Road Services Division
2006 Annual Traffic Safety Report

King County

Department of Transportation

Road Services Division

Prepared by

Section Manager
Matthew Nolan, P.E.

Unit Supervising Engineers

Fatin Kara, P.E.
Norton Posey, P.E
Mark Mitchell, P.E.
Kevin Chang, P.E.

Contributions by

Jamey Barker, P.E.
Jodi Scanlon
Kathy Ooka
Henry Perrin, P.E.

Cover Photo:
A major windstorm struck the Puget Sound region on Thursday, Dec. 14, 2006, bringing trees and power lines down across roads throughout unincorporated King County. The Road Services Division responded to more than 40 road closures in unincorporated King County, including blockages on major arterials. Every available maintenance employee was dispatched armed with chainsaws in an effort to clear trees and get roads reopened. Traffic crews are also responding to malfunctioning signals that were damaged by the high winds. The cover photo is one of the many photos of some of the storm damage taken by the maintenance crews.

King County

Department of Transportation

Road Services Division
Traffic Engineering Section
King Street Center, KSC-TR-0222
201 South Jackson Street
Seattle, WA 98104

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

During 2006, a total of 2,887 collision reports were filed within unincorporated King County. These included 20 fatalities and 1083 injury collisions, 1653 property damage only collisions and 131 unknown collisions. Using $1M for fatalities, $65,000 for injuries, and $6000 for property damage only and unknown collision types the estimated societal cost was $101.1 million.

Executive Summary Table A			
Most Severe Injury	**2006**	**2006**	**2006**
	Collision Reports		**Estimated Cost**
Dead at Scene	11		
Dead on Arrival	2		
Died in Hospital	7	**20**	**$20,000,000**
Disabling Injury	106		
Evident Injury	366		
Possible Injury	611	**1083**	**$70,395,000**
No Injury	1653	**1653**	**$9,918,000**
Unknown	131	**131**	**$786,000**
	2887		
			$101,099,000

This report reviews collision trends within unincorporated King County and the safety related programs utilized by the King County Department of Transportation (KCDOT) in the ongoing effort to reduce the number and severity of these collisions. This report is intended to provide critical information that can be used to better allocate limited safety funds, increase driver awareness of safety concerns, and improve the safety of the traveling public.

This report is prepared by the Road Services Division's Traffic Engineering Section, and is an integral part of KCDOT's Safety Management System.

1.1. Trends

It is necessary to account for these external factors when comparing 2006 collisions with data from previous years. To allow direct comparison, the data is "normalized" using the estimated collision rate (collisions per million vehicle miles traveled) for vehicular collisions, and using collisions per 100,000 population for pedestrian and bicycle collisions. The estimated collision rate (collisions per million vehicle miles) has fluctuated over the last six years, varying between 1.05 and 1.20 with no evident trend. Pedestrian and bicycle collision rates (collisions per 100,000 population) have also fluctuated, varying between 9.15 and 12.23 and 5.72 and 10.24 respectively with no evident trend since 2001.

Further information on trends is provided in the Sections of this report.

Executive Summary Table B

		All County Roads			
Year	Total Collision Reports	Average Daily Traffic Volumes (ADT)	Maintained Road Miles	Annual Million Miles Driven	Estimated Collision Rate
2001	2320	6,635	1,832	2,218	1.05
2002	2617	6,635	1,895	2,295	1.14
2003	2698	6,531	1,883	2,244	1.20
2004	2774	7,238	1,859	2,456	1.13
2005	2929	7,177	1,856	2,431	1.20
2006	2887	7,517	1,849	2,537	1.14

Executive Summary Table C

		Pedestrian		Bicycle	
Year	Population	Collisions	Collisions per 100,000 population	Collisions	Collisions per 100,000 population
2001	349,773	32	9.15	20	5.72
2002	351,675	43	12.23	36	10.24
2003	351,843	40	11.37	23	6.54
2004	356,795	35	9.81	27	7.57
2005	364,498	43	11.80	28	7.68
2006	367,000	36	9.81	26	7.08

1.2. 2006 Collisions

Approximately 62% of the collision reports in 2006 listed the first collision as a fixed object, rear end, or entering at angle.

Executive Summary Table D			
Collision Type	**2006**	**%**	**Cumulative %**
Fixed object	732	25.4%	25%
Rear - end	640	22.2%	48%
Entering at angle	407	14.1%	62%
Parked	256	8.9%	70%
Left turn	162	5.6%	76%
Other	145	5.0%	81%
Sideswipe	133	4.6%	86%
Driveway Leaving	108	3.7%	89%
Vehicle overturned	86	3.0%	92%
Driveway entering	83	2.9%	95%
Head on	41	1.4%	97%
Pedestrian	33	1.1%	98%
Bicycle	26	0.9%	99%
Animal	18	0.6%	99%
Right Turn	17	0.6%	100%

Fixed object collisions were the most frequent first collision, accounting for approximately 732 of all collisions and 10 of the 20 fatal collisions. The estimated societal cost of fixed object collisions was $28.9M. Most frequently struck objects were fences, utility poles, and tree stumps.

Pedestrian and bicycle collisions comprised of 33 and 26 of the 2887 collision reports, respectively.

Executive Summary Table E				
	All Collisions	**Pedestrian**	**Pedal Cyclist**	**Motorcyclist**
Collisions	2887	36	26	72
Injuries	1095	35	24	63
Fatalities	21	2	0	4
Percent of Collisions		1.25%	0.90%	2.49%
Percent resulting in injury	37.93%	97.22%	92.31%	87.50%
Percent resulting in death	0.73%	5.56%	0.00%	5.56%

While 0.73% of all collisions resulted in a fatality, pedestrian and motorcycle involved collisions resulted in a fatality 4.48% of the time, a significantly higher fatality percentage per collision. Pedestrian collisions accounted for 1.25% of the collisions and motorcycle collisions represent 2.49% of the collisions yet represent 29% of the fatalities.

A review of 2006 collision data indicates the following:

- 63% of all collisions occurred during dry pavement conditions.
- 43% of collisions occurred at intersections
- Rear-end, right angle, run-off-road, and left turn collisions comprise 81% of all intersection collisions.
- 30% of the non-intersection collisions were run-off-road collisions.
- 45% of the collisions occurred on roadways with steep grades, horizontal curves, or combinations of these alignments. Since these alignments are thought to comprise a much smaller percentage of King County's road system, it is likely that the collision rate at these locations may be significantly higher than at level tangent sections.
- 2% of the drivers involved in collisions were 16 and under, 28% were between 17 and 24 years old.
- Alcohol was involved in approximately 9% of all collisions.
- Defective equipment was discovered in vehicles in 64 collisions.

Additional 2006 collision information is contained in Sections of this report.

2.0 INTRODUCTION

The King County Department of Transportation (KCDOT) is pleased to present the 2006 Annual Safety Report. This report is prepared by the Road Services Division's Traffic Engineering Section. We hope that readers find this report informative and useful.

2.1. Report Purpose

This report was prepared for several purposes, including:

- To meet the requirements of WAC 308-330-245, which requires agencies to issue an annual safety report.
- To provide collision and safety information to elected officials, King County DOT staff, and the general public.
- To increase driver awareness with respect to safety concerns.

Ultimately, the goal of this report is to improve the safety of the traveling public.

2.2. Information Sources

The majority of the collision information provided in this report comes from the Washington State Department of Transportation (WSDOT) database. Collision location data for collisions occurring between 1997 and 2006 were entered into the King County Crash Records System (KCCRS) database by King County Department of Transportation (KCDOT) staff. In both cases, the information was obtained directly from collision reports prepared by the responding Officer at the scene of the collision. In order to be entered into the database, a collision must occur on a county-maintained roadway within unincorporated King County, and must meet the reporting threshold of $700 in property damage or result in an injury or fatality.

Other information used in this report is provided courtesy of several local agencies, including the State of Washington's Office of Financial Management for population data, the County Road Administration Board (CRAB) and the Road Services Division's Engineering Services section for roadway miles maintained by King County, and the Traffic Engineering Section for traffic count data.

Sources of information are discussed further in Appendix A.

2.2.1. Limitations of Data

A report is only as good as the data that it utilizes. For this reason it is important to be aware of the quality and limitations of the data in this report. The two databases contain information on nearly 100,000 collisions. While significant effort is directed toward quality control, databases of this size inherently contain data entry errors. The reporting officer's reports may also contain errors. Despite this, the overall quality of the data is considered acceptable for the purposes of this report.

2.3. Report Organization

This report is organized as follows:

- Section 1 Executive Summary
- Section 2 is the Introduction;
- Section 3 is a discussion of external factors;
- Section 4 addresses collision trends;
- Section 5 discusses collisions by collision type; and
- Section 6 provides a breakdown of collisions according to selected categories, such as lighting conditions, road surface conditions, and circumstances contributing to the collisions.

Appendix A provides further information on data sources used in this report, while Appendix B discusses formulas used

The King County Department of Transportation (KCDOT) is pleased to present the 2006 Annual Safety Report. This report is prepared by the Road Services Division's Traffic Engineering Section. We hope that readers find this report informative and useful.

3.0 EXTERNAL FACTORS

External factors such as development activity, new roadway construction, incorporations, and annexations influence the population, traffic volumes, and the road miles within unincorporated King County. Changes in population, traffic volumes, and road miles in turn affect the frequency of collisions by increasing or decreasing exposure. The term exposure refers to the risk of collisions due to the presence of vehicles on the road. Expo sure increases as the number of vehicles on a roadway and the length of a roadway increases. For example, given two similar roadways with different lengths, more collisions would be expected to occur on the longer roadway.

It is necessary to account for these external factors when comparing 2006 collisions with data from previous years. To allow direct comparison, the data is "normalized" using population and annual miles driven. Table 1 provides a comparison of these factors for 2001 through 2006.

Table 1

Population, Road Miles, & Traffic Volumes

Category	2006	2005	2004	2003	2002	2001
Population	367,000	364,498	356,795	351,843	351,675	349,773
Land Area (square miles)	1,755	1,755	1,755	1,758	1,758	1,758
Road Miles Maintained	1,849	1,856	1,859	1,883	1,895	1,832
Average Daily Traffic Volumes	7,517	7,177	7,238	6,531	6,635	6,635
Annual Miles Driven (million miles)	2,537	2,431	2,456	2,244	2,295	2,218

Data Sources:
King County Office of Budget - 2007, 2006, 2005, and 2002 Annual Growth Report
Appendix C

As indicated in Table 1, unincorporated King County's population, maintained road miles, and annual miles driven, have slightly increased over the past 6 years, while land area has decreased 3 square miles. These changes suggest that annexations and incorporations, which decrease road miles and miles driven, have had less influence than development and new road construction, which tend to increase them. Annexations and incorporations have also decreased the percentage of road miles in urban areas, and therefore affect the character of King County's road system.

Traffic volumes have increased approximately 10% over the past 6 years. This result is expected since principal arterials are used by motorists throughout the region, and therefore are affected by regional growth. The increase in volume on these roadways is of concern due to their importance to regional mobility.

4.0 COLLISION TRENDS

In evaluating collision data, it is important to review historical trends. This section discusses collision trends over the past 6 years. Data is addressed in terms of number of collisions and is also normalized to account for changes in population and roadway use within unincorporated King County. Trends in pedestrian, bicycle, and motorcycle collisions are also discussed.

4.1. <u>Overall Trends</u>

A total of 2,887 collision reports were filed in unincorporated King County in 2006.

It is necessary to account for external factors when comparing 2006 collisions with data from previous years. To allow direct comparison, the data is "normalized" using the estimated collision rate. The estimated collision rate (collisions per million vehicle miles) has fluctuated, varying between 1.10 and 1.54, with little evident trend.

Review of collision trends indicates the following additional changes over the past 6 years:

- The annual collision rate is fluctuating between 1.05 and 1.20.
- The annual number of collision reports filed has increased by 24%.
- The estimated annual societal cost of these collisions has increased by 1%.
- Pedestrian and bicycle collisions have increased by 12.5% and 30%, respectively.
- Pedestrian and bicycle collision rates (collisions per 100,000 people) have also increased by 7% and 24%, respectively.
- Motorcycle collisions increasesd from 40 in 2002 to 72 in 2006.

The trend for all of these measures is increasing.

Table 2

	Collisions				Collision rate per 100,00 population		
Year	**All**	**Pedestrians**	**Pedal Cyclist**		**Pedestrian**	**Pedal Cyclist**	**Population**
2001	2320	32	20		9.15	5.72	349,773
2002	2617	43	36		12.23	10.24	351,675
2003	2698	40	23		11.37	6.54	351,843
2004	2774	35	27		9.81	7.57	356,795
2005	2929	43	28		11.80	7.68	364,498
2006	2887	36	26		9.81	7.08	367,000

4.2. Six Year Collision History

Table 4 summarizes the number of collisions occurring annually over the past 6 years. The collisions are broken down by severity into property damage only (PDO), injury, and fatal collisions. It should be noted that the number of fatalities can be higher than the number a fatal collisions. For example the number of fatalities in 2006 was 21 while the number of fatal collision reports was 20 since there were multiple fatality collisions.

Table 3

Fatal Collisions versus Fatalities

Year	Total Fatal Collision Reports	Total Fatalities
2001	23	25
2002	13	14
2003	15	17
2004	21	25
2005	20	24
2006	20	21

As indicated in Table 4, the number of collision reports filed has increased over the last six years, with an increase of 24% for total collisions. PDO and total collisions have increased, while fatalities have staid the same.

