total		508		100%	

Table 20 Road Condition

Road Condition		Number of Crashes		Percent of Total Crashes	
Dry		277		55%	
Unknown		1		0%	
Poor Road Conditions	**Ice**	132	230	26%	45%
	Snow or Slush	74		15%	
	Wet	24		5%	
Total		508		100%	

Table 21 Light Condition

Light Condition	Number of Crashes	Percent of Total Crashes
Daylight	301	59%
Dark – Lighted	47	9%
Dark – Not Lighted	139	27%
Dawn	12	2%
Dusk	9	2%
Total	508	100%

Table 22 Contributing Circumstances

Contributing Circumstance	Number of Crashes	Percent of Total Crashes
Speed Related	93	18%
Weather Related	82	16%
Alcohol / Drug Influence	46	9%
Careless / Inattentive Driving	115	23%
Total	NA*	NA*

*More than one contributing circumstance per crash.

Characteristics of Crashes from RP 446.0 to RP 446.5 (Segment 4)

Table 23 Collision Type

Collision Type	Number of Crashes	Percent of Total Crashes
Left Turn, Opposite Direction	5	5%
Rear-End	58	55%
Right Angle	12	11%
Sideswipe, Opposite Direction	2	2%
Sideswipe, Same Direction	5	5%
Other	24	23%
Total	106	100%

Table 24 Roadway Relation

Roadway Relation	Number of Crashes	Percent of Total Crashes
On Roadway	89	84%
Unknown	3	3%
Median	2	2%
Outside Shoulder - Left	2	2%
Outside Shoulder - Right	1	0%
Shoulder	9	9%
Total	106	100%

Table 25 Number of Vehicles

Number of Vehicles Involved in Crash	Number of Crashes	Percent of Total Crashes
1	25	24%
2	77	73%
3	3	3%
4	1	0%
Total	106	100%

Table 26 Junction Relation

Junction Relation	Number of Crashes	Percent of Total Crashes
In Intersection	21	20%
Interchange (in or related)	44	42%
Intersection Related	15	14%
Non Junction	26	25%
Total	106	100%

Table 27 Weather Condition

Weather Condition	Number of Crashes	Percent of Total Crashes
Dry	60	57%
Unknown	1	0%
Cloudy	33	31%
Rain	3	3%
Sleet/Hail/Freezing Rain/Drizzle	4	4%
Snow	5	5%
Total	106	100%

Table 28 Road Condition

Road Condition	Number of Crashes	Percent of Total Crashes
Dry	76	72%
Unknown	2	2%
Ice	12	11%
Loose Gravel	1	1%
Snow / Slush	3	3%
Wet	12	11%
Total	106	100%

Table 29 Light Condition

Light Condition	Number of Crashes	Percent of Total Crashes
Daylight	83	78%
Dark – Lighted	15	14%
Dark – Not Lighted	7	7%
Dusk	1	1%
Total	106	100%

Table 30 Contributing Circumstances

Contributing Circumstance	Number of Crashes	Percent of Total Crashes
Speed Related	9	9%
Weather Related	9	9%
Alcohol / Drug Influence	6	6%
Careless / Inattentive Driving	62	59%
Total	NA*	NA*

*More than one contributing circumstance per crash.

Table 31 Direction

Direction	Number of Crashes	Percent of Total Crashes
EB	69	37%
WB	66	62%
Unknown	1	1%
Total	106	100%

