2015

Safety Management System Report

PIMA COUNTY
TRANSPORTATION

Traffic Engineering Division
Department of Transportation

PIMA COUNTY
TRANSPORTATION

May 23, 2017

Dear Reader:

In 2015, Pima County roadway crashes resulted in the loss of 12 people and injury to 780 more. Statewide in 2015, 895 people were lost and 53,554 were injured. Nationally in 2015, 35,092 people were lost and 1,715,000 were injured. Worldwide, the World Health Organization estimates that 1.24 million people die and 20-50 million are injured yearly in vehicle crashes[1]. This dreadful toll leads to considerable and avoidable pain and suffering and is a tremendous drain on both human and financial resources, both to each of us as individuals, as well as collectively as a society.

While many of the deaths and injuries were the result of a series of unlikely and unfortunate circumstances, many could have been prevented if those involved had taken the following simple precautions:

- Used seat belts, child restraints, or helmets, as appropriate
- Not driven, rode, or walked impaired
- Driven at a speed reasonable for conditions and followed at sufficient distance to react to the unexpected
- Not engaged in distracted behavior and stayed focused on the task of driving, walking, or riding
- Crossed the street at a signal or designated crossing
- Been patient, not aggressive, as well as well rested and in the right mood to drive
- Avoided driving, walking and riding at night or in unsafe weather
- Avoided unprotected left turns (right turns are typically lower risk)

Our life and well-being are a gift. It is our responsibility to protect and be accountable for this gift, not only for others but, more importantly, for ourselves as well.

This is not a matter of our free will or our "unalienable rights." It is a test of what we actually believe that the value and protection of life, and the quality of that life is the highest responsibility of all. Since it overrides all others, if we still choose not to take these simple and easy-to-follow precautions, we are choosing to ignore our responsibilities as good citizens and family members. We need to care for ourselves, as well as the common good.

Do not be selfish with your trip and time. Know that it is better to be a little late than being on time if that means you have to drive faster, push yellow lights, roll or run a stop sign that puts you at a higher risk of causing a crash that might take a life or cause injury. This self-focused behavior enhances the chances of a crash that could have very negative life changing consequences, such as the guilt of having killed or injured someone, jail time, financial setbacks or ruin, and death or lasting injury to yourself.

So, protect your life; for your sake, for the sake of those who care about you, and for the sake of those you care about. Wear seat belts, wear a helmet, do not drive impaired, drive reasonable speeds, give yourself space, do not be distracted, cross streets at safe places, and be peaceful, patient and vigilant while driving. Do this and help others to do this. Lead by example, focus on the fact that the value of all life, and protecting that life, is the highest value of all.

Thank you,

Seth Chalmers,
Traffic Engineering Division Manager

[1] Based on the most recent data, from 2013

Traffic Engineering Division

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PIMA COUNTY
TRANSPORTATION

MEMORANDUM

DATE: May 11, 2017

TO: Seth W. Chalmers, PE
Division Manager

FROM: William R. Strickler, PE
Civil Engineering Manager, SMS

SUBJECT: Safety Management System Program 2015 Annual Report
For Reported Crashes Which Occurred January 1st, 2015 to December 31st, 2015

Enclosed with this memo is the SMS Annual Update Report for Calendar Year 2015 data for your use. A copy of this report and the corresponding statistical tables, charts and summary tables can also be found on the Pima County Department of Transportation (PCDOT), Traffic Engineering Division (TED) website (http://dot.pima.gov/trafeng/).

The total number of crashes increased from 2,510 in calendar year 2014 to 2,637 in calendar year 2015, an increase of 5%. Due to the increase in crashes and a slight reduction in the County population, the per capita rate increased from 6.92 to 7.30. Also in this period, fatalities in Pima County decreased from 16 to 12. The combination of a decrease in critical-injury and fatal crashes and the slight population decrease reduced the critical-injury/fatal per capita rate from 0.29 to 0.23. The County crash severity index for calendar year 2015 was calculated to be 1.42, which is a decrease from the 1.47 in 2014.

This report is for crash data that occurred from Jan 1, 2015 to December 31, 2015. Typically, it is our objective to publish the SMS Report approximately 9 to 12 after the data period. Unfortunately, due to a variety of reasons, it has taken longer to complete this report. One of the main reasons it takes at least nine months (and sometimes longer) to develop and publish this report is the fact that this is not just a crash fact reporting document. This is not like the document the Arizona Department of Transportation (ADOT) publishes annually (called "Crash Facts"[1]). Instead, the PCDOT SMS is a comprehensive road and safety management system that not only reports the "crash facts" but also reports what PCDOT is doing to mitigate those crashes that have occurred (with both nominal and substantive actions and attention). It also presents in depth information on vehicle crash issues and considerations in order to put the on-going vehicle crash problem in the proper context, one that goes beyond finding blame or finding excuses.

Even though the report was unpublished until now, work continued on the projects from the priority listing. Out of the 70 safety projects identified in the 2015 Report, 20 projects have already been either started or completed. Work is already underway on the 2016 Report.

William R. Strickler

[1] http://www.azdot.gov/mvd/statistics/arizona-motor-vehicle-crash-facts

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Executive Summary

The Pima County Department of Transportation (PCDOT) Traffic Engineering Division (TED) has completed the 2015 Safety Management System (SMS) Program Annual Update Report, which reviews the crashes on unincorporated Pima County roads in the calendar year 2015. Pima County is the second most populated county in Arizona with over 1,010,000 citizens (over 360,000 citizens in unincorporated Pima County). PCDOT manages and operates nearly 2,200 miles of roadways, 104 signalized intersections, and 10,026 unsignalized intersections.

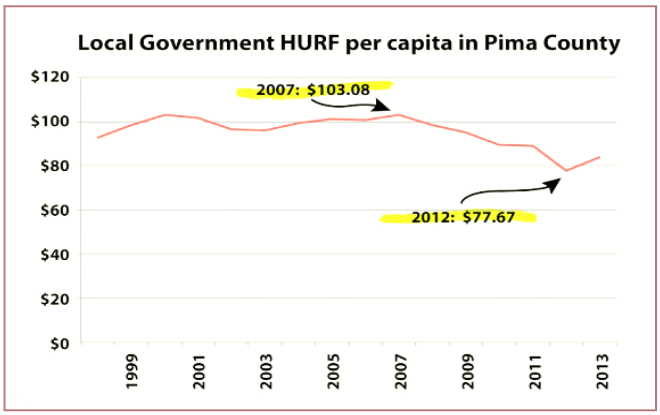
The SMS Annual report has five primary objectives:

- Briefly summarize the SMS program,
- List the preceding years crashes and related statistics on PCDOT roadways,
- Describe the SMS work performed in the preceding calendar year,
- Plan SMS work for the next fiscal year and the future, and
- Present Information on Transportation Safety

SMS Program

The SMS program uses local crash data to screen and analyze intersections and segments for crash history and possible patterns. In other words, it is an annual check-up on how Pima County roads are doing, using an objective, quantitative approach that involves analysis of crash and volume data. After screening and analysis, potential projects are prepared to mitigate the crashes and with the goal of improving safety. This project is then ranked with other potential projects and if ranked high enough is viable, and when funding is available will proceed to the design for "eventual implementation."

The term "eventual implementation" is used on purpose here. This term helps to describe the reality that the Pima County Department of Transportation (PCDOT) faces once a potential safety project is identified and prioritized within the SMS and that project enters the design and possible construction phase (the SMS List). Eventual implementation means that it can take years or even possibly decades to finish either design or construction or both. Sometimes a project, even after it is designed can end up on the shelf and sit for years and years before construction is funded or even considered for funding. Most of this time is due to the lack of funding or the type of funding or other complications which can be attributed to a host of factors. Some of these factors include, but are certainly not limited to right of way, politics, environmental considerations, citizen opposition, economic slowdowns, annexations, as well as many other factors that are beyond the control of PCDOT.



It is important to note that the Arizona State Legislature and current and past Governors have not considered raising gas tax for over ten years and have diverted millions of Highway User Revenue Funds (HURF), which could have been used for roads, to help fund the Department Public Service (DPS) and close other gaps in general revenues. This combined with the great recession of 2007 which significantly reduced Highway User Revenues (gas tax and vehicle fees) and Pima County financial obligations created by 1997 HURF

revenue Bond program has really hampered PCDOT ability to operate and maintain roadways, especially pavement. However, the County thru the DOT-57 Safety Improvement Bond Program (which is a part of the 1997 HURF Revenue Bond) has continued to provide some capital for safety projects. These funds along with other funding sources, local and federal, have allowed progress that has made a difference.