Table 4

Collision History

Most Severe Injury	2001	2002	2003	2004	2005	2006
Dead at Scene	12	11	7	14	16	11
Dead on Arrival			1	1		2
Died in Hospital	11	2	7	6	4	7
Disabling Injury	103	112	102	72	92	106
Evident Injury	383	392	328	346	407	366
Possible Injury	485	593	602	601	584	611
No Injury	1150	1400	1472	1542	1678	1653
Unknown	176	107	179	192	148	131
Total	2320	2617	2698	2774	2929	2887

The annual number of fatal collisions varied between 13 (2002) and 23 (2001) during the six-year period. Due to the relatively low number of fatal collisions, evaluation of trends over time would not yield statistically significant results. However, fatalities as a percentage of total collisions have been relatively consistent, ranging between approximately ½ to 1%.

4.3. Six Year Societal Cost

Figure 1 shows the estimated annual cost of collisions over the past 6 years. As indicated, the estimated cost of collisions during 2006 was $101.1 million[1].

Figure 1
Six Year Societal Costs

	2001	2002	2003	2004	2005	2006
Costs	$94.1	$93.3	$92.0	$97.6	$101.4	$101.1

Note: Data is not normalized to account for external factors. Normalized data is considered more appropriate when comparing collisions over time.

[1] The following estimated costs per collision are used in this calculation: Property Damage Only-$6,000, Injury-$65,000, Fatality-$1,000,000

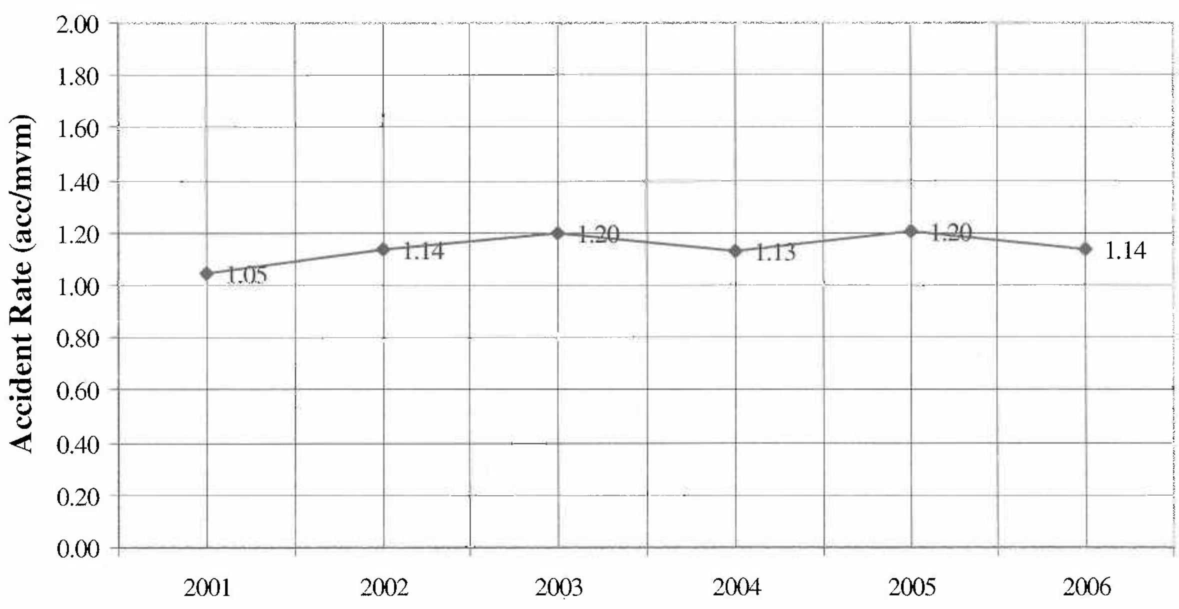
The cost attributed to collisions has fluctuated over the six-year period. It is worth noting that while the number of collisions increased between 2001 and 2003, the cost of these collisions decreased. This was due to a decrease in the severity of the collisions, while PDO collisions increased, the number of injury collisions and fatalities decreased. For 2004 and 2006 increases in all types of collisions resulted in increased estimated societal costs.

4.4. Six Year Estimated Collision Rate

The collision rate is frequently used to account for differences in traffic volumes when comparing the number of collisions at different locations or during different time periods. The collision rate is commonly expressed in collisions per million vehicle miles (acc/mvm).

The collision rate is obtained by dividing the number of collisions during a given time period by the number of miles driven during the same time period. Miles driven is determined by multiplying the length of the road by the number of vehicles traveling on the road. This is a fairly straightforward process for an individual roadway. For more complex street networks, the number of miles driven is estimated since traffic volumes are not available for all roads. Further information on determining collision rates is provided in Appendix B.

Figure 2
Six Year Calculated Accident Rates



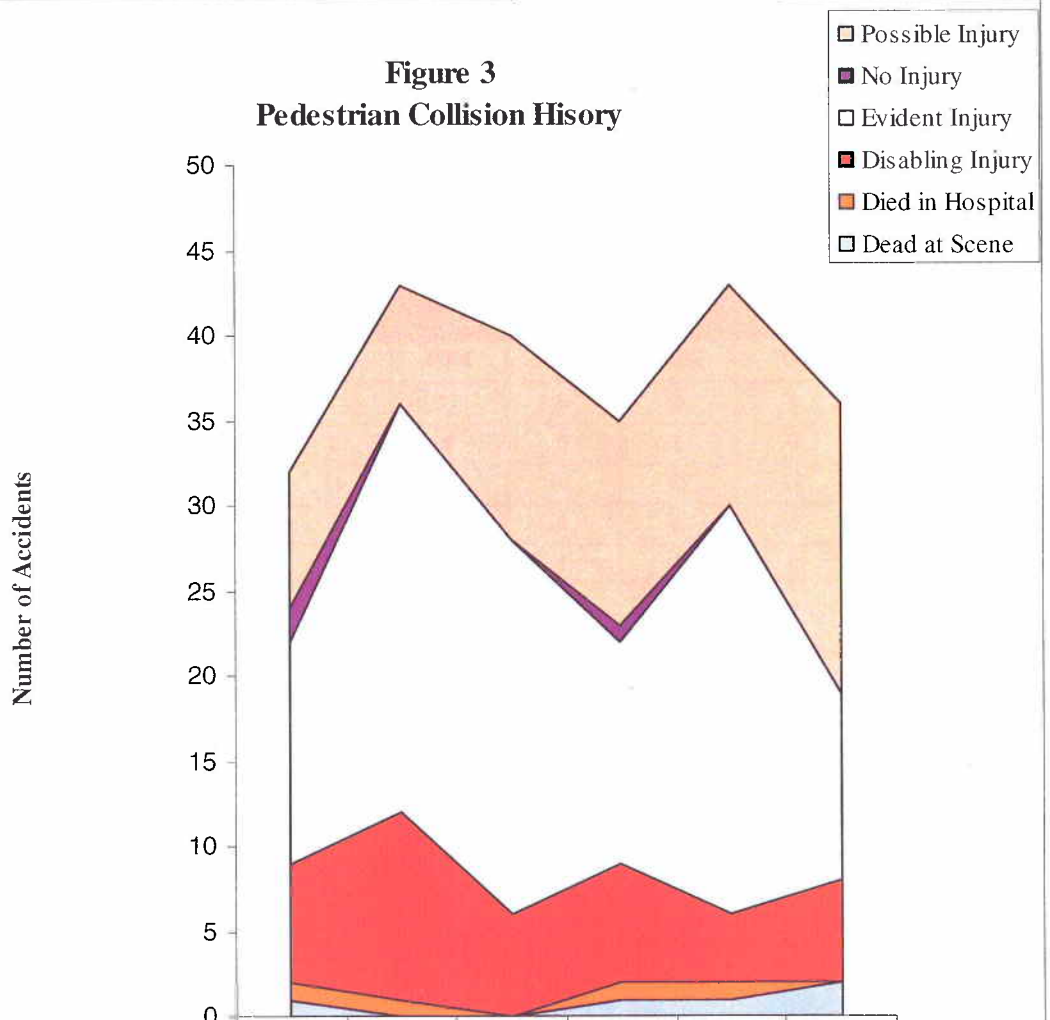
The estimated collision rate over the past 6 years is shown in Figure 2. The information used in this estimate is provided in Table C3 (Appendix C). Review of Figure 2 indicates that the estimated collision rate has varied between 1.05 and 1.20 acc/mvm during the last 6 years. No trend is currently evident.

It should be noted that due to limited data, a number of assumptions were made in estimating the collision rate. While the estimated collision rate is useful to compare changes over time within unincorporated King County, it is not valid as a basis for comparison with collision rates for individual roadways or from other jurisdictions.

4.5. 6 Year Pedestrian and Bicycle Collision History

Figures 3 and 4 show the number of pedestrians and cyclist involved in collisions occurring annually over the past 6 years. Since the vehicle can strike more than one pedestrian, the number of pedestrians involved in collisions can be higher than the number of collisions.

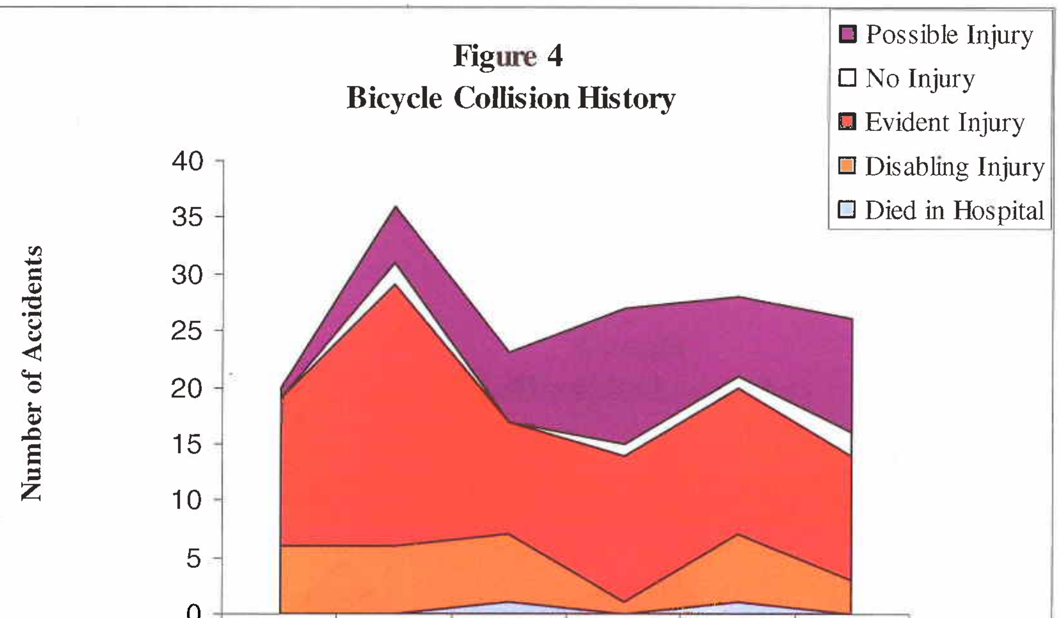
Figure 3
Pedestrian Collision Hisory



	2001	2002	2003	2004	2005	2006
Possible Injury	8	7	12	12	13	17
No Injury	2	0	0	1	0	0
Evident Injury	13	24	22	13	24	11
Disabling Injury	7	11	6	7	4	6
Died in Hospital	1	1	0	1	1	0
Dead at Scene	1	0	0	1	1	2

Year

Figure 4
Bicycle Collision History



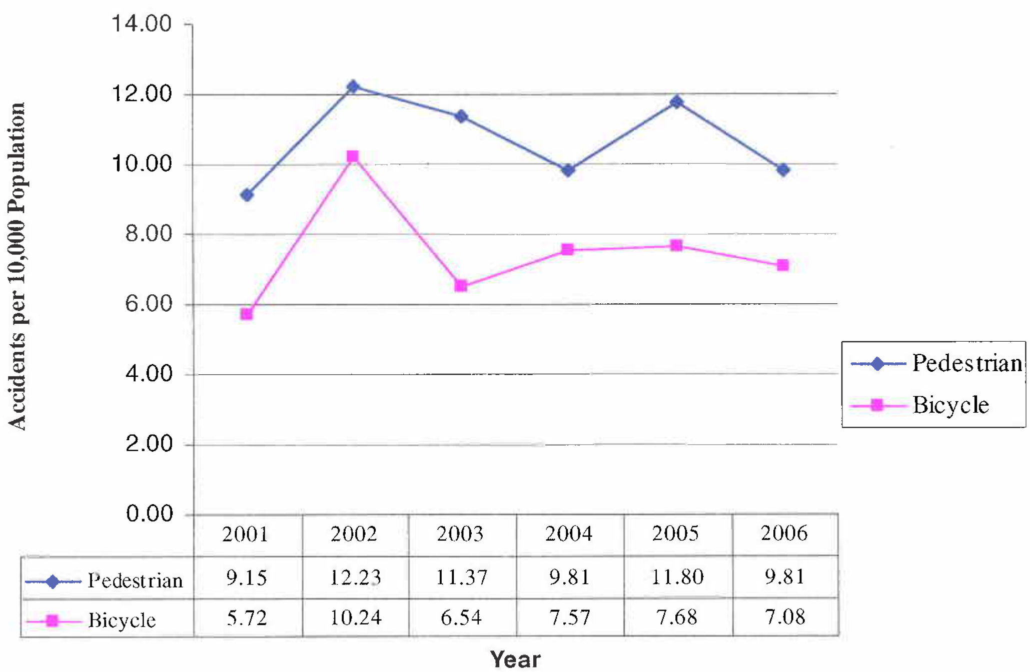
	2001	2002	2003	2004	2005	2006
Possible Injury	1	5	6	12	7	10
No Injury	0	2	0	1	1	2
Evident Injury	13	23	10	13	13	11
Disabling Injury	6	6	6	1	6	3
Died in Hospital	0	0	1	0	1	0

Year

Figures 3 and 4 show that the number of pedestrians and cyclists involved in collisions increased slightly since 2001.