Figure 1 Rural High Crash Severity Corridors

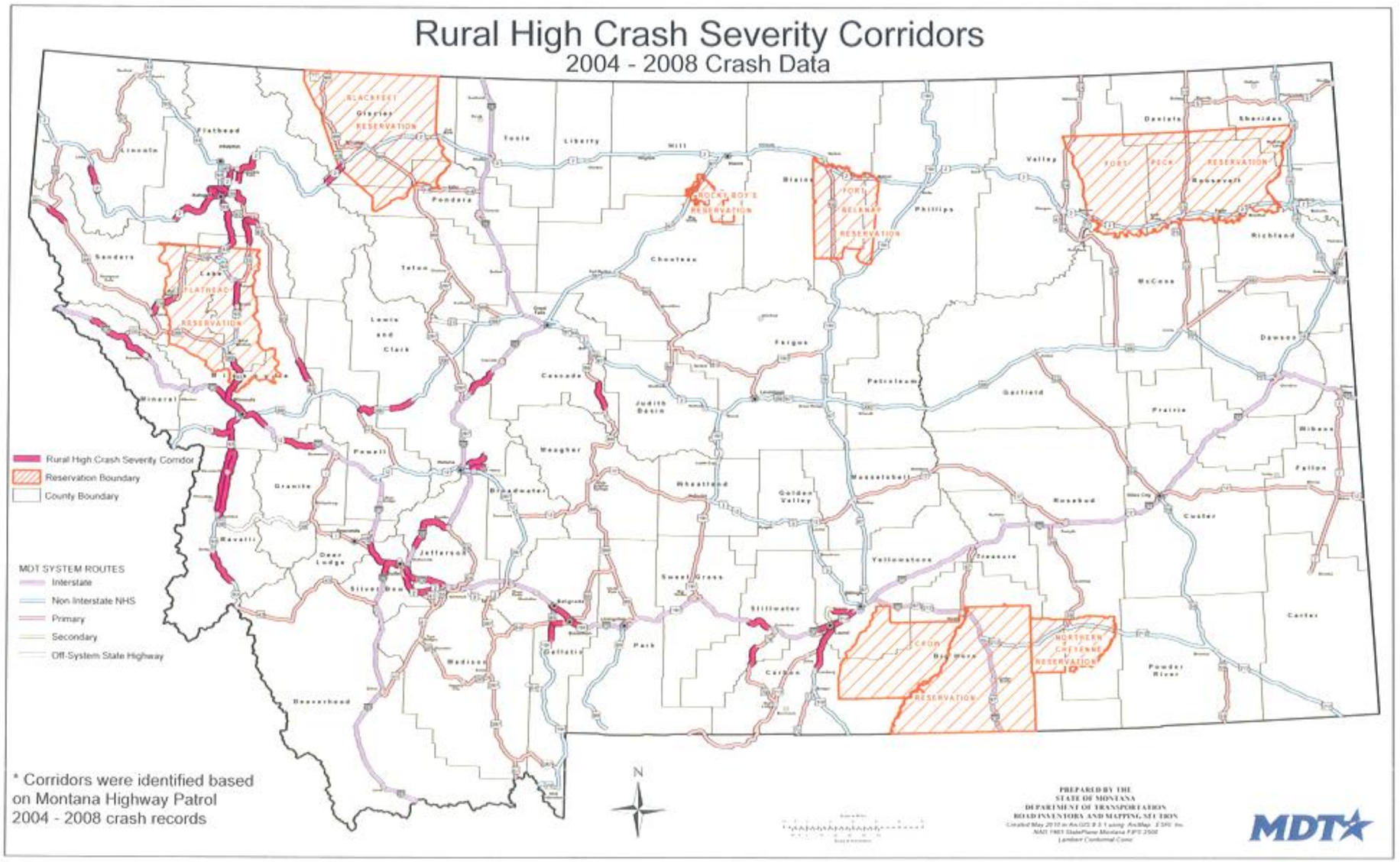
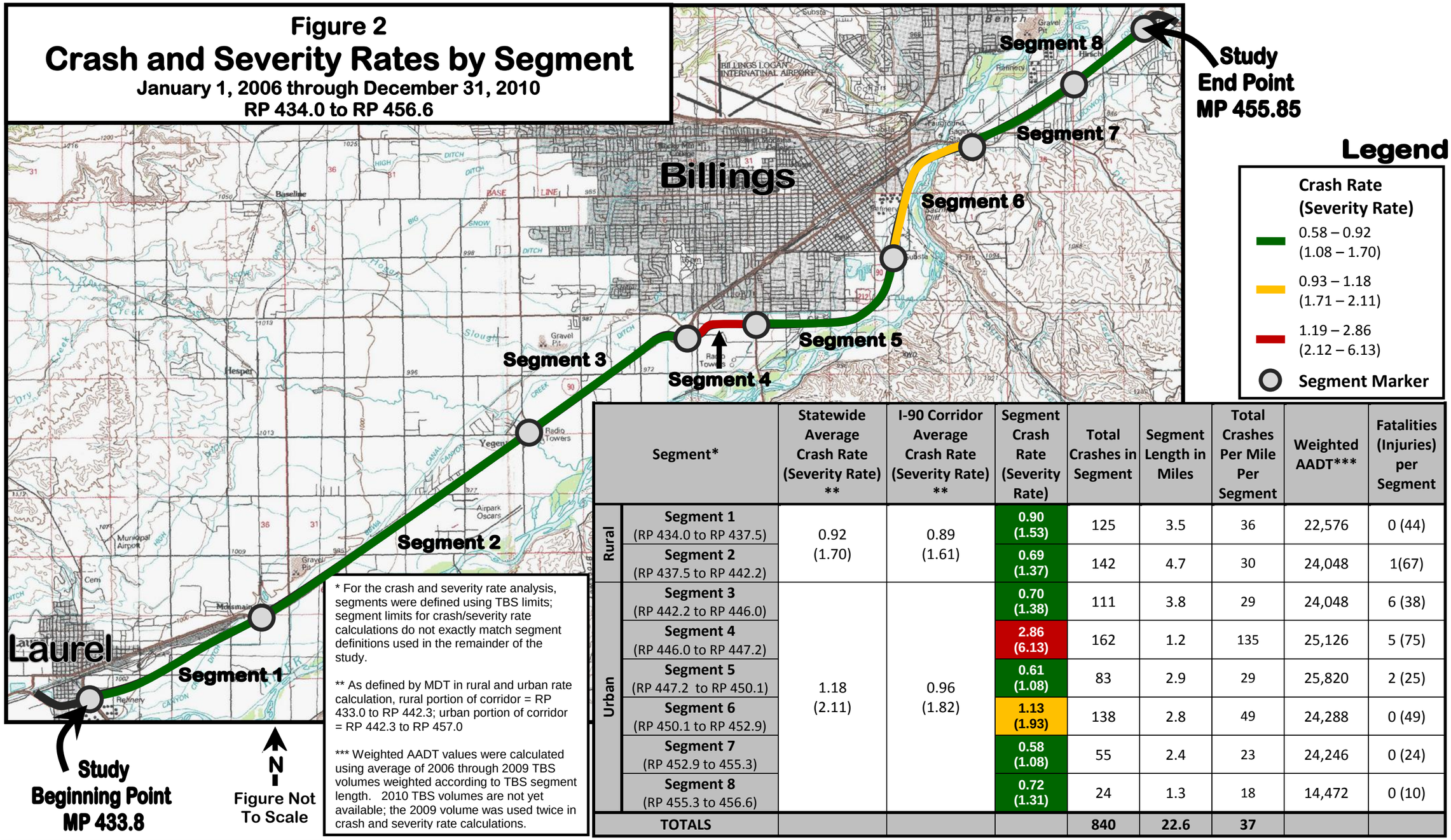