Preceding Years of Crash Statistics

In calendar year 2015, the total number of crashes increased 5.2% from calendar year 2014, from 2,508 to 2,636 crashes. The severity index for 2015 on county roadways also decreased from 1.47 in 2014 to 1.42. Below is a table listing the County safety goals and results for 2015 compared to 2014.

Table 1ES SMS Goals Status for 2015

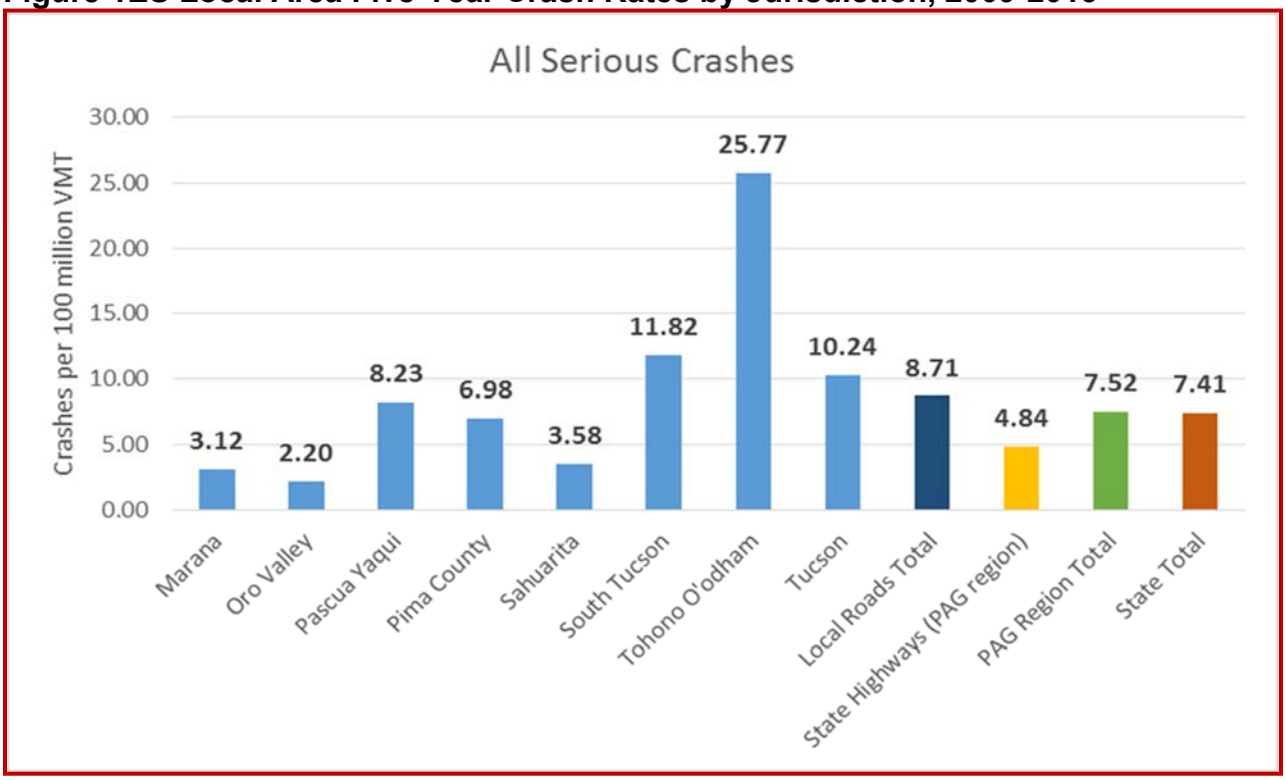
Crashes per Capita	*2014*	*2015*	*Change*	*Meet Goal?*
Crashes per Capita	6.92	7.30	Increase	***No***
Critical Injury/Fatal Crashes per Capita	0.29	0.23	Decrease	***Yes***
Critical Injury/Fatal Crashes	105	84	Decrease	***Yes***
Crash Severity Index	1.47	1.42	Decrease	***Yes***

Another statistic for comparison is the percent of fatal crashes, which is simply the number of fatal crashes divided by the total number of crashes. From Table 6, for 2015, Arizona statewide averaged 0.695% fatal crashes while Pima Counties' facilities averaged 0.455% fatal crashes. Given the rarity of fatal crashes, this indication is a sign that PCDOT is achieving positive results in the management of its roads and SMS Program.

An additional indication of the effectiveness of the Pima County SMS program comes from the Pima Association of Governments (PAG) Regional Safety Plan in Figure 1ES from Section 1. Figure 1ES shows the overall crash rates during the entire five-year period for all serious crashes. Crash rates are included for each jurisdiction, all non-state highways, state highways in the PAG region, all roadways, and for all roadways statewide. As seen in the chart, the overall crash rate for the PAG region is comparable to the statewide crash rate. However, when divided into non-state and state facilities, the crash rate on non-state facilities is higher than the rate on state facilities and the overall rate statewide.

The comparison shown on Figure 1ES demonstrates that the County has a lower "Serious crash rate" than the City of Tucson, PAG Region total and the Arizona State total. Figure 2ES shows that the County has a lower fatality rate and a more favorable trend than both the State of Arizona, and the nation as a whole. This in turn gives indication that the SMS program has provided positive results.

Figure 1ES Local Area Five-Year Crash Rates by Jurisdiction, 2009-2013



Pima Association of Governments Strategic Transportation Safety Plan, May 2016

Figure 2ES Arizona, National and Pima County Fatalities per 100,000 People

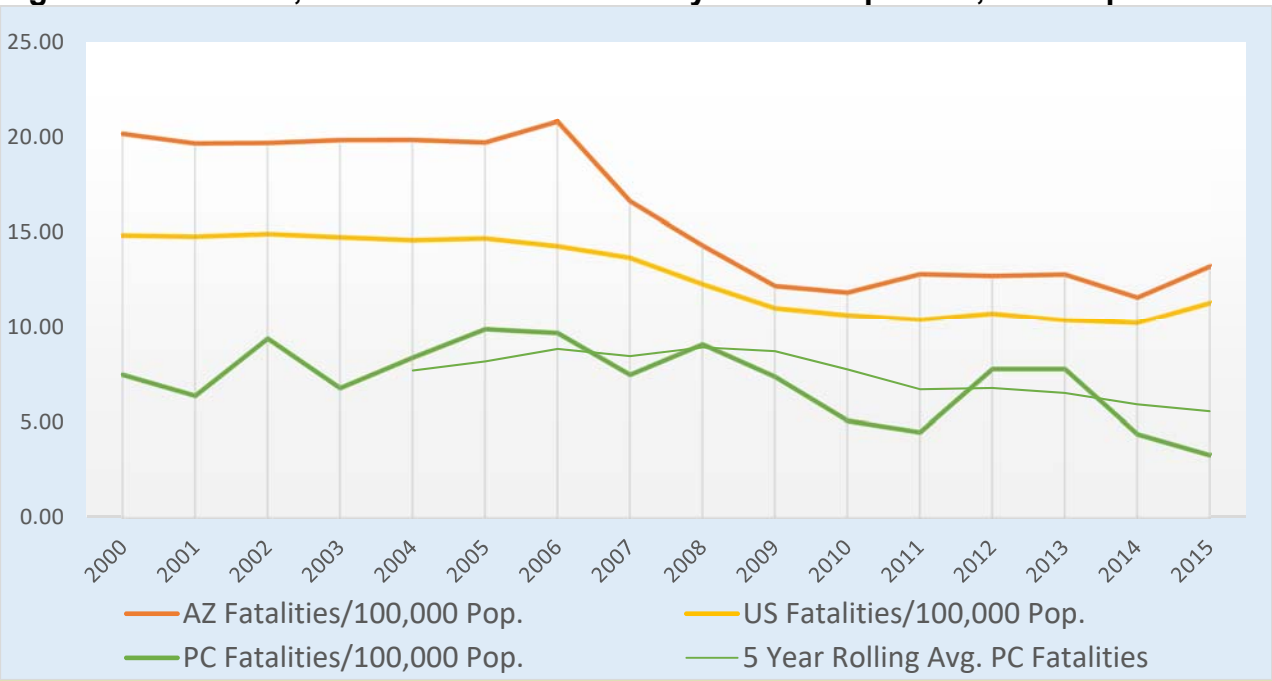


Table 2ES Pima County Statistics for Single Year and "5-Year Rolling Averages"