Figure 5 shows that the pedestrian and bicycle collisions per 100,000 residents of unincorporated King County have increased slightly since 2001.

Figure 5
Pedestrian and Bicycle Collisions per 100,000 Population

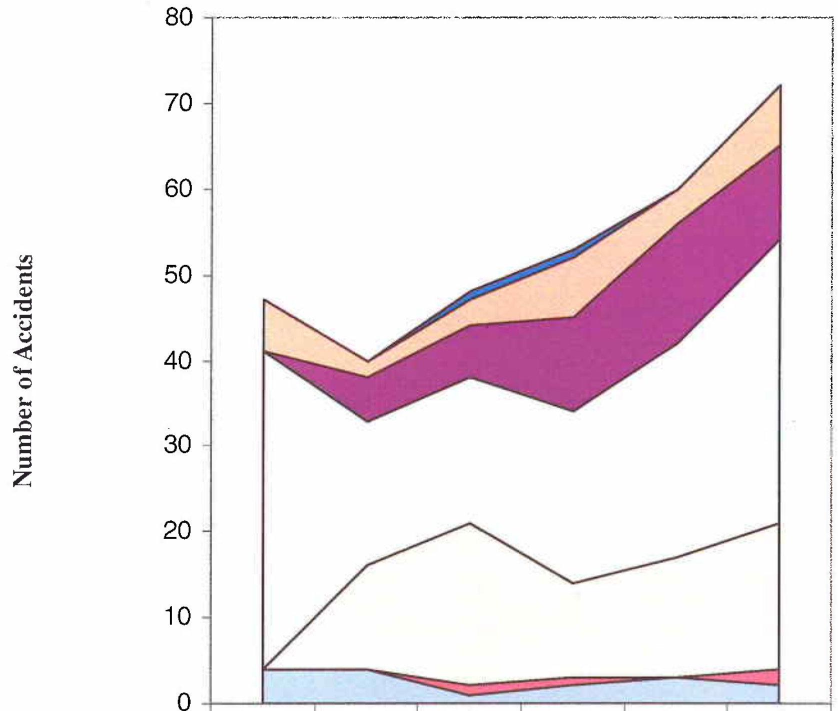


	2001	2002	2003	2004	2005	2006
Pedestrian	9.15	12.23	11.37	9.81	11.80	9.81
Bicycle	5.72	10.24	6.54	7.57	7.68	7.08

4.6. Six Year Motorcycle Collision History

The five-year motorcycle collision history is illustrated in Figure 6. The number of motorcycle collisions increased by nearly 53% between 2001 and 2006.

Figure 6
Motorcyle Collision History



	2001	2002	2003	2004	2005	2006
Unknown	0	0	1	1	0	0
No Injury	6	2	3	7	4	7
Possible Injury	0	5	6	11	14	11
Evident Injury	37	17	17	20	25	33
Disabling Injury	0	12	19	11	14	17
Died in Hospital	0	0	1	1	0	2
Dead at Scene	4	4	1	2	3	2

Year

Motorcycle collisions tend to be more severe than collisions involving larger vehicles. Nearly 90% of the motorcycle collisions resulted in injuries or fatalities.

While the number of miles driven by motorcycles is not available, information on the number of registered motorcycles is available from the Washington State Department of Licensing[2]. The number of registered motor vehicles and motorcycles in King County has increased by approximately 42% over the five year period of 2001 to 2005, while the number of collisions increased 28%. Also consider that 2.8% of the vehicles registered in Washington State are motorcycles and 2% of the collision reports involved motorcycles.

It should be noted that due to the relatively low number of motorcycle collisions, the recent increase would not generally be considered a statistically valid trend. However, considering this increase and the severity of motorcycle collisions, further endeavors in this area may be warranted.

Motorcycle collisions are discussed further in section 5.10.

[2] Department of Licensing figures include both incorporated cities and unincorporated King County

5.0 COLLISION TYPES

A breakdown of collision data according to the more frequent collision types is provided in this section. Factors influencing the frequency of collisions and methods used to reduce the number of collisions are also discussed.

While the discussion in this section focuses on the influence of roadway design, it is important to realize that human and vehicular factors have a great deal of influence on the frequency and severity of collisions. Such factors include driver ability and attention, sobriety, vehicle speed, and vehicle condition.

Figure 7 shows a breakdown of 2006 collisions by the type of collision. Approximately 62% of the collisions fall into one of three categories: run-off-road, rear end, and enter at angle collisions. Pedestrian and bicycle collisions comprise 1.1% and 0.9% of the collisions, respectively.

Figure 7
2006 Collisions by Type

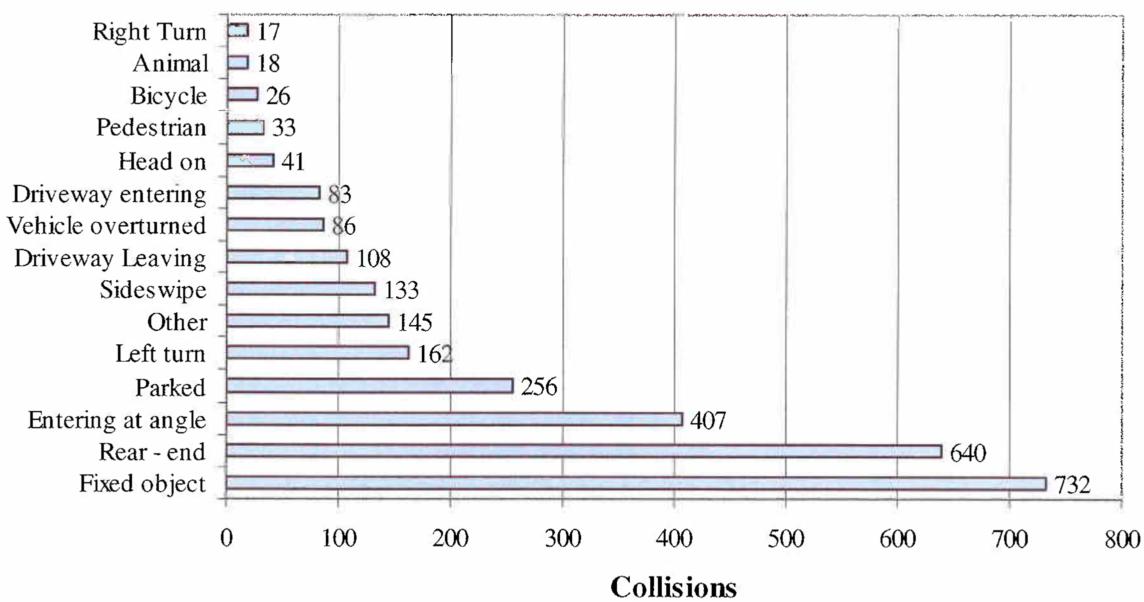
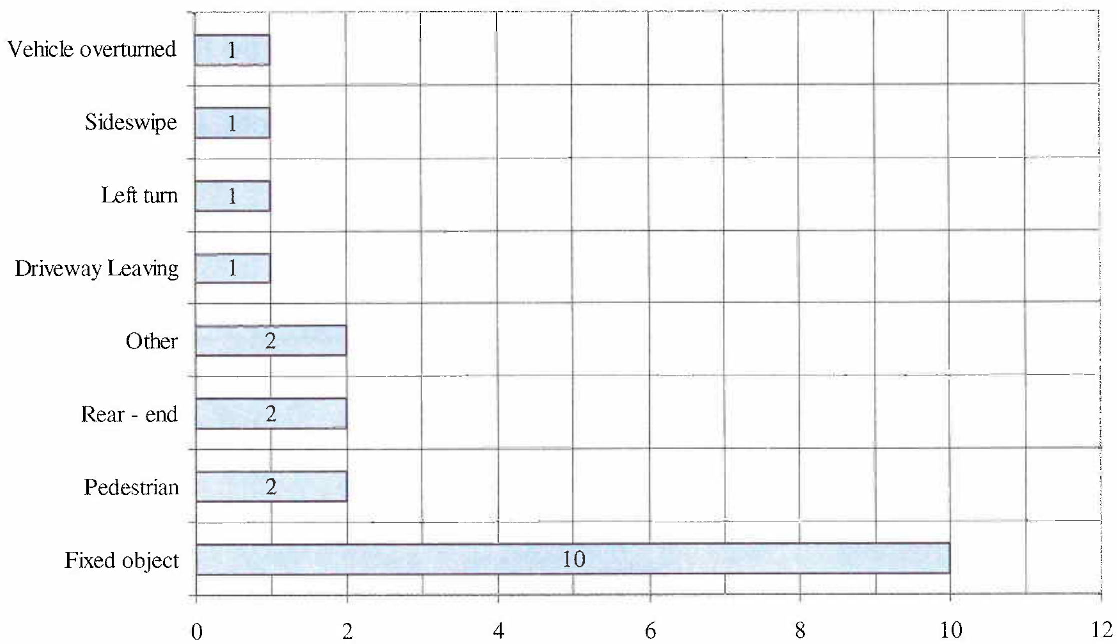


Figure 8 is a breakdown of the fatalities by collision type. It should be noted that while run-off-road collisions made up approximately one-fourth of the total collisions, they accounted for one-half of the fatal collisions. While this would not be considered statistically significant over a one-year time frame due to the number of fatal collisions (20 in year 2006), review of collision data for the last ten years indicates a nearly identical pattern. Nationwide, approximately one-third of fatal collisions are run-off-road collisions.[3]

Figure 8
2006 Fatal Collisions by Collsion Type



The following subsections discuss some of the more frequent collision types.

[3] NCHRP Report 500, Volume 6: "A Guide for Addressing Run-Off-Road Collisions"

5.1. Fixed Object (Run-Off-Road) Collisions

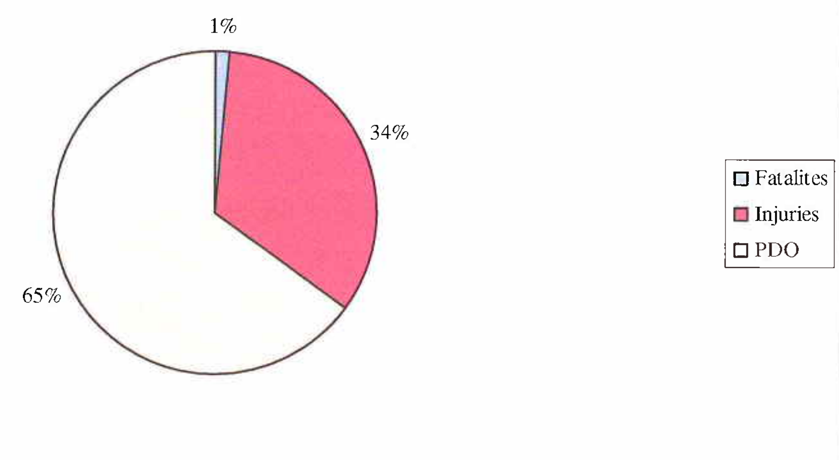
5.1.1. Definition

A run-off-road collision is defined as an event where a vehicle leaves the traveled portion of the roadway, and is unable to recover prior to encountering an object, body of water, or embankment (ditch). A large number of run-off-road collisions go unreported when the vehicle is able to return to the roadway and drive away after the collision. These tend to be minor collisions but can exceed the $700 reporting threshold, particularly when roadside objects such as guardrail, fire hydrants, and poles are damaged.

Features such as horizontal and vertical curves, narrow roadways, varying shoulder widths, roadside obstacles, and steep embankments tend to increase the frequency of run-off-road collisions. Roadway reconstruction, shoulder widening, and removal of obstacles can reduce the number and severity of run-off-road collisions. Installation of guardrail and other traffic barriers can reduce the severity of these collisions.

5.1.2. Collision Experience

Figure 9
2006 Fixed Object Collisions



As previously noted, approximately one-fourth of the vehicular collisions in unincorporated King County were run-off-road collisions, making this the most frequent collision type. 10 of the 20 fatal collisions that occurred in 2006 were run-off-road collisions. (Note: That there were 21 fatalities in 2006 that result from 20 fatal collisions since some of the collisions were multiple fatality collisions.) A total of 732 run-off-road collisions occurred during 2006, with an estimated cost of $28.8 million. A breakdown of these collisions according to severity is shown in Figure 9. Sixty five percent of the fixed object collisions were property damage only collisions.