Figure 2
Crash and Severity Rates by Segment
January 1, 2006 through December 31, 2010
RP 434.0 to RP 456.6



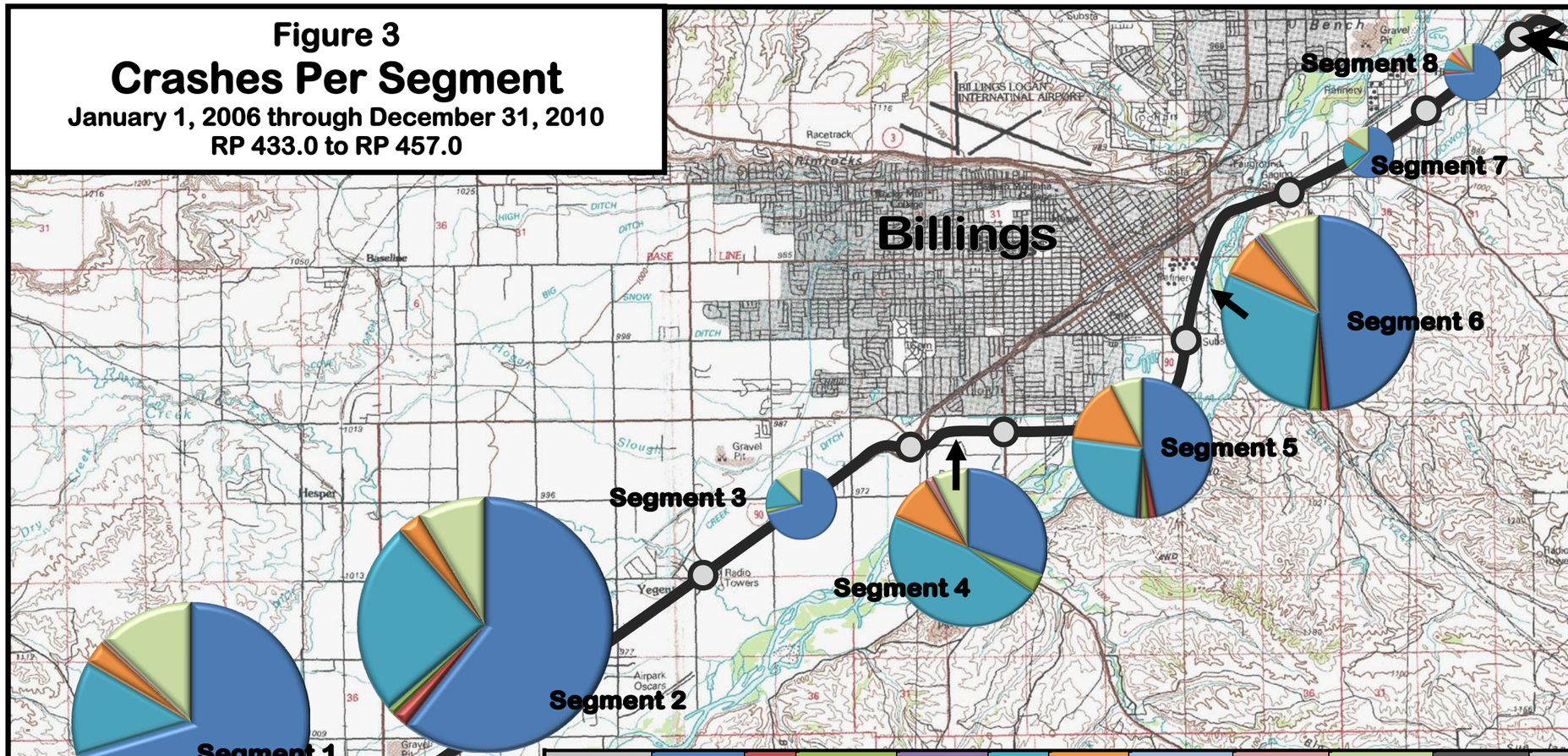
	Segment*	Statewide Average Crash Rate (Severity Rate) **	I-90 Corridor Average Crash Rate (Severity Rate) **	Segment Crash Rate (Severity Rate)	Total Crashes in Segment	Segment Length in Miles	Total Crashes Per Mile Per Segment	Weighted AADT***	Fatalities (Injuries) per Segment
Rural	Segment 1 (RP 434.0 to RP 437.5)	0.92 (1.70)	0.89 (1.61)	0.90 (1.53)	125	3.5	36	22,576	0 (44)
Rural	Segment 2 (RP 437.5 to RP 442.2)			0.69 (1.37)	142	4.7	30	24,048	1(67)
Urban	Segment 3 (RP 442.2 to RP 446.0)	1.18 (2.11)	0.96 (1.82)	0.70 (1.38)	111	3.8	29	24,048	6 (38)
Urban	Segment 4 (RP 446.0 to RP 447.2)			2.86 (6.13)	162	1.2	135	25,126	5 (75)
Urban	Segment 5 (RP 447.2 to RP 450.1)			0.61 (1.08)	83	2.9	29	25,820	2 (25)
Urban	Segment 6 (RP 450.1 to RP 452.9)			1.13 (1.93)	138	2.8	49	24,288	0 (49)
Urban	Segment 7 (RP 452.9 to 455.3)			0.58 (1.08)	55	2.4	23	24,246	0 (24)
Urban	Segment 8 (RP 455.3 to 456.6)			0.72 (1.31)	24	1.3	18	14,472	0 (10)
	TOTALS				840	22.6	37		

* For the crash and severity rate analysis, segments were defined using TBS limits; segment limits for crash/severity rate calculations do not exactly match segment definitions used in the remainder of the study.