Measures of Effectiveness Data	*Single Year*		*5-Year Rolling Average*	
	Year		Year	
	2014	**2015**	**2014**	**2015**
Total Number of Crashes	2,510	2,637	2,921	2,776
Population (Unincorporated Pima county)	362,067	361,023	357,093	358,620
Crashes per Capita (Crashes per 1,000 people)	***6.92***	***7.30***	***8.19***	***7.74***
Critical Injury and Fatal Crashes (classes 4/ 5)	***105***	***83***	***114***	***108***
Critical Injury and Fatal Crashes per Capita (per 1,000 people)	***0.290***	***0.230***	***0.319***	***0.302***
Total Number of Crashes with a Fatality (class 5)	16	12	21	20
Fatal Crashes per Capita (per 1,000 people)	0.044	0.030	0.059	0.056
Number of Actual Fatalities	16	12	22	20
Number of Injury Crashes (class 4, 3, 2)	754	780	839	810
Severity Index	***1.47***	***1.42***	***1.44***	***1.45***
Fatal Crashes per 100,000 people	4.42	3.32	5.94	5.58
Fatal Crashes, Involving a Teen Driver	1	3	2	3
Fatal Crashes, Drug/Alcohol Involved	3	6	8	8
Fatal Crashes, with no belt use	6	4	9	8
Fatal Crashes, Excessive Speeding Involved	3	1	2	2
All Crashes, Drug/Alcohol Involved	158	203	209	208
All Crashes, Signal Running	94	107	103	100
All Crashes, Stop Sign running	41	58	59	55
All Crashes, Excessive Speeding Involved	55	39	52	49
All Crashes, Pedestrian Involved *	38	39	34	35
Pedestrian Fatal Crashes	4	1	4	4
All Crashes, Motorcycle Involved	94	75	111	101
Motorcycle Fatal Crashes	2	1	5	4
Motorcycle Fatal Crashes, with no helmet use	2	1	2	2
All Crashes, Bicycle Involved	34	41	46	44
Bicycle Fatal Crashes	0	1	1	1

***Note: Pedestrian crashes from 2010 to 2014 data entry revisions.**

Distracted Driving

Distracted Driving statistics for Pima County are not shown in the table above and are in their development infancy. The distracted driving "field" in the Law enforcement reports was only included in 2014 and is not routinely used (most Officers have no distraction or unknown noted) Prior to that the only field that was represented on the accident reports was in the violation field as "inattention". Due to the inconsistent use of this item, Pima County does not have solid evidence as to the number of drivers involved. Hence, when "distracted driving" is cited as a cause of crashes this is often a matter of opinion or judgment and not necessarily something that is backed by robust data.

SMS Project Work Performed in 2015

The emphasis of TED and SMS has often been on spot treatments for specific locations. This emphasis is shifting to include system-wide crash prevention and studies. TED safety projects that were started or completed during calendar year 2015 included the following:

Table 3ES Pima County Projects Started or Completed in 2015

Project Description	Scope	Progress
RTA		
Palo Verde, Milton/Alvorde HAWKS, Sidewalk	Install two HAWKS and Sidewalk	In Design
DOT 57		
Motor Pullouts and Concrete Median Modifications	Construct Motor Patrol pullouts for County Sheriff's Dept. – Speed Management	Construction Complete
ITS Upgrades	Signal Cabinets, LED lamps, Video detection	Ongoing
Sign Post Upgrades	Replace County sign posts with square breakaway posts	Ongoing
TAP		
Bowes Rd./Vallarta Dr. Sabino High School	Install HAWK	Construction Started
Tanque Verde, Emily Gray School	Install HAWK	Construction Started
HSIP (Applications)		
Speedway Blvd. Painted Hills - Camino de Oeste	Added shoulders, alignment improv. HSIP funding requested	Design Authorized
PAG Areawide Signing and Striping Upgrade	Eligibility Requested	Ongoing
County Wide Pavement Markings Program	Eligibility Requested	Ongoing
Active Projects - 5 Year Plan		
Harrison Road Bike Lanes - Sabino HS/Cat Hwy.	Added Bicycle Lanes	Construction Started
Valencia Rd: Alvernon to Wilmot	Widening 4 to 6 lanes	Construction Complete
Valencia Rd: Wilmot to Kolb	Widening 4 to 6 lanes	Construction Complete
Aerospace Parkway (Hughes Access Relocation)	Access relocation	Construction Complete

SMS Work for 2015 and Beyond

In addition to the project work, SMS will maintain the HAWK Installation Program, Rural Road Safety Improvement Program, Intersection Safety and Operations Program, Strategic Speed Management Program, Neighborhood Traffic Management Program (NTMP), Dusk to Dawn Lighting Program, Safe Routes to School Program (SRTS), and Go Bike! a bike safety and education program. The Project Priority spreadsheet has about 80 projects identified for future design dependent on funding. The table below shows the wide variety of projects and funding sources considered for the coming years.

Table 4ES Proposed SMS Projects for FY 2015/2016

Project	Proposed Action	Funds	Design Cost	Constr. Cost	Anticip. Year
Roundabout Program	Design/promote roundabouts	TBD	$200,000		Ongoing
HAWK Program					
Palo Verde HAWK at Alvord & Milton	Install HAWKs	RTA	In-House	$380,000	2016
Flowing Wells at Wabash HAWK	Install HAWK	DOT-57	In-House	$130,000	2015
Advanced Warning Flashers Safety Program	Install advance warning flashing beacons at selected locations	DOT-57	In-House	$100,000	2016-17
Julian Wash Safety Improvements	Safety and Guardrail	DOT-57	$73,000	$115,000	2016-17
Sign Post Replacement Program	Reinstall all County signs with square tube breakaway posts	DOT-57	In-House	$100,000	Ongoing
Dynamic Speed Feedback Signs/Enforcement Pads	Installation	DOT-57 /GOHS		$100,000	Ongoing
Motor Pull-Outs and Concrete Work	Install concrete pullouts for motor-patrol officers		In-House	$154,000	Ongoing
Safety Management System Upgrade	Software procurement & annual data management				Ongoing
Projects of Opportunity (POO)					
Harrison Bike lanes	Bike lanes/safety shoulders			$60,000	2016
Anklam Road Safety Shoulders	Construct roadway shoulders and Guardrail	DOT-57	$100,000		2016
Speedway Blvd: Painted Hills to Camino de Oeste	Construct paved shoulders	HSIP /Applic.	$90,000	$1M	2016-17
Bicycle and Pedestrian Safety Program	Promote safety		$28,000		Ongoing
Safety Projects					
Old Spanish Trl/Cactus Forest Rd	Pavement Preservation	HSIP /Applic.	$57,000	$345,000	2016
Curtis Road Safety Improvements	Speed Management	DOT-57	$119,000		2017
Battery Back-Up Units	At Traffic Signals and HAWK Beacons				2015
Battery Replacement	Ongoing safety program to replace aging batteries				2015
Enhancement of Wireless Communication System	Systematic upgrades				2015

Project Before and After Crash Statistics Scoreboard, Summary of Table 18

Project	*3 Year Before / After Analysis Summary*
Safety Management System Projects	
Alvernon Way and Valencia Road Intersection	Increase in CR and SI
Camino de Oeste: Los Reales to Valencia	Decrease in CR, Increase in SI
Capital Improvement Program Projects	
Catalina Highway, Tanque Verde Rd to Houghton Rd	Decrease in CR and SI
Bowes Road @ Sabino High School HAWK	Increase in CR, Decrease in SI
La Cholla Blvd, River Road to Ruthrauff	Decrease in CR and SI
Magee/Cortaro Roads: Thornydale to Mona Lisa	Decrease in CR and Increase in SI

CR = Crash Rate, SI = Severity Index

1. Introduction, History and Goals of the Safety Management System

Everyone feels the impact of traffic crashes. These crashes place enormous burdens on medical facilities and law enforcement and fire departments, as well as placing severe physical and emotional stress on the families of those involved. It is a major health and welfare issue not only in Pima County but also for the entire state and our country. Thus, the crashes "problem" requires consistent and dedicated attention not only by government but also by all users of roadways.

To help address the crash problem, the Pima County Department of Transportation (PCDOT) conceived and implemented the Safety Management System (SMS) through the Traffic Engineering Division (TED). The primary mission of the program is to develop a proactive, data-driven multidisciplinary systems approach to address traffic safety issues on roads in unincorporated Pima County. Pima County also endeavors to assist the Pima Association of Governments (PAG) and the Arizona Dept. of Transportation (ADOT) in trying to help reduce serious injury and fatal crashes as stated in the Arizona Strategic Highway Safety Plan (SHSP).