Figure 10
2006 First Object Struck

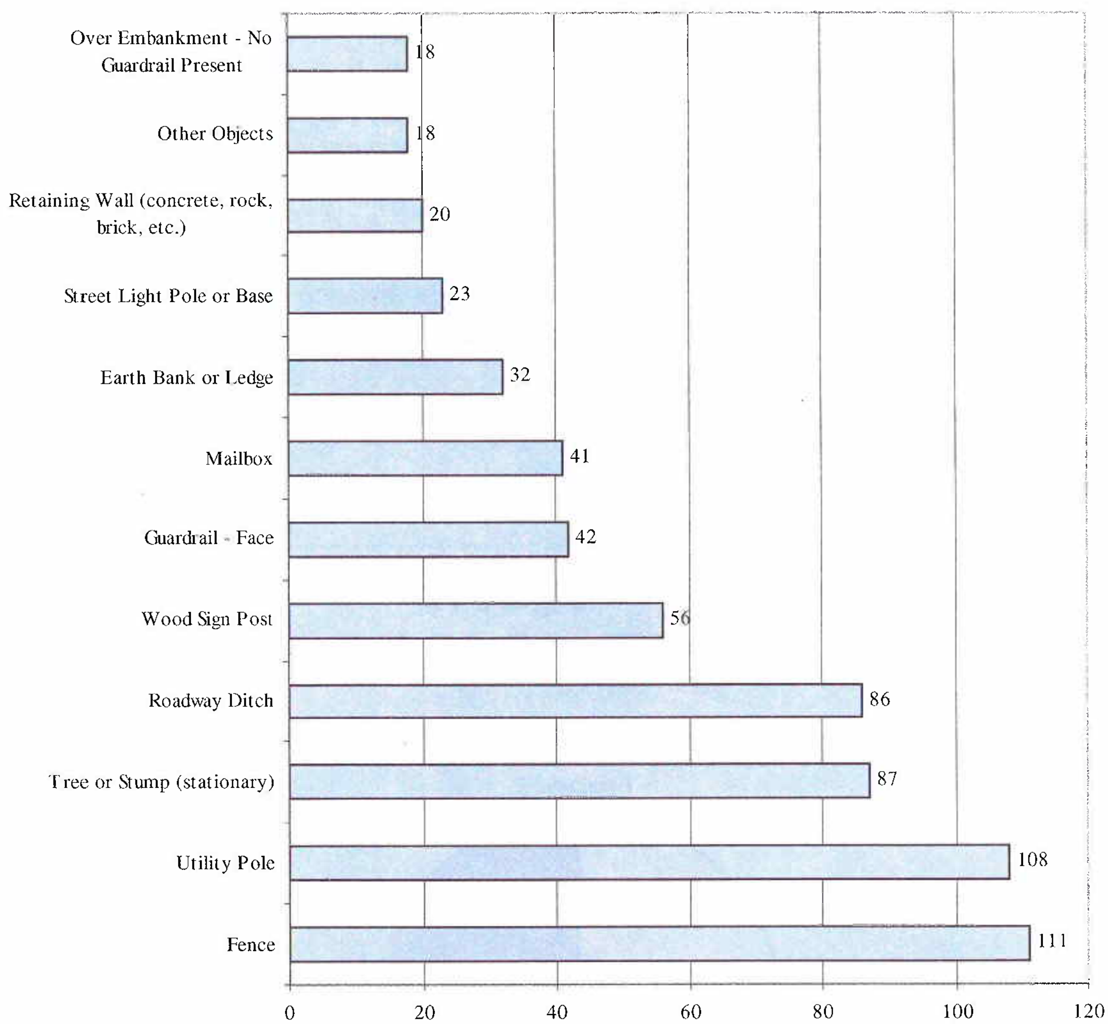


Figure 10 shows a breakdown of run-off-road collisions by the type of object struck. Several objects can be struck during a single collision, and this breakdown refers to the first object encountered according to the Officer's report. As shown in Figure 10, fences, utility poles and trees were the most frequently struck objects, comprising 42% of the run-off-road collisions. Isolated fixed objects (utility poles, fences, trees, signs and mailboxes) were involved in 50% of the run-off-road collisions. Utility poles were the mostly frequently struck isolated fixed objects.

5.2. Rear-End Collisions

5.2.1. Definition

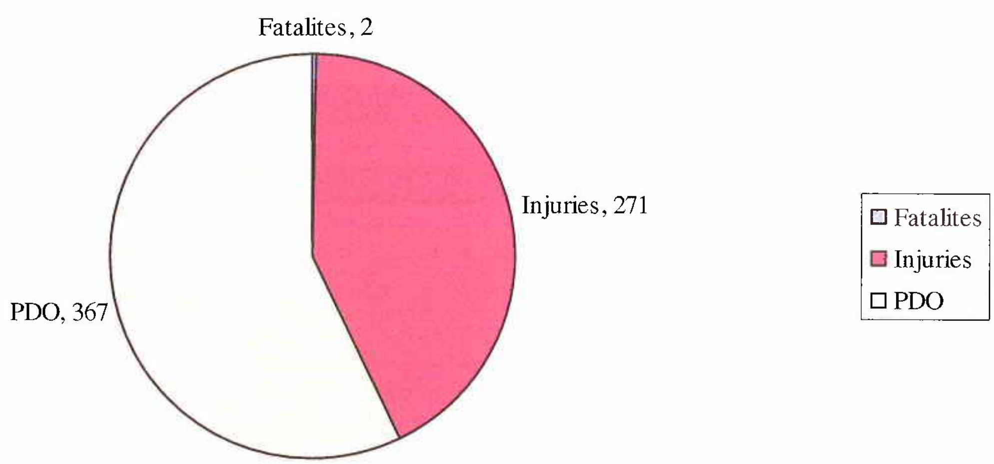
A rear-end collision occurs when one vehicle runs into the rear of another vehicle that is traveling in the same direction. This collision type does not include collisions with parked cars. In almost all cases, fault is assigned to the driver of the rear vehicle.

Rear-end collisions frequently occur when a vehicle suddenly overtakes another vehicle that has slowed or stopped unexpectedly. The front vehicle may slow or stop at traffic lights or stop signs, prior to turning, or in response to emergency situations. Traffic congestion and limited sight distance can also increase the number of rear-end collisions.

Treatments to reduce the number of rear-end collisions can include adding turn lanes, reducing congestion, or improving sight distance. Sight distance improvements include trimming trees, removing visual obstructions, and reconstruction of roadways to reduce horizontal and vertical curvature.

5.2.2. Collision Experience

Figure 11
2006 Rear End Collisions



As previously noted, nearly one-fourth of the vehicular collisions in unincorporated King County were rear end collisions, making this the second most frequent collision type. A total of 640 rear end collisions occurred during 2006, with an estimated cost of $21.8 million.

A breakdown of these collisions according to severity is shown in Figure 11.

5.3. Entering at Angle Collisions

5.3.1. Definition

A right angle collision is defined as a collision where one vehicle enters a roadway and is struck by a second vehicle at an angle of approximately 90 degrees. The entering vehicle may be entering from a driveway or another street, and may be attempting to cross the street or turning right. A right angle collision occurs because one of the vehicles fails to yield the right-of-way, whether assigned by a traffic signal, yield or stop sign, or by state law (in the case of driveways and uncontrolled intersections).

Right angle collisions occur most frequently at locations where driveways or minor streets intersect higher volume streets, particularly where traffic congestion or limited sight distance is present. Engineering solutions include traffic controls such as all way stop control, signals, and roundabouts, and sight distance improvements. Driveway collisions can usually be reduced by access control measures such as closing or relocating driveways, or prohibiting movements such as left turns. All of these solutions can have undesirable side effects, including increases in other types of collisions. For this reason these improvements need to be carefully evaluated prior to implementation to ensure that the benefits outweigh the limitations.

5.3.2. Collision Experience

Right angle collisions were the third most frequent type of collision, comprising 14% of collisions during 2006. A total of 407 right angle collisions occurred, with an estimated cost of $12.3 million. A breakdown of these collisions according to severity is shown in Figure 12.

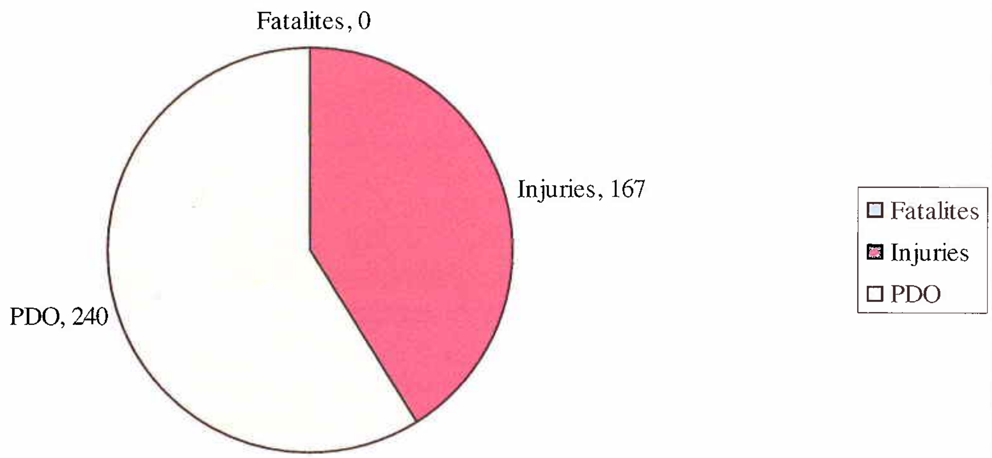


Figure 12
2006 Entering at Angle Collisions

5.4. Left Turn Collisions

5.4.1. Definition

A left turn collision occurs when one vehicle attempting to make a left turn collides with another vehicle traveling in the opposite direction. State law requires the left turning vehicle to yield to oncoming traffic unless a sign or traffic signal indicates otherwise.

The number of left turn collisions may be higher at locations with high traffic volumes, congestion, or limited sight distance. Improvements such as left turn lanes and left turn signal phasing[4] are frequently used to reduce the number of left turn collisions.

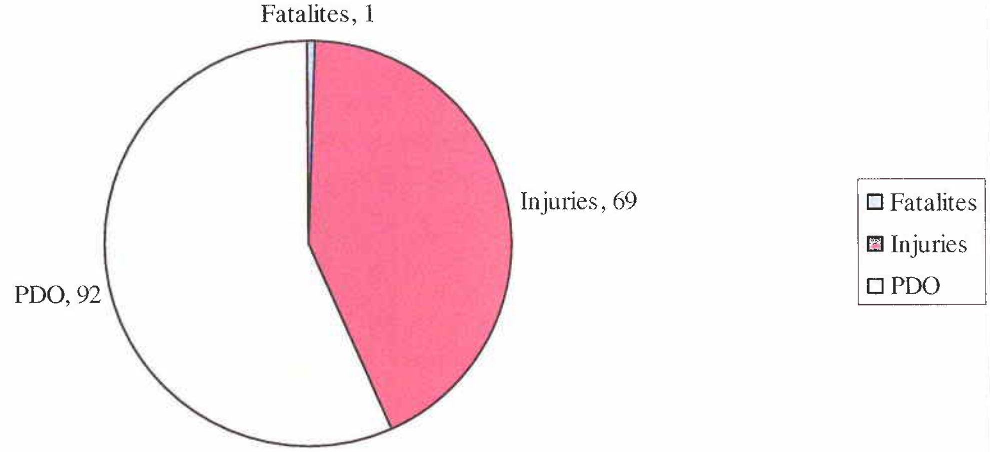
5.4.2. Collision Experience

Six percent of the collisions during 2006 were left turn collisions. A total of 162 left turn collisions occurred, with an estimated cost of $6.0 million.

A breakdown of these collisions according to severity is shown in Figure 13.

[4] Left turn signal phasing uses a "green arrow" signal head and provides a "protected" movement for left turning vehicles

Figure 13
2006 Left Turn Collisions



5.5. Parked Car Collisions

5.5.1. Definition

Parked car collisions occur when a vehicle leaves the road and collides with a vehicle outside of the traveled portion of the roadway. The parked vehicle can be occupied and running, but cannot be moving. This collision type does not include collisions that occur in parking lots or other privately owned areas unless the parked vehicle is located adjacent to a roadway and is struck by a vehicle that departed from the roadway immediately prior to the collision. This collision type also excludes collisions with vehicles stopped in travel lanes (e.g. vehicles stopped at a signal or while waiting to turn).

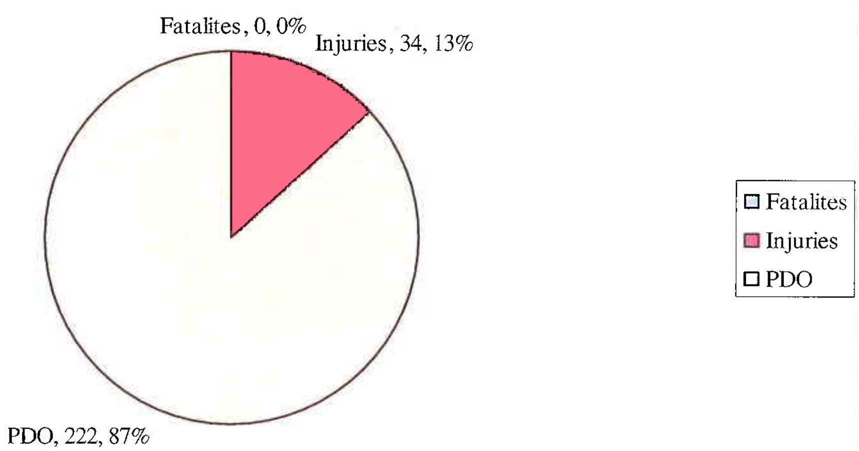
This type of collision occurs most frequently on roadways with on-street parking. Factors that can increase the number of parked car collisions include limited sight distance, high speeds and volumes, retail land use, and wide roadways with no lane designation. Improvements to reduce the number of parked car collisions include parking prohibitions, adding striping to differentiate between travel and parking lanes, and increasing the width of parking areas.

5.5.2. Collision Experience

Nine percent of the collisions during 2006 were parked car collisions. A total of 256 parked car collisions occurred, with an estimated cost of $3.5 million.

A breakdown of these collisions according to severity is shown in Figure 14. As indicated in this figure 87% of parked car collisions in 2006 were property damage only.

Figure 14
2006 Parked Car Collisions



5.6. Sideswipes

5.6.1. Definition

A sideswipe is defined as a shallow-angle collision. Typically the vehicles are traveling on the same roadway, and can be moving in the same or opposite directions.

Same direction sideswipes frequently occur in areas where lane changes, merging or sudden stops are required. These collisions can frequently be reduced using the same approaches as for rear-end collisions.