** As defined by MDT in rural and urban rate calculation, rural portion of corridor = RP 433.0 to RP 442.3; urban portion of corridor = RP 442.3 to RP 457.0

*** Weighted AADT values were calculated using average of 2006 through 2009 TBS volumes weighted according to TBS segment length. 2010 TBS volumes are not yet available; the 2009 volume was used twice in crash and severity rate calculations.

Figure 3
Crashes Per Segment
January 1, 2006 through December 31, 2010
RP 433.0 to RP 457.0



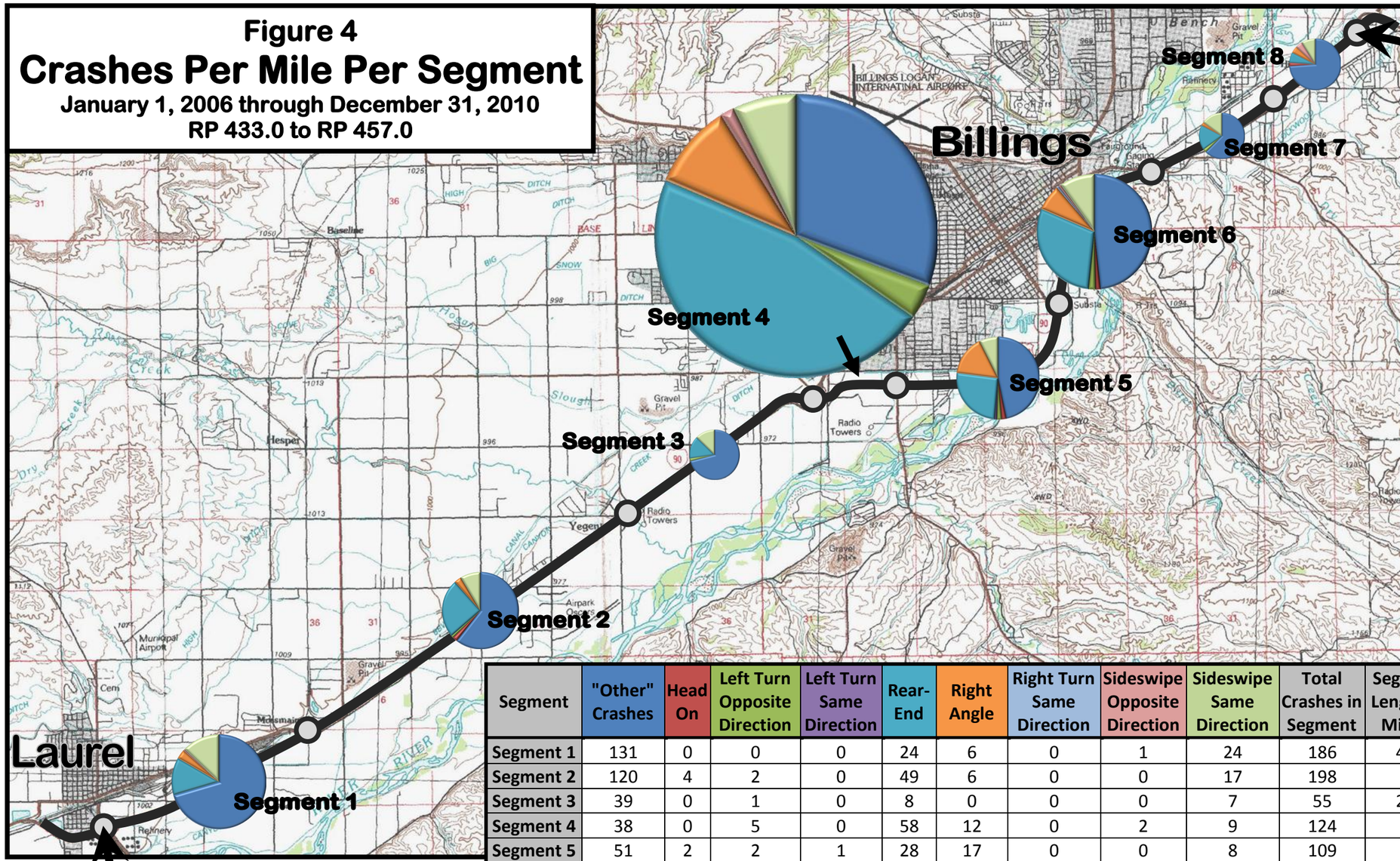
Note: Pie charts are scaled relative to the absolute number of crashes in each segment, regardless of segment length. Pie slices correspond to collision type categories, which are listed in the table below.