The purpose of the annual report is to screen and evaluate the roadway system for changes in crash frequency, location or severity and then identify, develop and evaluate potential improvement projects based upon a priority ranking system. PCDOT programs the projects for design and construction per the priority ranking and the funding source to try and obtain the maximum amount of benefit. At times, this means we program the design funding first and then seek out construction funding sources.

Traffic crashes are rare events that, when studied in a systematic way, may indicate problems along a corridor or within a transportation system. The number of crashes at any particular location may indicate the intensity of a potential traffic safety issue. The same type of crash combined with the same type of road geometry at a crash site may indicate a system wide traffic safety issue.

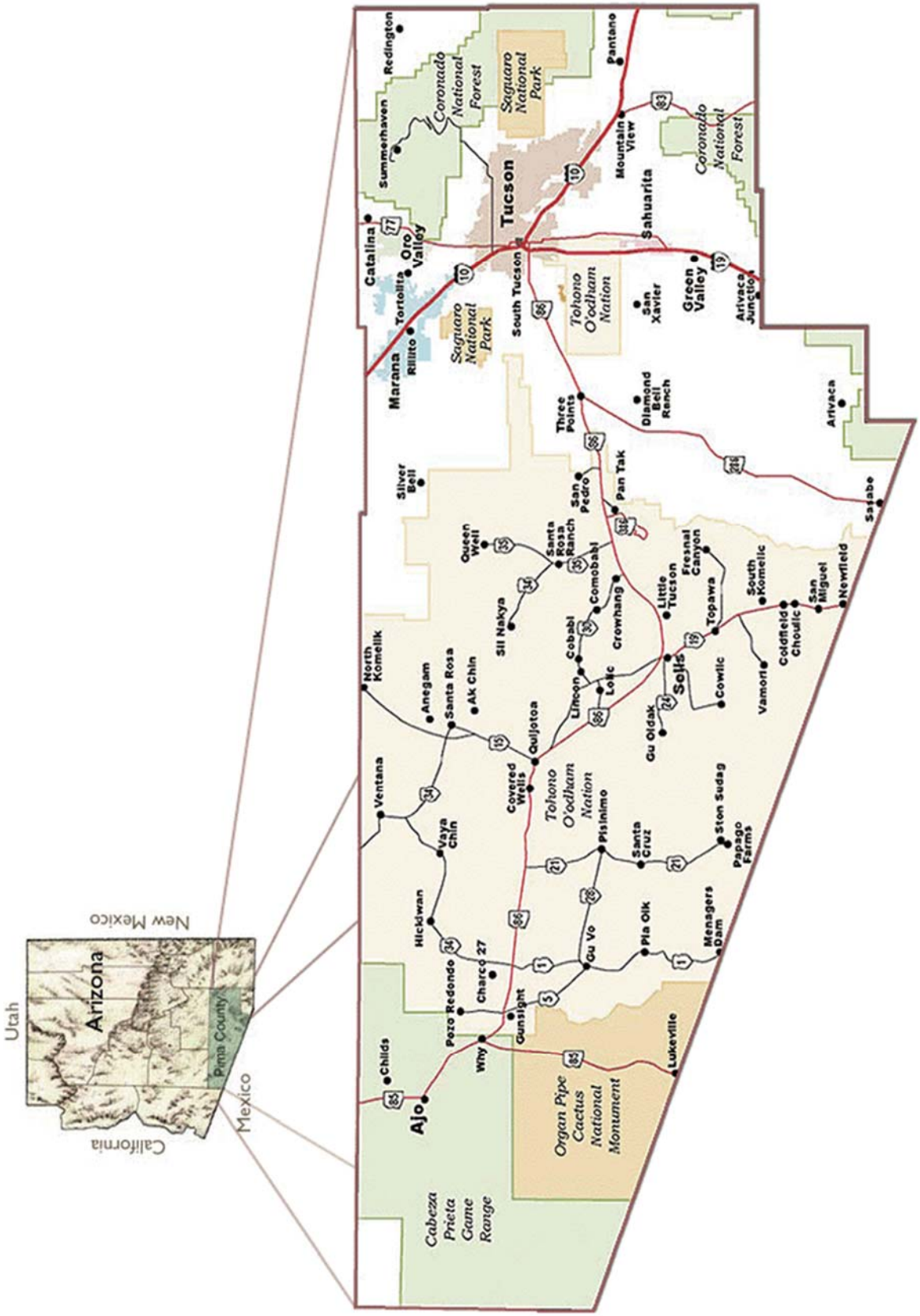


Figure 3 Pima County Arizona

Therefore, to address the crash problem and its other responsibilities PCDOT provides adequate or better roadway infrastructure and operates and maintains it reasonably safe for ordinary travel and use. Additionally, when PCDOT has notice that this condition is in potential peril it will take timely action to determine if it is and to mitigate the condition. As per its responsibility, PCDOT provides a facility that the public can safely use under normal conditions.

> ***"We know that 94 percent of all car crashes are caused by human choice or error,"***
>
> ***U.S. Transportation Secretary***

It is important to note the use of "opportunity to be used safely under normal conditions" in the last sentence of the preceding paragraph. This leads to the term "shared responsibility." Shared responsibility means that road users have to do their part to make roads safe for not only themselves, but other users as well. Drivers, pedestrians and bicyclists need to act reasonably in terms of their own behavior (e.g. follow the rules of the road) and their condition. This includes accounting for their limitations in terms of mental capacity, eyesight and physical condition. It is nearly impossible to account for road users who are impaired or have a disability that interferes with their road use, let alone if they act unreasonable or exhibit risky behavior. Road users also need to provide adequate or better equipment and maintenance, as applicable, for their use of that road, sidewalk or path and to use appropriate safety devices (e.g. seat belts, helmets, etc.). If road users do not conscientiously do their part crashes, can or will happen.

Definition of a Motor Vehicle Traffic Crash

If the response is "yes" to the seven questions below or eight if a railroad train is involved, then the traffic incident is a reportable motor vehicle traffic crash.

1. Did the incident include one or more occurrences of injury, death, or damage?
2. Was there at least one occurrence of injury, death, or damage that was not a direct result of a natural disaster?
3. Was there bodily injury, death, or damage to the property of any one person in excess of one thousand dollars ($1,000)? See Arizona Revised Statute 28-667.
4. Did the incident involve one or more vehicles?
5. Of the vehicles involved, was at least one moving?
6. Was the incident an unstabilized situation (loss of control)?
7. Did the unstabilized situation, injury or damage originate on a roadway?
8. If a vehicle in transport collided with a railroad train, did the collision occur at or near a railroad crossing?

Crash Events

Rare and Random Events

A roadway crash is a rare and random event compared to the thousands of turning movements and braking actions that take place on rural and urban streets on a daily basis. For Pima County in 2015, there were 2,637 crashes in 2015 or 7.30 crashes per 1,000 people. Serious injury and fatalities crashes averaged 23 per 100,000 people. Crashes do not have a single causation but rather a series of events that include driver behavior, vehicle maintenance, and the surrounding area conditions, wide open rural or congested urban. If anyone of these events changes prior to or during the crash, the crash may be avoided.

Contributing Factors

In 1970, William Haddon developed a distinct set of concepts or paradigm to analyze roadway crashes. Below is a table containing some of the factors involved in crashes but not all the possible circumstances. As shown, many extenuating circumstances lead to a vehicle crash. Human factors, such as driver error are generally the cause in over 90% of crashes.

By examining and understanding the factors in the table, local governing bodies can determine which areas can readily be improved to reduce crashes and crash severities. Possible changes could be additional driver education, road repairs, improved rescue operations, or more programs to increase seat belt usage and reduce drinking and driving.