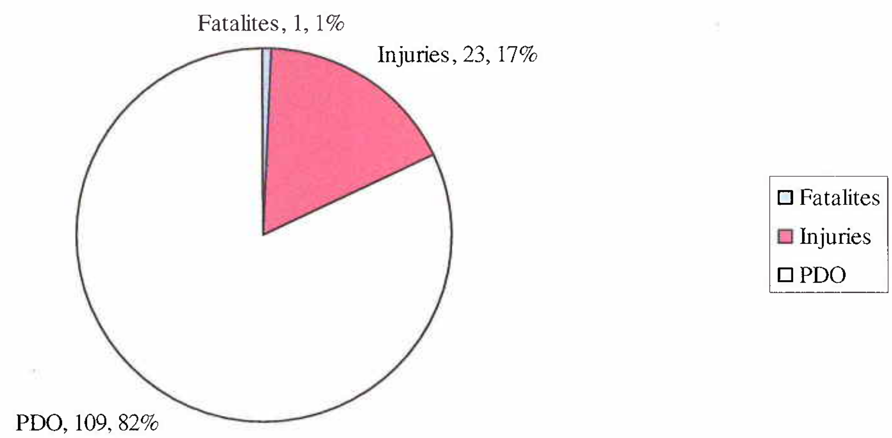
Features such as horizontal and vertical curves, narrow roadways, varying lane widths, and merging zones tend to increase the frequency of opposite direction sideswipes. Typical improvements include roadway reconstruction and centerline treatments such as rumble strips, medians, and islands.

5.6.2. Collision Experience

Five percent of the collisions were sideswipes. A total of 133 sideswipes occurred, with an estimated cost of $3.1 million.

A breakdown of these collisions according to severity is shown in Figure 15. As indicated 82% of the sideswipes were PDO collisions.

Figure 15
2006 Sideswipe Collisions



5.7. Head-On Collisions

5.7.1. Definition

A head-on collision occurs when two vehicles traveling in opposite directions collide at little or no angle.

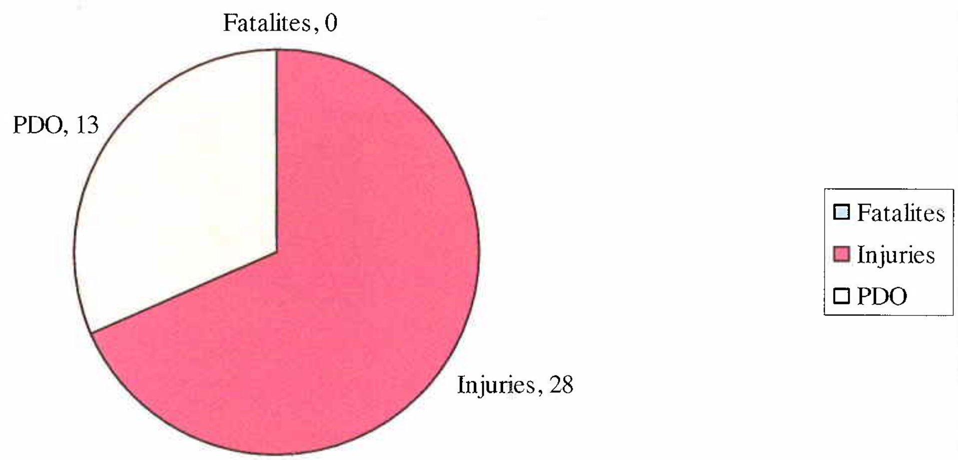
As with opposite direction sideswipes, features such as horizontal and vertical curves, narrow roadways, varying lane widths, and merging zones tend to increase the frequency of head-on collisions. Typical improvements include roadway reconstruction and centerline treatments such as rumble strips, medians, and islands.

5.7.2. Collision Experience

One percent of the collisions were head-on collisions. A total of 41 collisions occurred, with an estimated cost of $5.4 million.

A breakdown of these collisions according to severity is shown in Figure 16. As indicated by this figure, head-on collisions tend to be more severe than most other collision types.

Figure 16
2006 Head On Collisions



5.8. Pedestrian Collisions

Reported pedestrian collisions are infrequent, but receive special attention due to their severity. Pedestrian collisions that do not result in injuries are rarely reported, and therefore the frequency of these collisions is not known.

A number of approaches are utilized with the intention of reducing the number of pedestrian collisions. These approaches include physical improvements such as pathways, sidewalks, and enhanced crosswalks; and other actions such as providing crossing guards at schools, education, and enforcement of jaywalking and speed limit laws. Due to the infrequent nature of these collisions, it is difficult to assess the impact of improvements at specific locations unless large numbers of pedestrian collisions have occurred.

5.8.1. Collision Experience

Pedestrian collisions comprised 1.14% of the collisions during 2006. A total of 40 collisions occurred, with an estimated cost of $4.0 million. A breakdown of pedestrian collisions according to severity is shown in Figure 17.

Figure 17
2006 Pedestrian Collisions

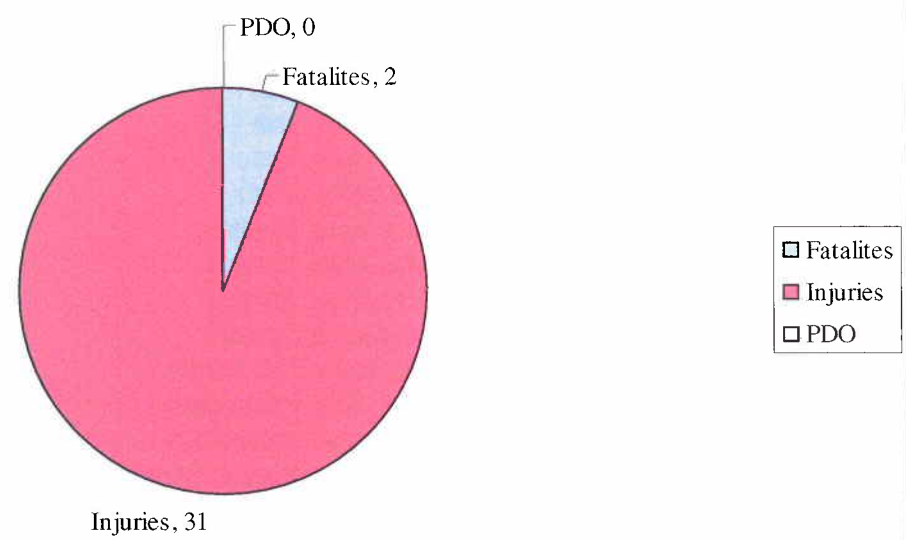
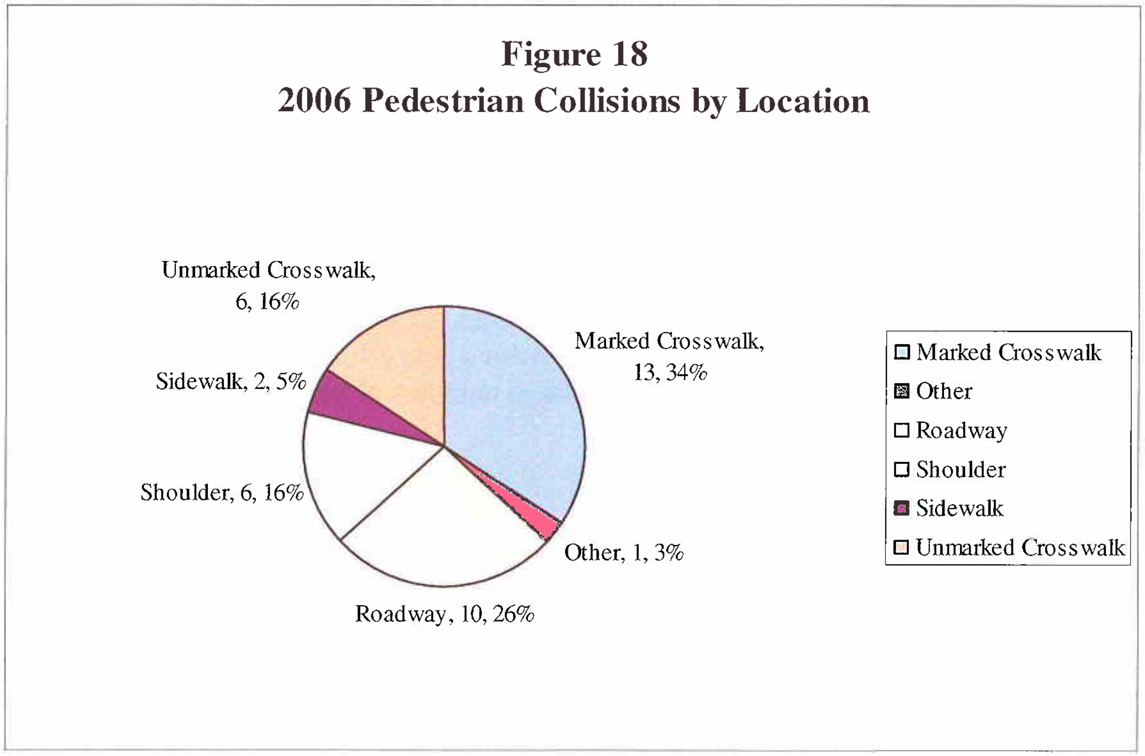
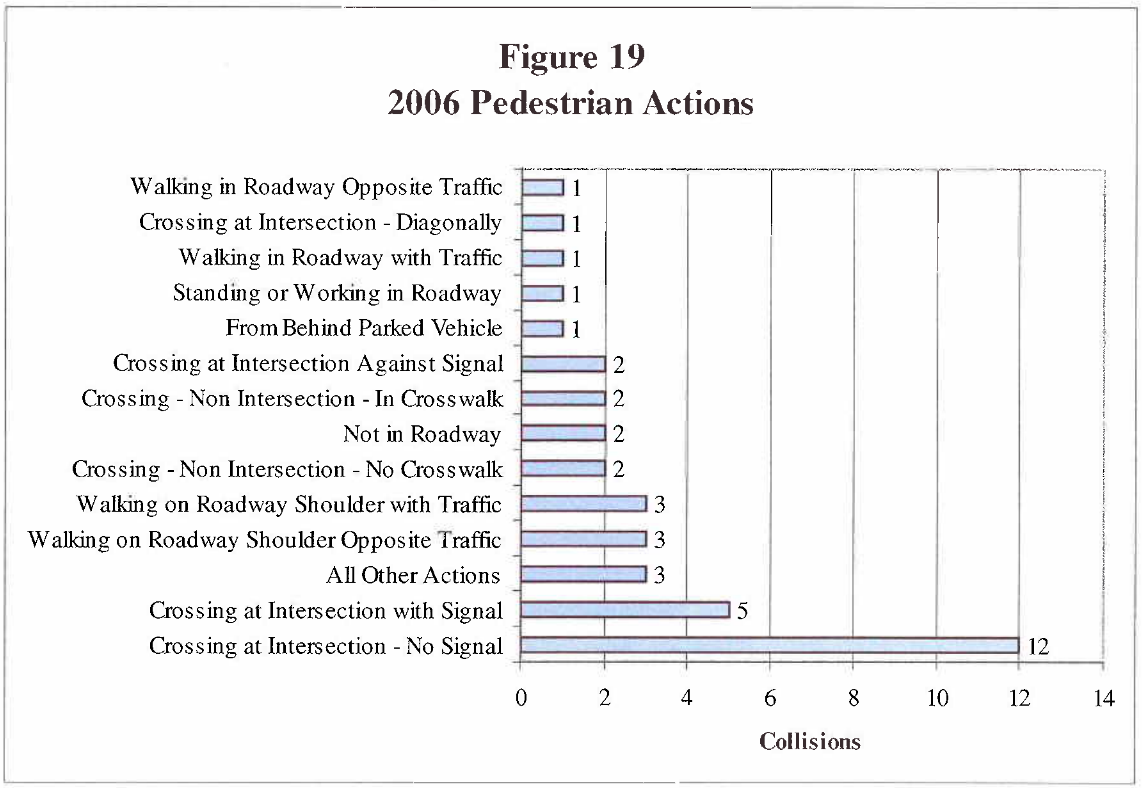


Figure 18 provides a breakdown of pedestrian collisions by location. 42% of the collisions occurred at non-intersection locations (roadway and shoulder).



12 of the collisions occurred while crossing at an intersection without a signal, 5 while crossing an instersection with a signal.



5.9. Bicycle Collisions

As with pedestrian collisions, bicycle collisions are infrequent, but receive special attention due to their severity.

5.9.1. Definition

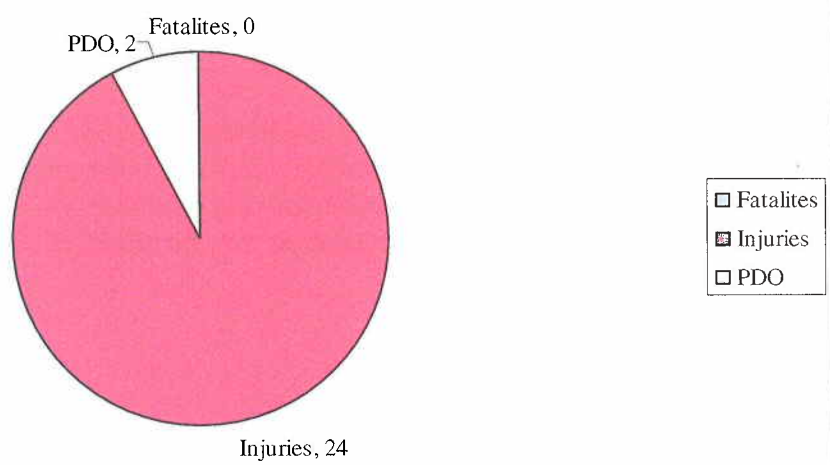
The bicycle collision category includes all collisions with human-powered wheeled vehicles, and for this reason the category is sometimes referred to as "pedalcycle" collisions.

A number of approaches are utilized with the intention of reducing the number of bicycle collisions. These approaches include physical improvements such as wider shoulders, bike lanes, and separated pathways. Other actions that do not have physical improvements include education and enforcement. Due to the infrequent nature of these collisions, it is difficult to assess the impact of improvements at specific locations.

5.9.2. Collision Experience

Bicycle collisions comprised 0.9% of the collisions during 2006. A total of 26 collisions occurred, with an estimated cost of $1.6 million.