Legend

Segment	"Other" Crashes	Head On	Left Turn Opposite Direction	Left Turn Same Direction	Rear-End	Right Angle	Right Turn Same Direction	Sideswipe Opposite Direction	Sideswipe Same Direction	Total Crashes in Segment	Segment Length in Miles*	Total Crashes Per Mile Per Segment	Total Fatalities	Total Injuries
Segment 1	131	0	0	0	24	6	0	1	24	186	4.5	**41**	0	60
Segment 2	120	4	2	0	49	6	0	0	17	198	6	**33**	5	81
Segment 3	39	0	1	0	8	0	0	0	7	55	2.5	**22**	2	24
Segment 4	38	0	5	0	58	12	0	2	9	124	1	**124**	4	59
Segment 5	51	2	2	1	28	17	0	0	8	109	3	**36**	3	38
Segment 6	73	2	3	0	45	11	1	1	15	151	3	**50**	0	52
Segment 7	25	0	1	0	7	1	0	0	6	40	2	**20**	0	17
Segment 8	34	1	0	0	3	2	0	2	4	46	2	**23**	0	20
TOTALS	**511**	**9**	**14**	**1**	**222**	**55**	**1**	**6**	**90**	**909**	**24**	**38**	**14**	**351**

* Note: Segment length is approximated. For the purposes of the crash analysis, Segments 1 and 8 were extended slightly beyond the study beginning and end points.

Figure 4
Crashes Per Mile Per Segment
January 1, 2006 through December 31, 2010
RP 433.0 to RP 457.0



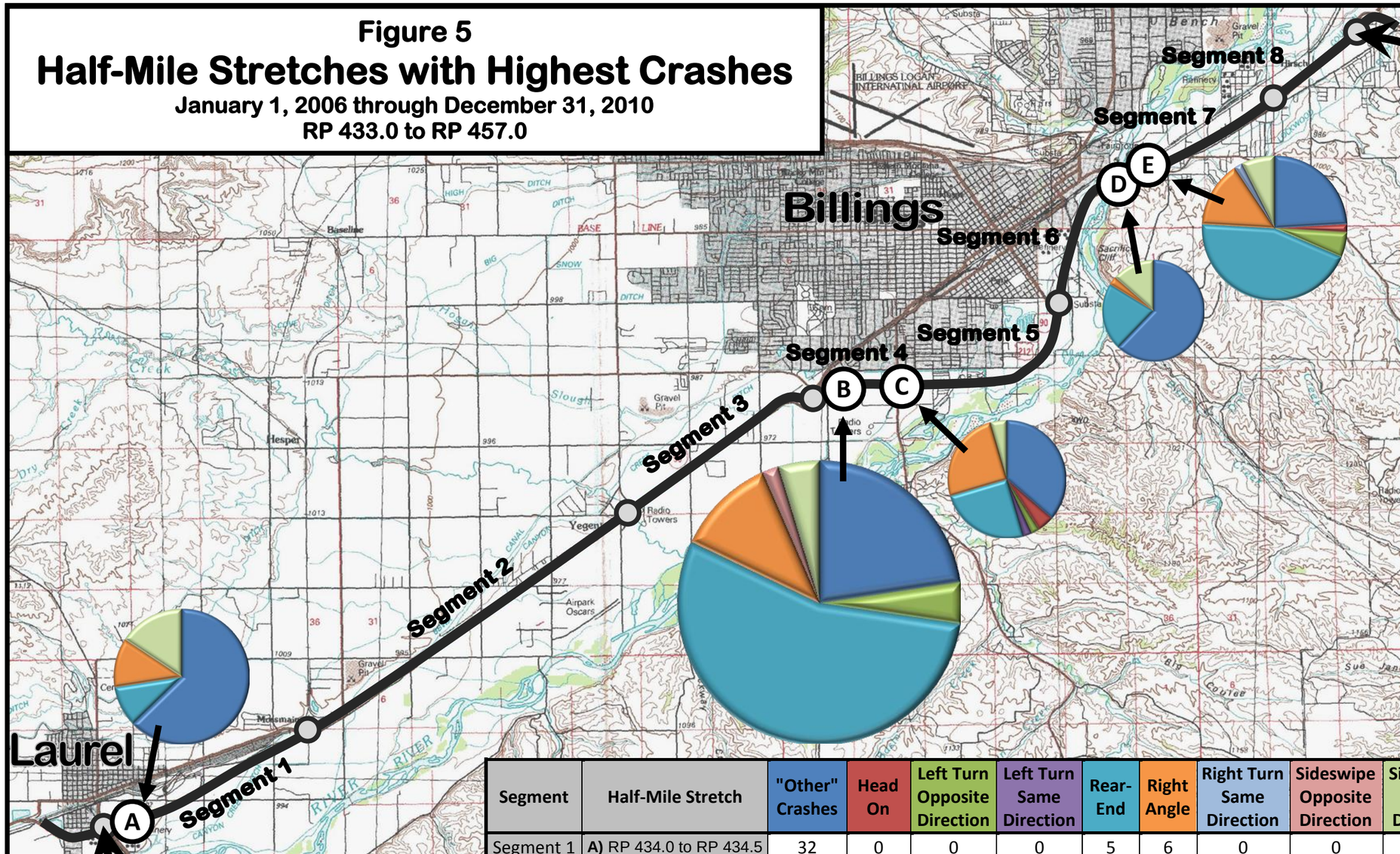
Note: Because each segment varies in length, pie charts are scaled relative to the number of crashes per mile in each segment, as opposed to the absolute number of crashes in a segment. Pie slices correspond to collision type categories, which are listed in the table below.