Typical Haddon Matrix – Crash-Contributing Factors

Factors Affecting Crashes

Crash Phase	Human Factors	Vehicle and Equipment Factors	Environmental Factors
Pre-crash	• Education • Attitudes • Impairment • Law Enforcement	• Road Worthiness • Lighting • Braking • Speed Management	• Road design and road layout • Speed limits • Pedestrian facilities
Crash	• Use of restraints • Impairments	• Occupant restraints • Other safety devices • Crash-protective design	• Crash-protective roadside objects
Post-Crash	• First-aid skills • Access to medics	• Ease of access • Fire risk	• Rescue facilities • Congestion

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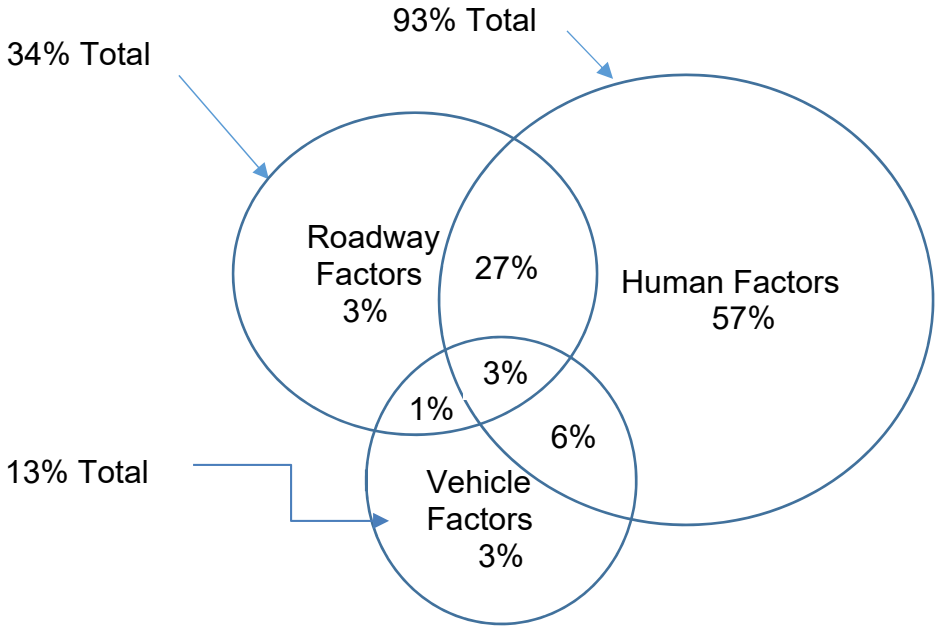
Strategies to Mitigate Affecting Factors

- Planning design and maintenance to improve the roadway system
- Driver education, public awareness campaigns to increase seat belt use, reduce drunk and distracted driving
- Legislation, Ordinances and Policy changes, such as a mandatory motorcycle helmet law

- Speed limit, seat belt, drinking, and distracted driving enforcement with increased penalties and fines
- Advancements in auto technology such as driver assisted vehicles with automatic braking, side airbags, back-up cameras and lane-departure warnings, as well as technical improvements in signing, striping, illumination and traffic signals
- Traffic demand management that includes additional mass transit and multi modal transportation alternatives

Contributing Factors to Vehicle Crashes



From the 2010 Highway Safety Manual, Chapter 3 Fundamentals, Figure 3 – 3, Page 3 – 7, the source for the HSM is "*Treat 1979*"

This diagram (not to scale) shows the relative proportions of the factors that contribute to a crash. As shown human factors at 93% are by far most influential in the series of events leading up to a crash. Therefore, from the Haddon Matrix, education, driver training, anti-impairment programs, law enforcement and seat belt training could be used to focus on human behavior to reduce crashes and severities. Crashes with all three factors involved, human, roadway and vehicle are a rare occurrence at 3%.

"Highway systems have three major components: the road, traffic control, and users with or without a vehicle. For the highway system to operate efficiently, and safely, each of these components must work together as a combined unit. This task is not easy, largely because of the wide range of roadway environments, vehicles and users."

Ref: NCHRP Report 600 Human Factors Guidelines for Road Systems, 2nd Edition TRB 2012

SMS History

In 2002 after discussions with the County's attorney, PCDOT developed the SMS program to convert the high-ranking crash intersections and roadway segments into actual safety projects. PCDOT ranks the projects in a second ranking system based on crashes, project costs, volumes, etc., for future funding and construction. This program also initiated the first annual SMS program document dated 2002. As part of the SMS strategy, PCDOT generates all follow up traffic safety studies in a timely manner and adds them to the project priority list/program.

Each year thereafter, in addition to publishing the intersection/segment ranking list, the County also publishes a project ranking list and identifies projects targeted for design and construction over the next 5 years. PCDOT processes funding requests for in house operating HURF, DOT CIP funding, PAG/RTA funding, or Federal funding. Application for funding does not guarantee success because almost all local or federal funding programs are competitive. Use of local bond funds is subject to spending caps. Based in part on a projects size or design issues, some projects languish but remain on the ranking list.

Pima County has a consistent history of providing important safety improvement projects as far back as 1974. From 1974 to 2011, a total of 124 safety projects were designed and constructed using the initial 1979 General Obligation Bond and the later 1997 HURF Revenue Bond that provided DOT-57 Safety Funding that was specifically designated for road safety. Pima County also had General Obligation bonds in 1974, 1980, 1985 and 1986 that targeted transportation projects.

SMS Goals

The Safety Management System Program Documentation Report, August 2002 defines the current SMS program. This report established five primary goals for the Pima County SMS program, which are as follows:

1. Reduce the annual number of traffic crashes per capita.
2. Reduce the annual number of critical-injury/fatal traffic crashes per capita.
3. Reduce the overall number of critical-injury and fatal crashes each year.
4. Reduce the crash severity index.
5. Promote community awareness and support for improving traffic safety

Goals 1 through 4 are quantitative goals and goal number 5 is qualitative. PCDOT tracks the quantitative goals on a yearly basis as well as on a 3-year rolling average.

The severity index is a number used in the Crash Statistics calculation of the Priority Index. It can indicate whether an intersection or segment has a low, average, or higher than average number of severe injury crashes. More information on the Severity Index and the Priority Index is in Section 6: Traffic Crash Statistics.

PAG Goals

Building on the U.S. DOT goal of "Towards Zero Deaths" the current safety vision for the Pima Association of Governments (PAG) region is "*Working Together Towards Zero Deaths, Everyone Gets Home Alive*".

From their Strategic Transportation Safety Plan the overall goal is to enhance Safety for bicyclists, pedestrians, transit riders, wheelchair users, children and the driving public. The regional goal for traffic safety is to reduce the number of fatal and serious injury crashes in the PAG region by 7 to 10% during the next five years starting in 2016.

Arizona DOT Goals

SHSP Vision

Toward Zero Deaths by Reducing Crashes for a Safer Arizona

From the 2014 Arizona State Highway Safety Plan (SHSP) the goal is to reduce fatalities and the occurrence and severity of serious injuries on all public roadways in Arizona. The objective is to reduce the total number of fatalities and serious injuries in Arizona by three to seven percent during the next five years from the 2013 base year.

Emphasis Areas:

State Top Focus Issues

Speeding and aggressive driving
Impaired driving
Occupant protection
Motorcycles
Distracted driving

State Secondary Focus Issues

Roadway infrastructure and operations
Age related
Heavy vehicles / buses / transit
Nonmotorized users
Natural risks
Traffic incident management
Interjurisdictional

The SMS Annual Report

Each year, the SMS group within TED produces an SMS Program Annual Update Report (the report contained within) to

- Briefly summarize the SMS program
- List the preceding years crashes and related statistics
- Describe the SMS work performed in the preceding calendar year
- Plan SMS work for the next fiscal year and the future

Through the systematic collection and analysis of county-related crash data, the SMS Program Annual Update Report aids in identifying the following factors:

- Information needed for safety analysis
- High-crash locations and system-wide crash types
- Significant crash patterns and generally related causes and countermeasures
- Standard values for service life, capitol recovery factors, costs, and effectiveness
- A priority ranking for planning and budgeting traffic safety enhancements

Data Retrieval

The SMS program systematically uses data collected by the TED Studies Section to prioritize safety improvements to target available and potential funding to implement safety projects. The crash data is the basis for all the SMS intersection and segment studies and Project Priority Ranking, and comes directly from the Pima County Sheriff's Department Crash Reports.

Unreported Motor Vehicle Crashes

Pima County crash information comes to TED from the Sheriff's Department Crash Reports; data outside of this source is rarely used or needed. Unreported crashes are generally tend to be "fender benders" without injuries and less than $1,000 in damages, therefore they are not statistically significant to affect the SMS Project Analysis and Priority Rankings.

In 2015, the US Department of Transportation, National Highway Traffic Administration published a report based on a phone survey that found about 30% of crashes go unreported. They found the majority of these 30% unreported crashes involve only minor property damage and no significant personal injury. The average unreported crash tends to have a lower severity than the average law enforcement-reported crash: i.e., crashes that do not result in enough damage to meet a State's reporting threshold are generally not reported.

In Arizona by state law, drivers who are involved in a crash that resulted in injury or death must report the crash. However, for crashes generating less than $1,000 in damage there is no law requiring reporting.

Fender Bender?

Save Your Rear

And Quickly Clear!