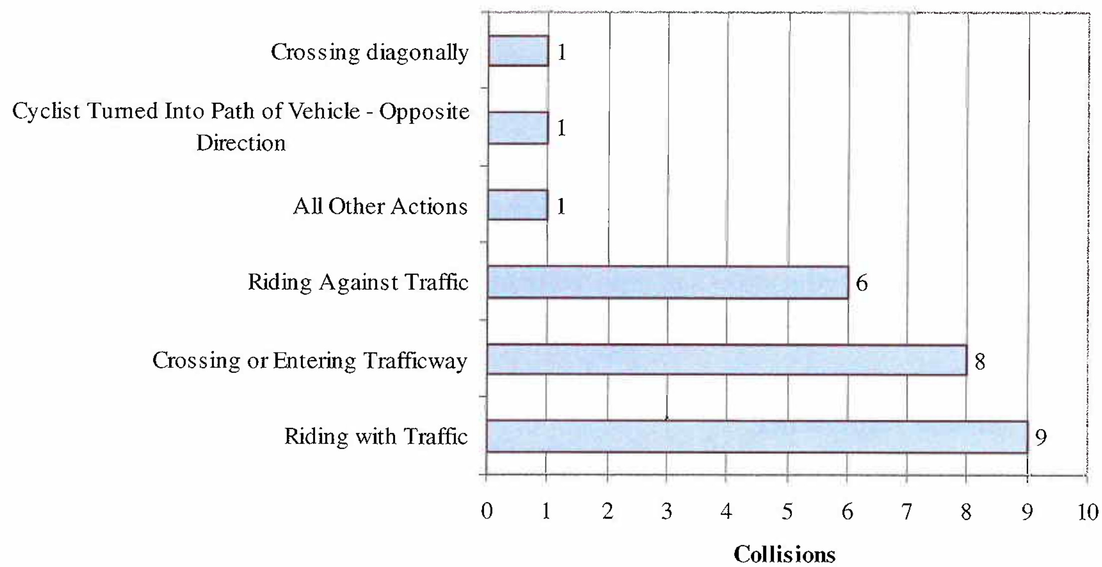
Figure 20
2006 Bicycle Collisions



A breakdown of bicycle collisions according to severity is shown in Figure 20.

Figure 21 provides a summary of bicycle collisions according to the cyclists actions. A majority of the collisions occurred while the cyclist was riding with traffic, crossing or entering traffic, and riding against traffic.

Figure 21
2006 Cyclist Actions



5.10 Motorcycle Collisions

5.10.1 Definition

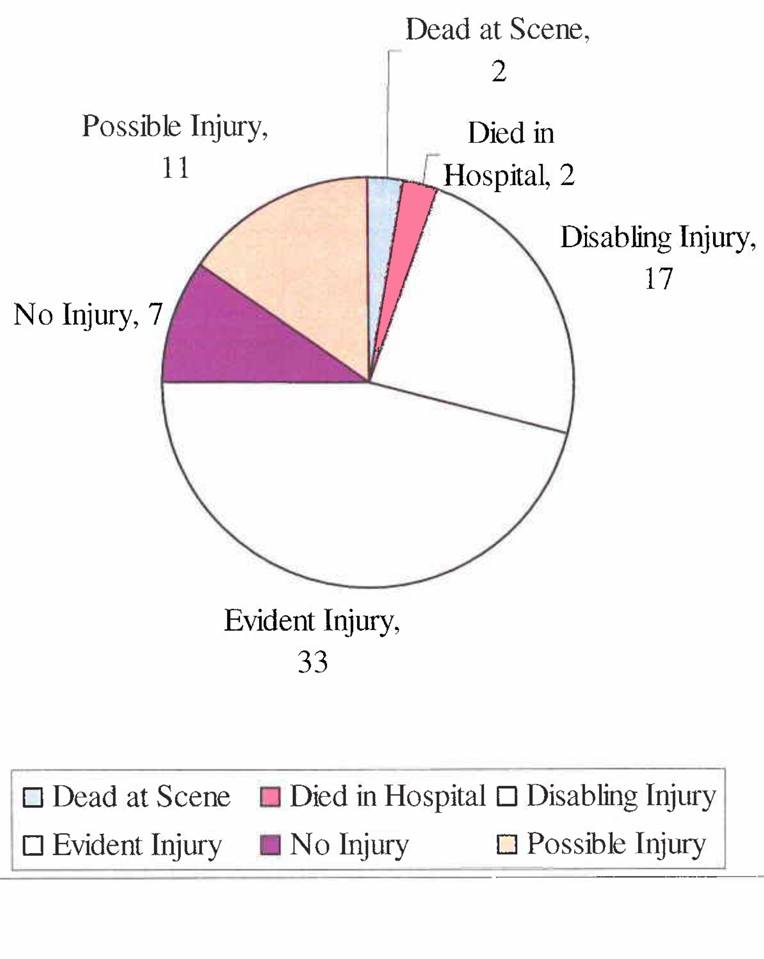
Motorcycle collisions tend to be severe due to the limited protection provided by motorcycles when compared with passenger cars and other enclosed vehicles. Passage and enforcement of helmet laws are probably the most effective means of reducing the severity of motorcycle collisions. Education may be effective in reducing the frequency of these collisions.

5.10.2 Collision Experience

Motorcycle collisions comprised 2.49% of the collisions during 2006. A total of 72 collisions occurred, with an estimated cost of $8 million. Four fatal collisions occurred, more than any other category except run-off-road collisions.

A breakdown of motorcycle collisions according to severity is shown in Figure 22. As indicated 90% of the collisions were injury or fatal collisions. As noted in section 4.6, due to the severity of motorcycle collisions and recent increases in the number of collisions, further effort in this area (e.g. education and licensing requirements) may be warranted.

Figure 22
2006 Motorcycle Collisions by Severity



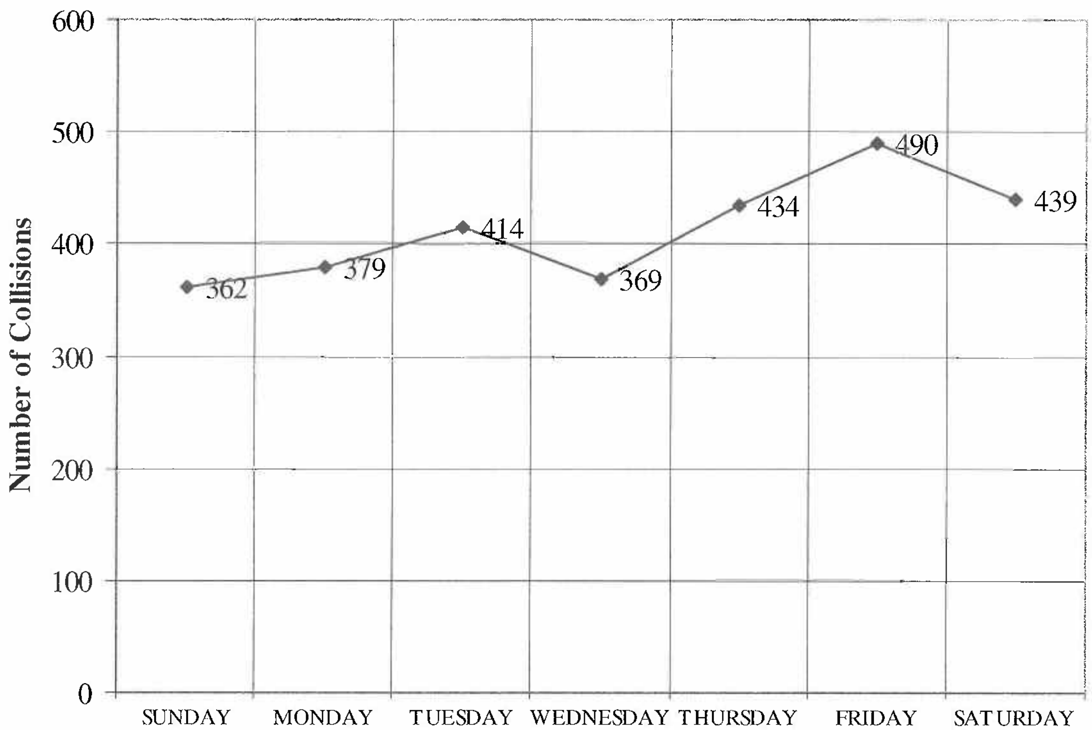
6.0 OTHER COLLISION INFORMATION

This section provides information on collisions by miscellaneous categories such as the time of day, road surface conditions, and circumstances contributing to the collision. As with the previous section, strategies for reducing the number of collisions are also discussed. A special studies subsection focusing on particular areas of interest is also included. The areas of focus for this subsection will vary from year to year.

6.1. Time and Day of Week

Figure 24 illustrates the relationship between collisions and the time of day, with a breakdown by weekdays and weekends. As expected, the majority of collisions occurred during the weekday AM and PM peak periods. In general, there appears to be a strong correlation between traffic volumes and collision frequency. A notable exception is during weekends between 2 and 4 AM, when the number of collisions appears to be higher in proportion to the number of vehicles on the road.

Figure 23
2006 Day of Week Collisions



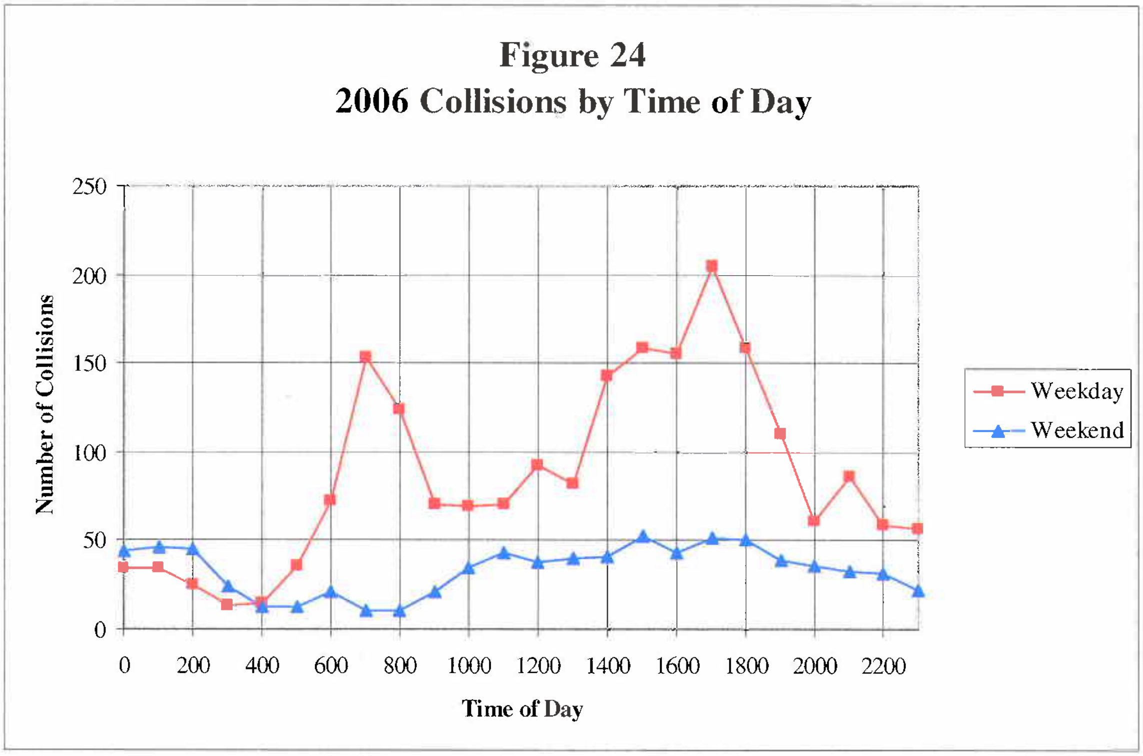


Figure 24
2006 Collisions by Time of Day
Number of Collisions
Time of Day
0
50
100
150
200
250
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
Weekday
Weekend

6.2. Weather and Road Surface Conditions

Inclement weather can decrease visibility and create situations that distract drivers. In addition, wet, snowy, or icy pavement greatly increases stopping distance and decreases maneuverability. Figures 25 and 26 provide a breakdown of collisions according to road surface and weather conditions. 63% of the collisions occurred when the roadway was dry. Comparison according to severity indicates that in 2006, the percentages of property damage only, injury, and fatal collisions were nearly identical for wet and dry road surface conditions. When road conditions are dry there is a slightly higher percentage for fatal and injury collisions.