Legend

Segment	"Other" Crashes	Head On	Left Turn Opposite Direction	Left Turn Same Direction	Rear-End	Right Angle	Right Turn Same Direction	Sideswipe Opposite Direction	Sideswipe Same Direction	Total Crashes in Segment	Segment Length in Miles*	Total Crashes Per Mile Per Segment	Total Fatalities	Total Injuries
Segment 1	131	0	0	0	24	6	0	1	24	186	4.5	41	0	60
Segment 2	120	4	2	0	49	6	0	0	17	198	6	33	5	81
Segment 3	39	0	1	0	8	0	0	0	7	55	2.5	22	2	24
Segment 4	38	0	5	0	58	12	0	2	9	124	1	124	4	59
Segment 5	51	2	2	1	28	17	0	0	8	109	3	36	3	38
Segment 6	73	2	3	0	45	11	1	1	15	151	3	50	0	52
Segment 7	25	0	1	0	7	1	0	0	6	40	2	20	0	17
Segment 8	34	1	0	0	3	2	0	2	4	46	2	23	0	20
TOTALS	511	9	14	1	222	55	1	6	90	909	24	38	14	351

* Note: Segment length is approximated. For the purposes of the crash analysis, Segments 1 and 8 were extended slightly beyond the study beginning and end points.

Figure 5
Half-Mile Stretches with Highest Crashes
January 1, 2006 through December 31, 2010
RP 433.0 to RP 457.0



Note: Pie charts are scaled relative to the absolute number of crashes in each half-mile stretch, each of which are equal in length. Pie slices correspond to collision type categories, which are listed in the table below.

Legend

Segment	Half-Mile Stretch	"Other" Crashes	Head On	Left Turn Opposite Direction	Left Turn Same Direction	Rear-End	Right Angle	Right Turn Same Direction	Sideswipe Opposite Direction	Sideswipe Same Direction	Total Crashes in Stretch	Total Fatalities	Total Injuries
Segment 1	**A)** RP 434.0 to RP 434.5	32	0	0	0	5	6	0	0	8	51	0	9
Segment 4	**B)** RP 446.0 to RP 446.5	24	0	5	0	58	12	0	2	5	106	2	50
Segment 5	**C)** RP 447.0 to RP 447.5	16	2	1	1	11	11	0	0	2	44	1	16
Segment 6	**D)** RP 452.0 to RP 452.5	23	0	0	0	8	1	0	0	5	38	0	6
Segment 6	**E)** RP 452.5 to RP 453.0	13	1	3	0	24	8	1	0	4	54	0	25
	TOTALS	108	3	9	1	106	38	1	2	24	293	3	106