(ADOT)

<u>Arizona Revised Statutes section 28-666</u>

"28-666. <u>Notice of accident</u>
The driver of a vehicle involved in an accident resulting in injury to or death of a person shall give notice of the accident immediately by the quickest means of communication, whether oral or written, to:

1. The local police department, if the accident occurs within a municipality
2. The office of the county sheriff
3. The nearest office of the highway patrol"

Unreported Pedestrian and Bicycle Crashes

Pedestrian and bicyclist crashes in Pima County may have a certain percentage unreported also. Collisions between bicyclists and pedestrians, bicyclists and other bicyclists, or bicycles and a fixed object do not involve law enforcement and are not required to be documented on a crash form. In general, the Pima County Sheriff's office generates a Crash Report if a motor vehicle is

involved. Bicycle crashes and pedestrian crashes without motor vehicle involvement could be the following:

- Bicyclist strikes pedestrian
- Bicyclist strikes curb or object
- Bicyclist strikes bicyclist
- Bicyclist or pedestrian falls

If there are serious injuries, medical attention could be summoned and an Incident report may be generated. As with unreported vehicle crashes, these unreported crashes would not be expected to have much impact on intersection and segment safety analysis or therefore affect the SMS Safety Project Priority Ranking. However, it is still an area of concern. Thus, it is an area where PCDOT TED will be doing additional work in the future

Standard Safety Related Services

TED works on myriad of traffic-related issues, many of which stem from requests from the Pima County Board of Supervisors, citizens, other Pima County departments, and other agencies. Many of these requests require data collection and analysis, handled by the Studies Section. The Signal, Sign, or Marking Shop handles service and maintenance requests, depending on the nature of the request. In 2015, TED handled 1,253 requests. These are broken down in the following way:

Special Event – El Tour de Tucson

- 658 general maintenance items
  - 435 signing and marking maintenance requests
  - 223 electrical and signal issues reported

- 595 traffic study and safety concerns
  - 59 crash and safety studies
  - 43 traffic signal warrant studies, including left-turn phasing and roundabout studies
  - 409 general traffic studies, including:
    - Neighborhood Traffic Management Program (NTMP)
    - data requests
    - signing and marking reviews and needs studies
    - miscellaneous study requests
    - development services, right-of-way and private development reviews
  - 84 special event permits

These requests resulted in the following:

- 3,262 maintenance work orders for repair of existing installations/facilities
  - 134 work orders for recommended improvements based on traffic study/review
  - 13 safety project proposals:

- 9 projects for installation of traffic signals or roundabouts
- 4 projects for roadway widening (two-way left-turn lanes and paved shoulders)

Most of the data and analysis represented by this report is due to the direct output of the Studies Data Section. All of these efforts have resulted in a positive impact on the operations and maintenance of the Pima County roads. Although it is difficult to actually measure or quantify these direct impacts on safety individually, collectively they represent an overall effort in prevention.

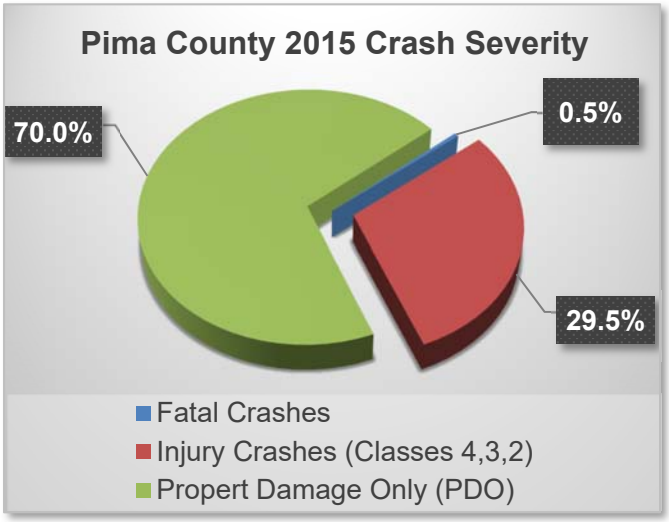
2. Crash Trends

Safety Goals

PCDOT manages the safety of a transportation network of nearly 2,200 miles of roadways, 104 signalized intersections and 10,026 unsignalized intersections. Each year, in accordance with the SMS program, TED tabulates and compares key crash data with the previous year. A comparison of 2014 crash data with 2015 data for the four tracked SMS goals is shown below in Table 5:

Table 5 SMS Goals Status for 2015

Crashes per Capita	*2014*	*2015*	*Change*	*Meet Goal?*
Crashes per Capita	6.93	7.30	Increase	***No***
Critical Injury/Fatal Crashes per Capita	0.29	0.23	Decrease	***Yes***
Critical Injury/Fatal Crashes	105	83	Decrease	***Yes***
Crash Severity Index	1.47	1.42	Decrease	***Yes***



For 2015, 70.0% of the County crashes were Property Damage Only or PDOs. These are crashes where medical attention is not required, generally known as "fender benders." Injury crashes (which includes critical and minor injuries) accounted for 29.5% of the total crashes. Fatal crashes contributed the final 0.5% to bring the total to 100%.

By comparison, for 2015, Arizona statewide crashes consisted of 68.3% PDOs, 31.0% Injuries and 0.7% fatalities, almost identical results.

Additional Safety Measures (GHSA & NHTSA)

The Governors Highway Safety Association (GHSA) in coordination with the National Highway Traffic Safety Administration (NHTSA) set forth the following list of measures. These are the minimum measures required for States and federal agencies in the development and implementation of behavioral highway safety plans and programs.

Core outcome measures – States will set goals and report progress

- C-1) Number of traffic fatalities; states are encouraged to report 3-year moving averages, or 5-year moving averages as when annual counts are sufficiently small that random fluctuations may obscure trends (this applies to all fatality measures)

- C-2) Number of serious injuries in traffic crashes (State crash data files)
- C-3) Fatalities/VMT; states should set a goal for total fatalities/VMT (vehicle miles traveled) and should report both rural and urban fatalities/VMT as well as total fatalities/VMT.
- C-4) Number of unrestrained passenger vehicle occupant fatalities, all seat positions (FARS)
- C-5) Number of fatalities in crashes involving a driver or motorcycle operator with a BAC of .08 and above
- C-6) Number of speeding-related fatalities
- C-7) Number of motorcyclist fatalities
- C-8) Number of unhelmeted motorcyclist fatalities
- C-9) Number of drivers age 20 or younger involved in fatal crashes
- C-10) Number of pedestrian fatalities

Core behavior measure – States will set goals and report progress

- B-1) Observed seat belt use for passenger vehicles, front seat outboard occupants (survey)

Activity measures – States will report progress

- A-1) Number of seat belt citations issued during grant-funded enforcement activities (grant activity reporting)
- A-2) Number of impaired driving arrests made during grant-funded enforcement activities (grant activity reporting)
- A-3) Number of speeding citations issued during grant-funded enforcement activities (grant activity reporting)

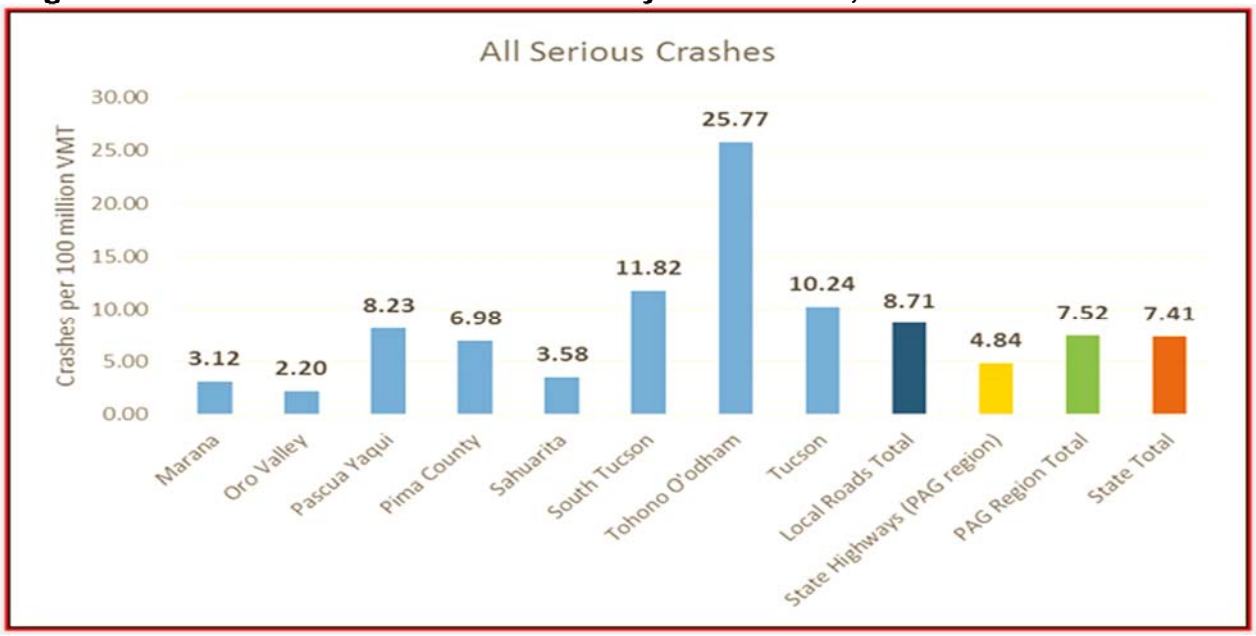
Pima County Traffic Engineering Division is examining including these measures (for comparison reasons) in the safety analysis of their roadway facilities. Currently the County maintains data for all of the measures listed above except for the following:

- C-3) Fatalities/VMT,
- C-4) Number of unrestrained passenger vehicle occupant fatalities, all seat positions
- B-1) Observed seat belt use for passenger vehicles, front seat outboard occupants (survey)

Pima County Crash Trends, 2000 to 2015

Figure 4 shows a comparison of Pima County with local jurisdictions, provided by the PAG Strategic Transportation Safety Plan (STSP). Of the 12 jurisdictions listed, there are four lower crash rates and six higher rates than Pima County's crash rate. Note that the State crash rate on the far right of the figure is about 6.1% higher than Pima County. Also, note the PAG Region Total is about 7.8% higher than Pima County. The SMS program has provided systematic results over a long term of consistent delivery.

Figure 4 Local Area 5-Year Crash Rates by Jurisdiction, 2009 to 2013



Pima Association of Governments Strategic Transportation Safety Plan, May 2016

Pima County and State Data Comparison

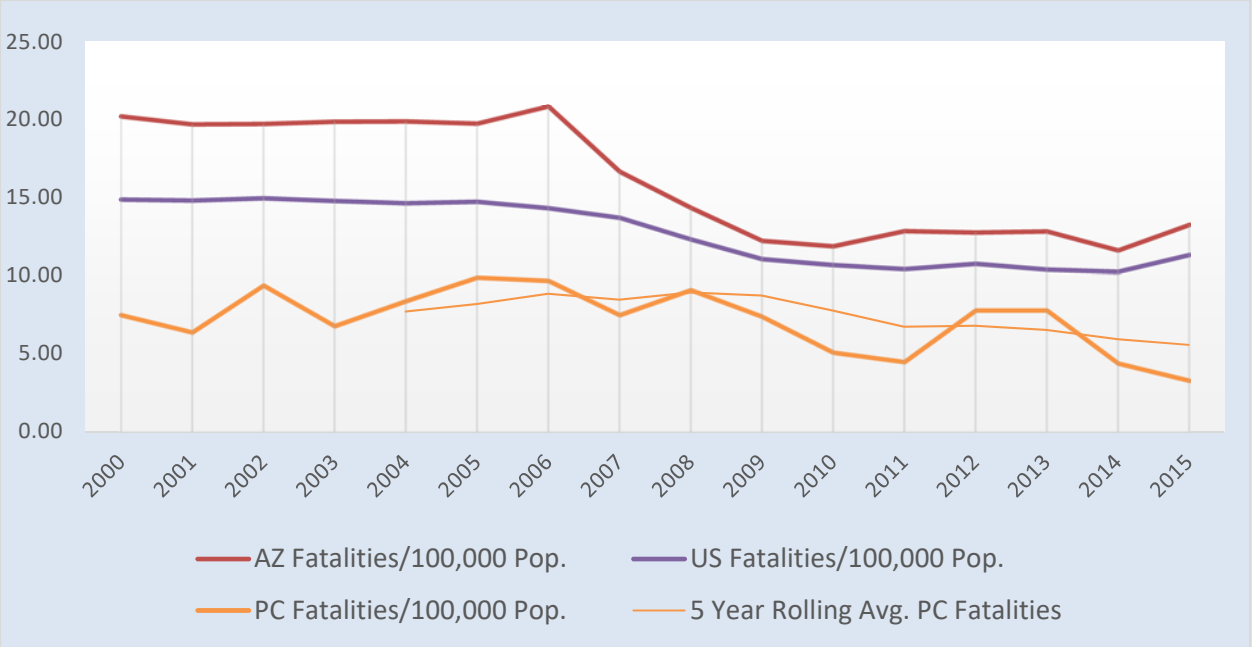
PCDOT maintains a database containing all crashes on Pima County roadways each year to help track four of the primary goals and to aid in determining what systematic changes, if any, could address the crashes. A summary of that data and SMS measurements is contained in Table 6, and a plot of the five-year average for crashes per capita and critical-injury/fatal crashes per capita in Figure 4. The Arizona Department of Administration[1] (ADOA) in their yearly report of Employment and Population Statistics provides the population data used to calculate per capita statistics in this report.

Figure 5 shows the rate of Fatalities per 100,000 people for the past fifteen years, comparing National, State and County statistics. In general, the State average is slightly above the National Average and Pima County is below. The National and State rate begin increasing in 2014 while the County maintained a downward trend.

PCDOT uses a rolling average, or moving average, to analyze data over time to reduce the peaks and valleys of raw data and provide a discernable trend. TED takes each five-year group averages the data together and plots to the year to provide a smooth trend line. In 2013, the Federal Highway Administration (FHWA) released new Performance Measures, which require States to use a five-year rolling average. The 2013 (2012 data) SMS Report began utilizing the five-year rolling average to align with the FHWA requirements.

[1] -Arizona Department of Administration-Employment and Population Statistics: https://population.az.gov/

Figure 5 Arizona, National and Uninc. Pima County Fatalities per 100,000 People



SMS provides crash data comparisons with crashes occurring within the State of Arizona as well as Pima County. Two sets of data have been accumulated utilizing published crash statistics from the ADOT website (http://www.azdot.gov/mvd/statistics/). The first data set shows the summarized total statewide crash and fatality data compared to the County data for the past 15 years (2000-2015), in Table 7. The second data table 8 compares Arizona urban with rural crash statistics.

Table 7 also shows that while Pima County has a relatively low number of fatal crashes, the percentage of fatal crashes to total crashes is almost identical to the state percentage, 0.709 for the State compared to 0.712 for Pima County.

Table 6 Pima County Road Safety Statistics for Single Year and " 5-Year Rolling Averages "