Figure 25
2006 Weather Conditions

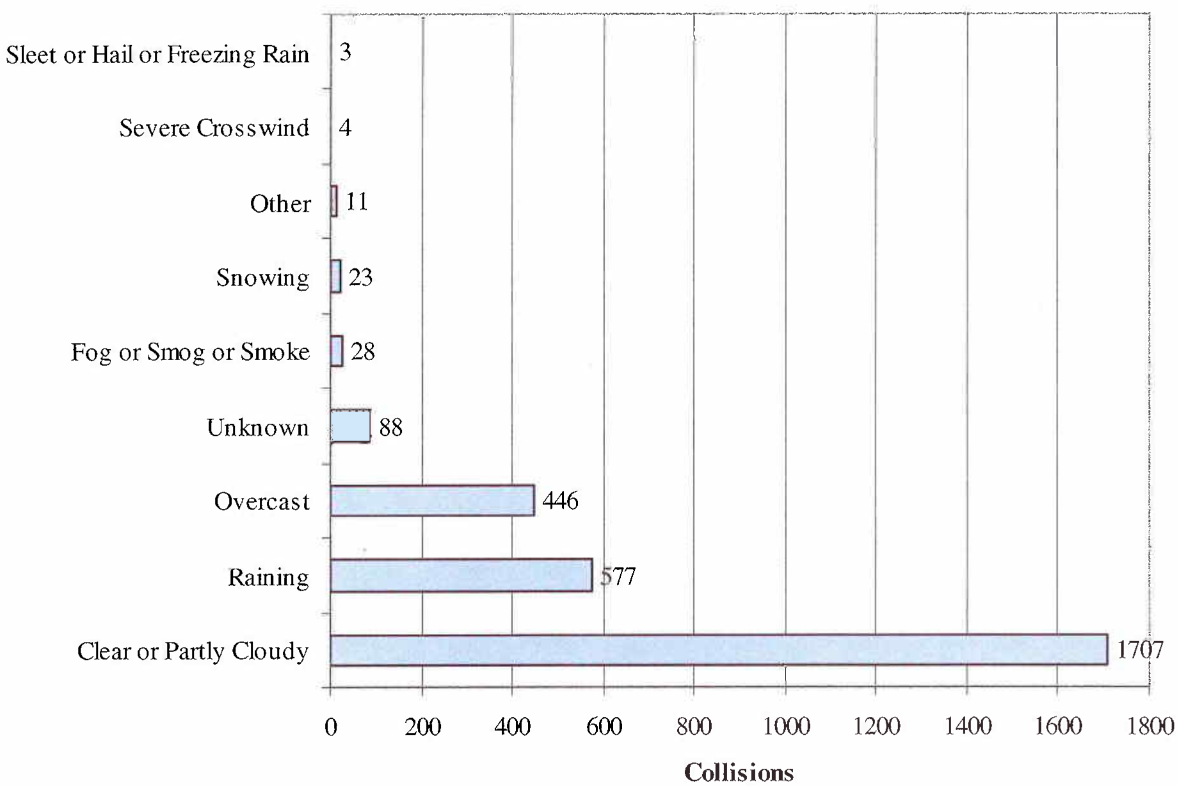
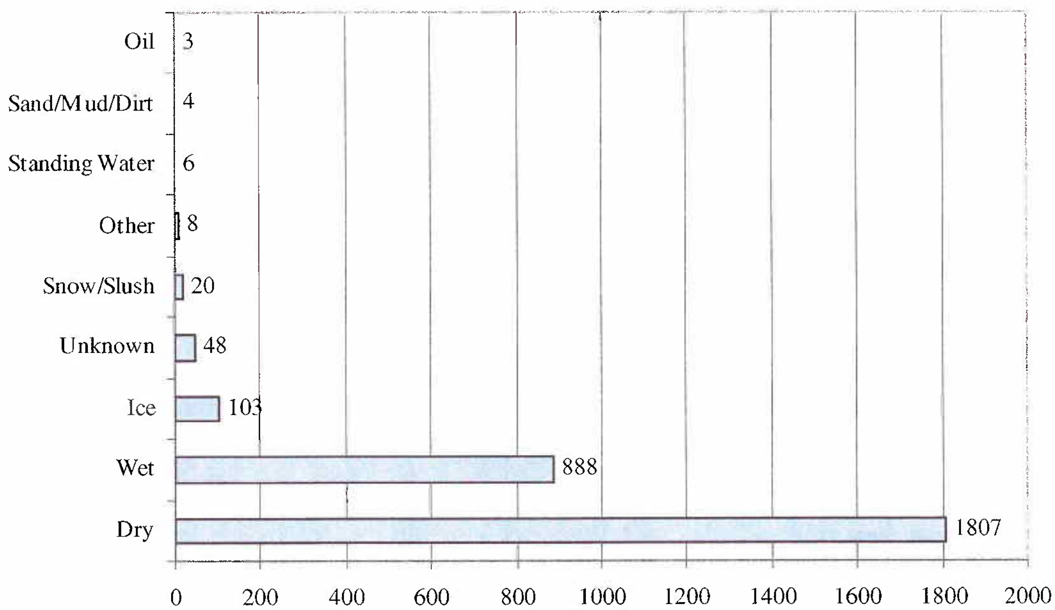


Table 5		
Road Conditions versus Severity		
Road Condition	**Severity**	**%**
Dry	Fatal	1.0%
Dry	Injury	39.9%
Dry	PDO	59.1%
Wet	Fatal	0.2%
Wet	Injury	33.5%
Wet	PDO	66.3%

Figure 26
2006 Road Surface Conditions



6.3. Collision Locations

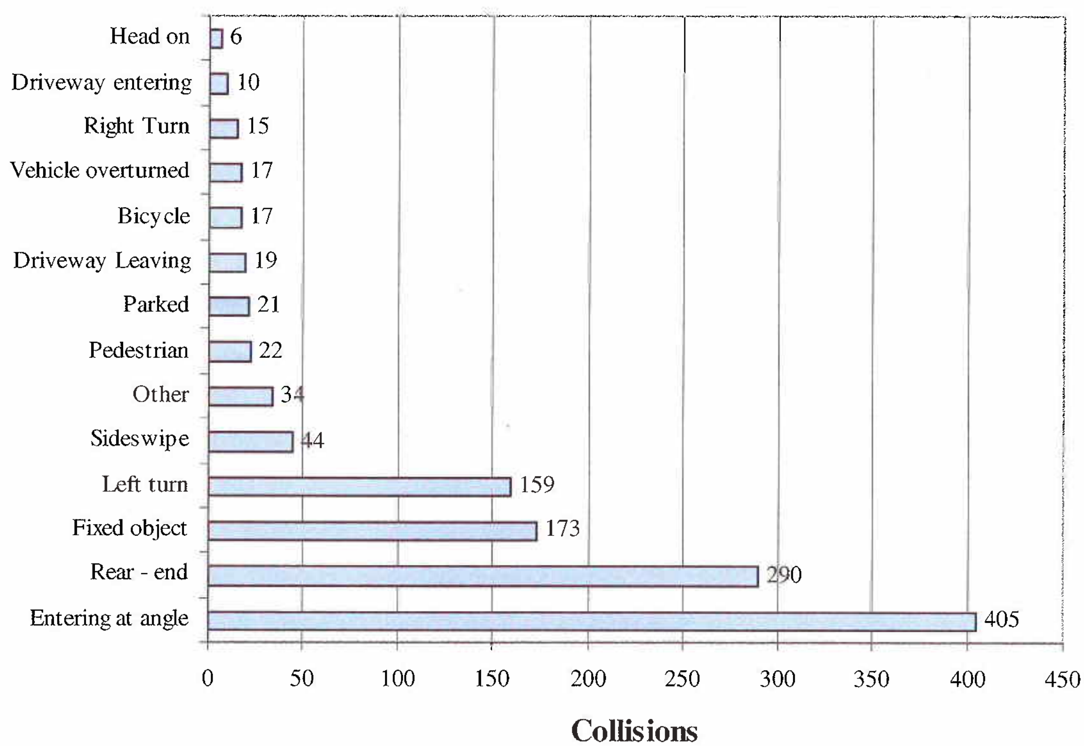
6.3.1. Intersection and Non-intersection Collisions

Intersections constitute only a small portion of the roadway system, yet national statistics indicate that more than 50% of collisions in urban areas and over 30% of collisions in rural areas occur at intersections. This is expected, since intersections are the point on the roadway system where traffic movements most frequently conflict with one another. [5]

Within unincorporated King County, 43% percent of the collisions in 2006 occurred at intersections. King County roadways vary from rural to urban in character. As expected, the percentage lies between the national averages for rural and urban areas.

Figure 27 provides a breakdown of intersection collisions by collision type. As indicated, the highest collision types at intersections were entering at angle (33%) rear-end (24%), left turn (13%) and fixed object (14%) collisions. These four collision types comprise over 80% of the collisions at intersections.

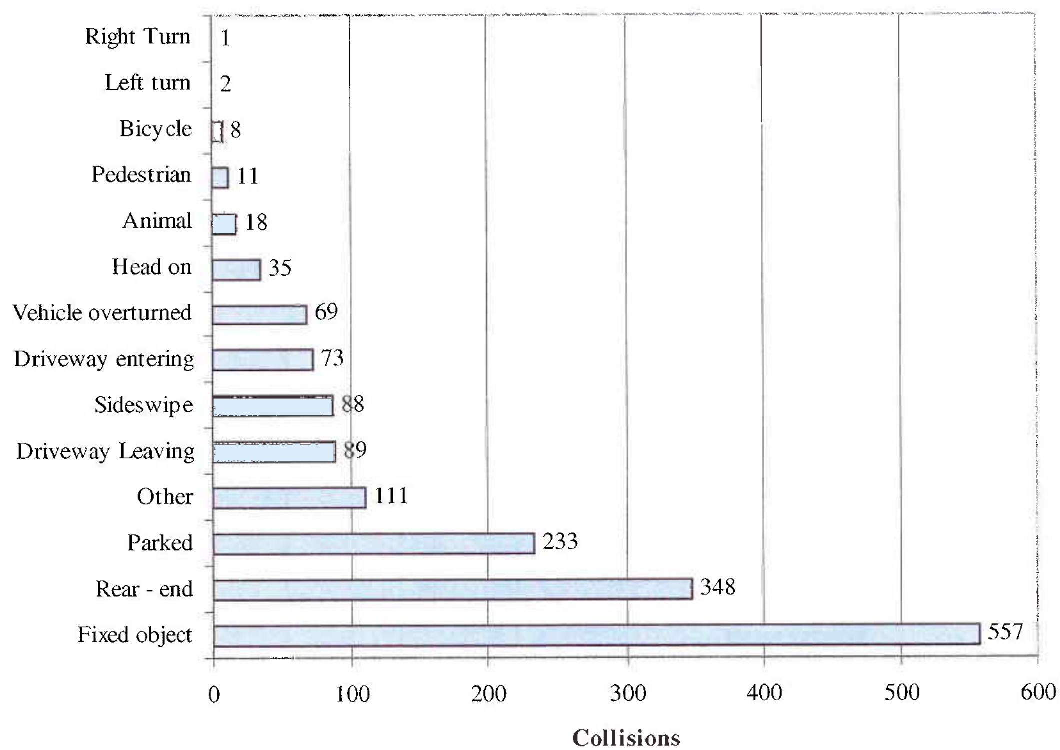
Figure 27
2006 Intersection Collisions by Type



[5] NCHRP Report 500, Volume 5 "A Guide for Addressing Unsignalized Intersection Collisions"

Figure 28 provides a breakdown of non-intersection collisions by collision type. 34% of the non-intersection collisions were fixed object collisions, making this the most frequent collision type. Rear-end (21%) and parked car (14%) collisions were the second and third most common collision types.

Figure 28
2006 Non-Intersection Collisions by Type

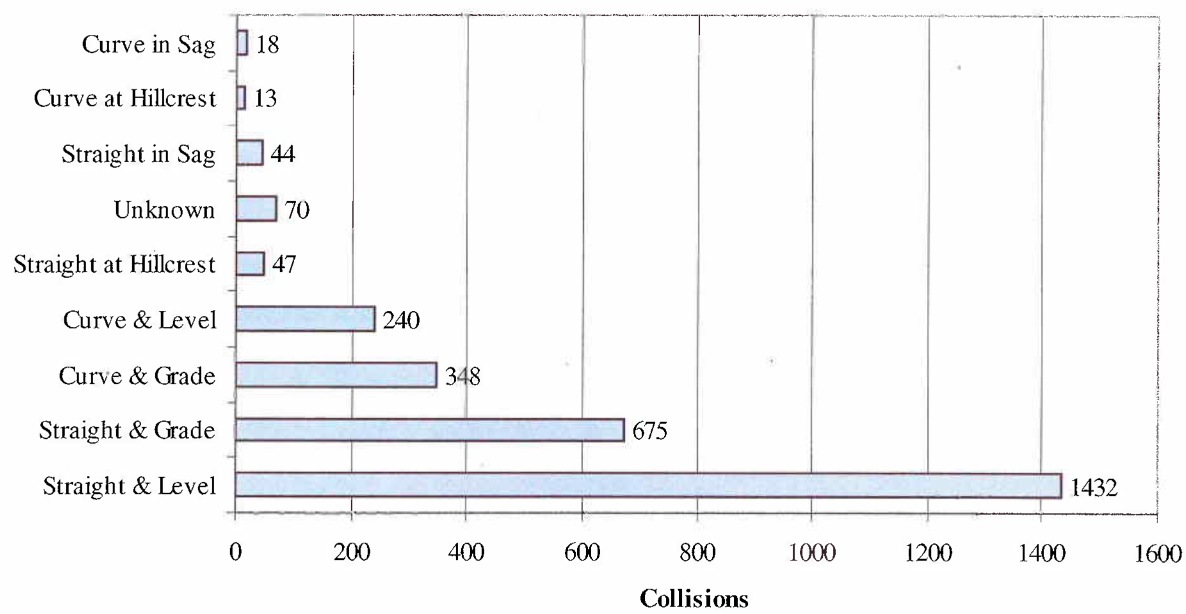


6.3.2. Roadway Alignment

Horizontal curves, steep grades, and vertical curves present additional challenges to drivers, and result in an increased risk of collisions. National statistics indicate that the collision rate on horizontal curves is nearly three times higher than on tangent[6] sections. It should be noted that fewer collisions occur on curves than on tangent sections, but the collision rate is higher on curves since they comprise a small percentage of the total road miles.[7]

Figure 29 provides a breakdown of collisions according to roadway alignment. As indicated, 50% of the collisions occurred on straight and level sections, and 48% occurred on horizontal curves or grades, and 2% had no identified roadway alignment.

Figure 29
2006 Collisions by Alignment



The collision rate would be the most meaningful way to compare collisions according to road alignment, since it accounts for roadway length. However, collision rates cannot be determined at the present time since mileage according to roadway alignment is not available for King County.

[6] Tangent refers to a roadway with little or no horizontal curves.
[7] NCHRP Report 500, Volume 7: "A Guide for Reducing Collisions on Horizontal Curves".

Table 6 provides a breakdown of collisions according to roadway alignment and collision type. Most collisions of type took place on straight and level sections, while the majority head-on collisions occurred on horizontal curves or grades.

Table 6

Collision Type and Roadway Type Relationship

	Curve and				Straight and			
Collision Type	**Grade**	**Level**	**Hillcrest**	**Sag**	**Grade**	**Level**	**Hillcrest**	**Sag**
Rear - end	31	15		1	168	380	14	13
Fixed object	156	137	3	12	135	261	5	11
Entering at angle	20	14			122	221	10	5
Parked	21	13	1	2	43	156	6	3
Left turn	11	3	1		53	86	3	3
Driveway Leaving	7	3			32	62	2	1
Driveway entering	3	1	1		17	60		
Other	35	15	1	1	27	58	2	2
Sideswipe	28	10	1	1	32	52	1	5
Vehicle overturned	24	14	4	1	11	30	1	
Pedestrian	1	2			8	21	1	
Bicycle		3			9	13	1	
Animal					5	12		
Head on	11	10	1		6	12	1	
Right Turn					7	8		1

6.3.3. Geographic Distribution

Collision data is coded geographically using Traffic Engineering's route order system. Preliminary attempts have been made to translate the route order into a coordinate-based system so that collisions and other Traffic information can be included in King County's Geographical Information System (GIS) database. While completing this task will require significant resources, the ability to review collision locations with GIS would provide significant benefits. Completing the conversion is recommended.

6.4. Demographics

A breakdown of collisions by driver age and gender is provided in Table 7.

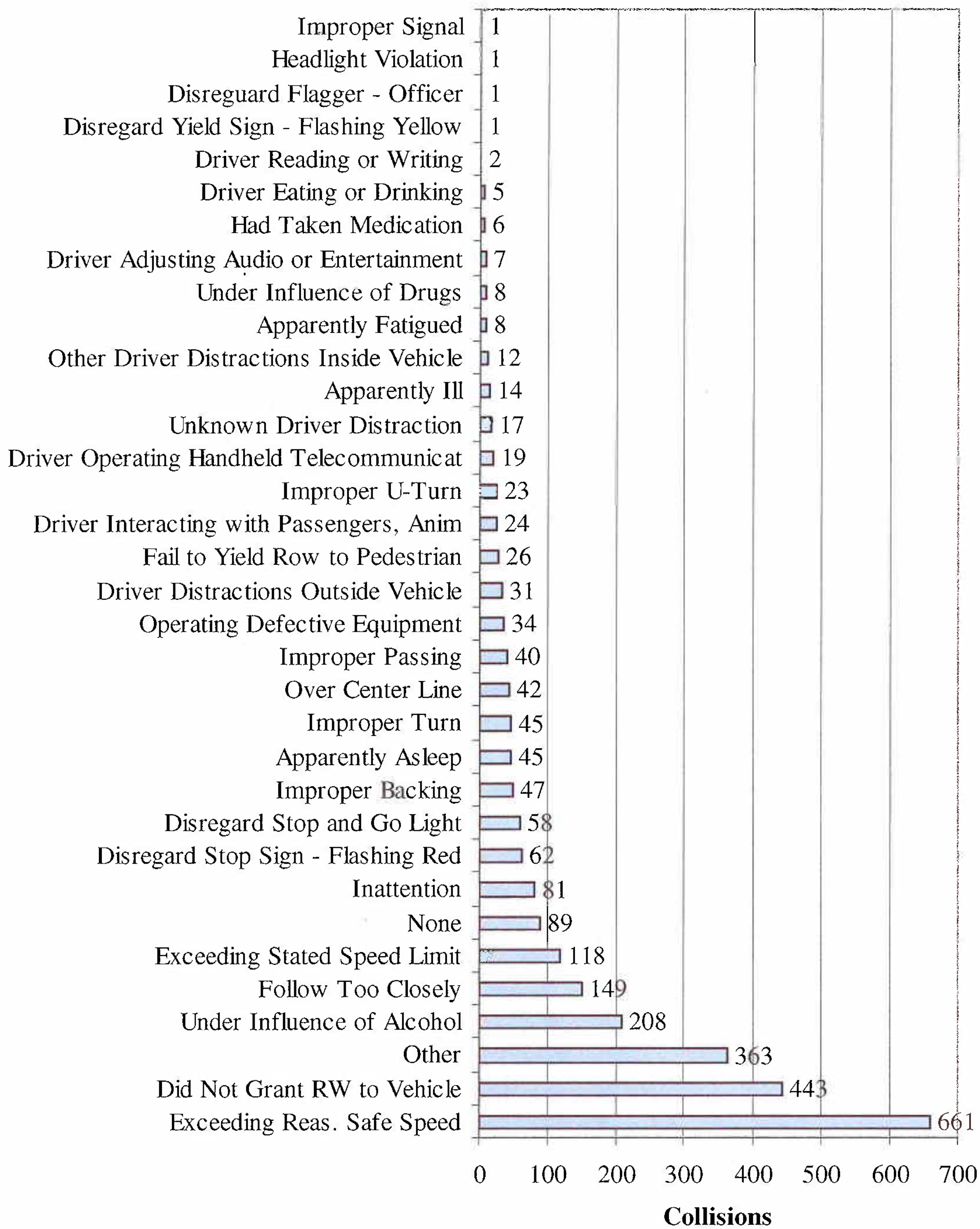
Table 7							
Collision Frequency by Age and Gender							
		Males		**Females**		**Both Gender**	
Age		**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
9	16	50	56%	40	44%	90	2%
17	24	757	62%	458	38%	1225	28%
25	34	477	64%	270	36%	755	17%
35	44	475	56%	370	44%	850	20%
45	54	456	60%	310	40%	771	18%
55	64	235	59%	166	41%	405	9%
65	74	99	63%	57	37%	156	4%
75	105	46	52%	42	48%	89	2%
		2595	60%	1713	40%	4341	

Twenty eight percent of the drivers involved in collisions were between 17 and 24 years old. Drivers age 65 and over were involved in 6% of the collisions.

6.5. Contributing Circumstances

A collision is the result of a series of events referred to as contributing circumstances. The nature of the collision would be changed if any of these circumstances had not occurred, and in many cases the collision would not have taken place at all. Figure 30 provides a breakdown of collisions by contributing circumstance. There are several contributing circumstances involved in every collision, and the circumstance provided is the one listed on the Officer's report.

Figure 30
2006 Contributing Circumstances of Unit 1 Driver



6.6. Special Studies

The special studies subsection provides an opportunity to focus on particular areas of interest each year. The relationship between pavement condition and bicycle and motorcycle collisions is addressed in this report.

6.6.1. Bicycle and Motorcycle Wet Pavement Collisions

Wet pavement increases the stopping distance for bicycles and motor vehicles. Rainy conditions also decrease maneuverability and visibility. These factors would be expected to increase the number of motorcycle and bicycle collisions during rainy weather. However, many motorcyclists and bicyclists avoid riding during rainy weather, which would decrease the number of collisions. Review of collision data from 2002 through 2006 indicates that approximately 8% of the motorcycle and 15% of the bicycle collisions occurred under wet pavement conditions. This suggests that the number of collisions during inclement weather is influenced more by the decrease in motorcycle and bicycle use during inclement weather than by the increased risk to these road users.

Figure 31
2006 Motorcycle Collisions by Roadway Surface Conditions

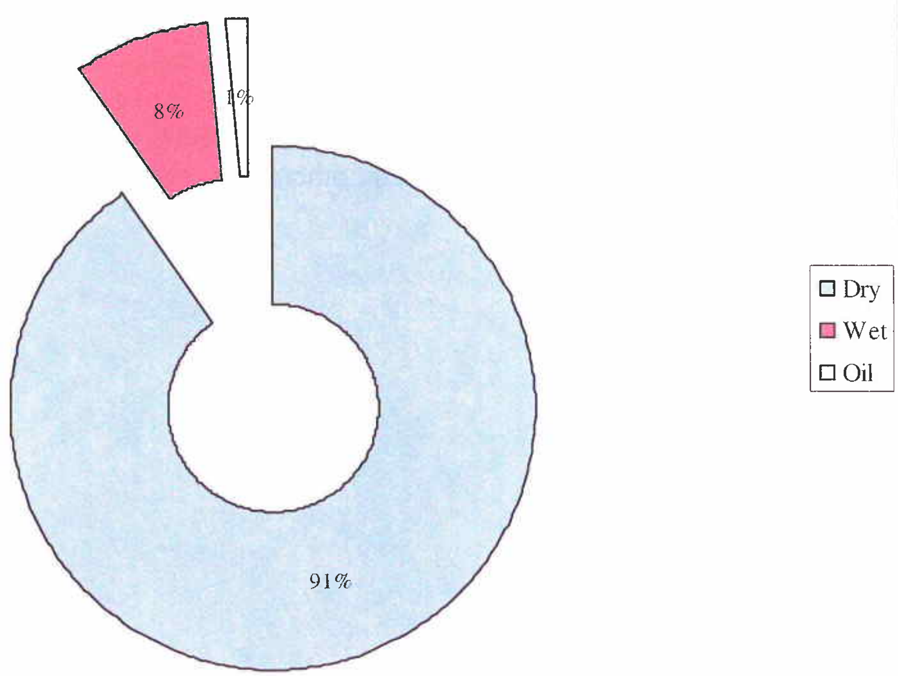
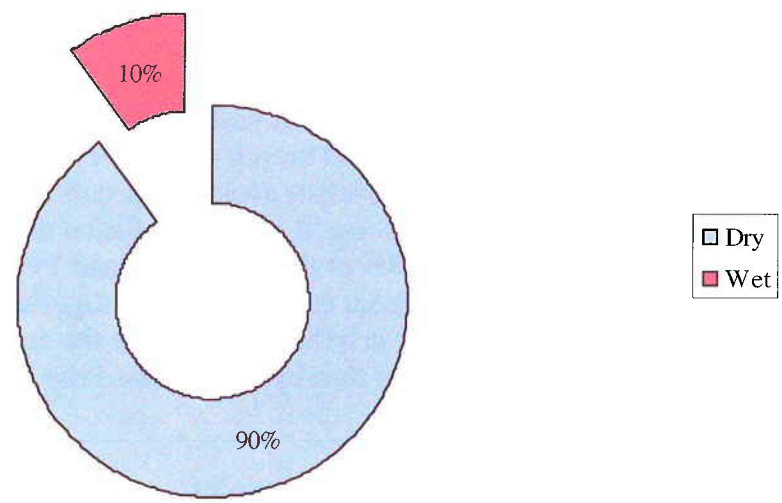


Figure 32
2006 Bicycle Collisions by Roadway Surface Conditions



6.6.2. Defective Equipment

Defective equipment can range from severe deficiencies such as non-working brakes to less serious items such as a broken turn signal. Defective equipment was found in vehicles in 64 of the collisions that occurred during 2006. It is likely that there are many additional collisions where defective equipment was present but not discovered.

APPENDIX A

DATA SOURCES

Collision Data

Collision information was obtained from the Washington State Department of Transportation on April 28 2007.

Vehicular collisions which involve more than $700 damage to one party, or involve injury or death are required to be reported to the Washington State Patrol by a traffic collision report or a Police Traffic Collision Report.

Injuries are classified on the basis of conditions that occurred at the time of the collision, except in the case of fatalities. An injury resulting in a death within 30 days of the collision is classified as a fatal injury.

Population Data and Square Footage of King County

Population and square footage of Unincorporated King County is courtesy of King County's Office of Management and Budget Annual Growth Reports for 2001 through 2007.

King County Maintained Roadway Figures

King County's Maintenance Section, and The County Road Administration Board (CRAB) provided the number of miles of roadway King County maintains.

Traffic Count Data

King County's Traffic Engineering Section, Traffic Impact and Data Analysis Unit provided Traffic Count information used in this report.

Licensed Vehicles

Information on licensed vehicles was obtained from the Washington State Department of Licensing website.

APPENDIX B

FORMULAS USED IN THIS REPORT

Collision Rate

The collision rate for a given roadway during a one-year time period is calculated using the following formula:

$$R = (Acc * 10^6)/(ADT*365*L), \text{ where}$$

R = collision rate in collisions per million vehicle mile (acc/mvm),
Acc = number of collisions in one year period,
ADT=average daily traffic volume, and
L=length of study section, in miles.

The collision rate for a street network during a one-year time period can be calculated using the following formula:

R = Acc/AMD, where AMD = annual miles driven in million vehicle miles.

AMD is calculated using:

AMD= WADT*365*RM, where

WADT= weighted average daily traffic for the street network, calculated by $WADT = (\Sigma ADT*L)/ \Sigma L$, and
RM = road miles for the street network (in million miles).

Traffic volumes for the local streets are not available. Therefore it is necessary to estimate the AMD using arterial volumes. To compensate for the lower volumes on local streets, the result was divided by two. This results in the following formula:

AMD(estimated) = WADT*365*RM/2.

Since the AMD is estimated, the collision rate for King County roadways is also an estimate. This estimate is useful in comparing historic rates on county roadways, but would be not be appropriate to compare with collision rates for other jurisdictions.

Societal Costs of Collisions

The cost of collisions were calculated using the following formula:

Cost = $6,000*PDO + $65,000*I + $1,000,000*F, where

PDO = Property Damage Only collisions
I = collisions with one or more injuries, and
F = collisions with one or more fatalities.

Percentage Increase/Decrease

The percentage increase between two measurements made at different times is calculated using the following equation:

Increase (%) = (y-x)/100x, where x = the earlier value and y = the later value

The percentage decrease between two measurements made at different times is calculated using the following equation:

Decrease (%) = (x-y)/100x, where x = the earlier value and y = the later value

Note that result of subtracting the two values is divided by the earlier value for both increases and decreases. These results are not interchangeable: an increase from 50 to 100 is a 100% increase, while a decrease from 100 to 50 is a 50% decrease.