Measures of Effectiveness Data	Year																5-Year Rolling Average											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Number of Crashes	3509	3736	3707	3937	4189	4121	3986	4,029	3,775	3,210	3,375	2,903	2,990	2,843	2,506	2,636	3,816	3,938	3,988	4,052	4,020	3,824	3,675	3,458	3,251	3,064	2,923	2,776
Population (Unincorporated Pima county)	305,039	313,915	320,665	325,425	332,510	342,120	352,105	360,365	364,107	365,950	353,387	354,957	356,881	358,172	362,067	361,023	319,511	326,927	334,565	342,505	350,241	356,929	359,183	359,753	359,056	357,869	357,093	**358,620**
Crashes per Capita (Crashes per 1,000 people)	***11.50***	***11.90***	***11.56***	***12.10***	***12.60***	***12.05***	***11.32***	***11.18***	***10.37***	***8.77***	***9.55***	***8.18***	***8.38***	***7.94***	***6.92***	***7.30***	***11.93***	***12.04***	***11.92***	***11.85***	***11.50***	***10.74***	***10.24***	***9.61***	***9.05***	***8.56***	***8.19***	***7.74***
Critical Injury and Fatal Crashes (class 4/ 5)	***236***	***219***	***242***	***200***	***249***	***242***	***234***	***174***	***162***	***141***	***112***	***109***	***123***	***121***	***105***	***84***	***229***	***230***	***233***	***220***	***212***	***191***	***165***	***140***	***129***	***121***	***114***	***108***
Critical Injury and Fatal Crashes per Capita (per 1,000 people)	***0.774***	***0.698***	***0.755***	***0.615***	***0.749***	***0.707***	***0.665***	***0.483***	***0.445***	***0.385***	***0.317***	***0.307***	***0.345***	***0.338***	***0.290***	***0.233***	***0.718***	***0.705***	***0.698***	***0.644***	***0.610***	***0.537***	***0.459***	***0.387***	***0.360***	***0.338***	***0.319***	***0.302***
Total Number of Fatality Crashes (class 5)	23	20	30	22	28	34	34	27	33	27	18	16	28	28	16	14	25	27	30	29	31	31	28	24	24	23	21	20
Fatal Crashes per Capita (per 1,000 people)	0.075	0.064	0.094	0.068	0.084	0.099	0.097	0.075	0.091	0.074	0.051	0.045	0.078	0.078	0.044	0.039	0.077	0.082	0.088	0.085	0.089	0.087	0.077	0.067	0.068	0.065	0.059	0.057
Number of Actual Fatalities			**32**	**28**	**31**	**39**	**37**	**31**	**34**	**27**	**18**	**16**	**28**	**30**	**16**	**14**			**33**	**33**	**34**	**34**	**29**	**25**	**25**	**24**	**22**	**21**
Number of Injury Crashes (class 4, 3, 2)	1337	1325	1212	1214	1314	1262	1235	1252	1095	961	924	850	830	837	754	777	1,280	1,265	1,247	1,255	1,232	1,161	1,093	1,016	932	880	839	810
Severity Index	***1.64***	***1.58***	***1.58***	***1.51***	***1.55***	***1.54***	***1.54***	***1.48***	***1.46***	***1.47***	***1.41***	***1.44***	***1.44***	***1.47***	***1.47***	***1.42***	***1.57***	***1.55***	***1.54***	***1.52***	***1.51***	***1.50***	***1.47***	***1.45***	***1.45***	***1.45***	***1.44***	***1.45***
Fatal Crashes per 100,000 people	7.54	6.37	9.36	6.76	8.42	9.94	9.66	7.49	9.06	7.38	5.09	4.51	7.85	7.82	4.42	3.88	8	8	9	8	8.91	8.71	7.74	6.71	6.78	6.53	5.94	5.69
Fatal Crashes, Involving a Teen Driver	4	3	6	3	10	9	5	6	6	1	1	4	3	3	1	3	5	6	7	7	7	5	4	4	3	2	2	3
Fatal Crashes, Drug/Alcohol Involved	9	6	13	8	14	13	19	15	13	5	6	6	12	14	3	7	10	11	13	14	15	13	12	9	8	9	8	8
Fatal Crashes, with no belt use	9	5	9	13	5	9	17	11	10	8	9	5	10	14	6	5	8	8	11	11	10	11	11	9	8	9	9	8
Fatal Crashes, Excessive Speeding	10	2	7	7	7	13	13	9	13	2	0	3	3	2	3	1	7	7	9	10	11	10	7	5	4	2	2	2
All Crashes, Drug/Alcohol Involved	254	257	236	268	302	263	264	299	259	218	212	228	221	228	158	203	263	265	267	279	277	261	250	243	228	221	209	208
All Crashes, Signal Running	81	110	111	129	126	113	118	130	109	130	119	96	105	99	94	107	111	118	119	123	119	120	121	117	112	110	103	100
All Crashes, Stop Sign running	90	96	82	70	94	73	117	78	68	62	81	79	51	45	41	58	86	83	87	86	86	80	81	74	68	64	59	55
All Crashes, Excessive Speeding Involved	140	149	145	175	207	242	239	131	122	59	55	51	51	49	55	39	163	184	202	199	188	159	121	84	68	53	52	49
All Crashes, Pedestrian Involved *	26	27	34	37	25	31	18	29	33	39	32	30	25	44	38	40	30	31	29	28	27	30	30	33	32	34	34	35
Pedestrian Fatal Crashes					2	3	1	4	3	5	1	3	4	6	4	1					3	3	3	3	3	4	4	4
All Crashes, Motorcycle Involved							171	157	148	150	124	106	108	123	94	77							150	137	127	122	111	102
Motorcycle Fatal Crashes							6	6	11	9	6	5	6	5	2	3							8	7	7	6	5	4
Motorcycle Fatal Crashes, no helmet							5	3	6	5	3	3	1	2	2	3							4	4	4	3	2	2
All Crashes, Bicycle Involved							64	56	59	52	51	46	41	58	34	42							56	53	50	50	46	44
Bicycle Fatal Crashes							4	0	1	2	0	0	0	3	0	2							1	1	1	1	1	1

* NOTE: Pedestrian crashes were updated from 2010 to 2014 with data entry revisions.

Table 7 Arizona State Wide Crashes Compared to Pima County Crashes

Arizona State Wide Crashes vs **Pima County Crashes**

Year	Total Crashes	Fatal Crashes	% Fatal Crashes	Number of Fatalities	Injury Crashes	Number of Injured	Property Damage Crashes
2000	131,368	891	0.678	1,036	47,485	76,626	82,992
2001	131,573	934	0.710	1,047	46,150	73,962	84,489
2002	134,228	984	0.733	1,132	46,209	74,230	87,045
2003	130,895	971	0.742	1,118	45,177	71,901	84,747
2004	138,899	998	0.719	1,159	46,789	73,693	91,120
2005	140,574	1,049	0.746	1,193	45,526	71,053	93,699
2006	143,043	1,125	0.786	1,300	45,271	69,814	96,699
2007	141,092	952	0.675	1,071	43,530	66,015	96,610
2008	119,588	842	0.704	937	37,180	56,009	81,566
2009	107,149	709	0.662	806	33,506	50,809	72,934
2010	106,895	695	0.650	759	33,416	50,459	72,784
2011	103,945	756	0.727	827	33,220	49,849	69,969
2012	103,909	738	0.710	821	33,576	50,057	69,595
2013	107,348	777	0.724	844	34,047	50,284	72,524
2014	109,554	708	0.646	774	34,451	50,890	74,395
2015	**116,609**	**811**	**0.695**	**895**	**36,139**	**53,554**	**79,659**
TOTAL	1,966,669	13,940	0.709	15,719	641,672	989,205	1,310,827

Year	Total Crashes	Fatal Crashes	% Fatal Crashes	Number of Fatalities	Injury Crashes	Number of Injured	Property Damage Crashes
2000	3,509	23	0.655	24	1,337	2,179	2,149
2001	3,740	20	0.535	21	1,327	2,047	2,393
2002	3,704	30	0.810	32	1,210	1,854	2,464
2003	4,008	22	0.549	28	1,240	1,875	2,746
2004	4,261	28	0.657	31	1,345	1,984	2,888
2005	4,131	34	0.823	39	1,264	1,894	2,833
2006	3,987	34	0.853	37	1,236	1,906	2,717
2007	4,029	27	0.670	31	1,252	1,818	2,750
2008	3,776	33	0.874	34	1,097	1,674	2,646
2009	3,211	27	0.841	27	960	1,371	2,222
2010	3,375	18	0.533	18	922	1,270	2,432
2011	2,903	16	0.551	16	850	1,275	2,036
2012	2,990	28	0.936	28	830	1,171	2,131
2013	2,843	28	0.985	30	837	1,129	1,981
2014	2,508	16	0.638	16	754	1,031	1,739
2015	**2,637**	**14**	**1**	**14**	**780**	**1,139**	**1,845**
TOTAL	55,612	398	0.716	426	17,241	25,617	37,972

Table 8 Arizona State Wide Crashes, Urban Compared to Rural

Urban vs **Rural**

Year	Total Crashes	Fatal Crashes	% Fatal Crashes	Number of Fatalities	Injury Crashes	Number of Injured	Property Damage Crashes
2000	105,879	375	0.354	400	38,687	61,366	66,817
2001	106,929	463	0.433	495	37,854	60,002	68,612
2002	107,521	453	0.421	489	37,283	59,291	69,785
2003	104,436	402	0.385	432	36,314	56,916	67,720
2004	114,916	470	0.409	520	38,916	60,388	75,530
2005	115,896	517	0.446	558	37,709	57,732	77,670
2006	115,901	519	0.448	572	36,495	55,507	78,887
2007	114,854	441	0.384	479	35,024	52,501	79,389
2008	96,475	391	0.405	414	29,868	44,316	66,216
2009	84,941	299	0.352	325	26,534	39,656	58,108
2010	84,802	354	0.417	380	26,716	39,907	57,732
2011	82,864	370	0.447	389	26,805	18,874	55,689
2012	83,543	376	0.450	394	27,272	40,252	55,895
2013	87,084	420	0.482	443	27,813	54,000	58,851
2014	89,352	378	0.423	397	28,284	41,730	60,690
2015	**94,404**	**440**	**0.466**	**471**	**29,441**	**43,426**	**64,523**
TOTAL	1,589,797	6,668	0.419	7,158	521,015	785,864	1,062,114

Year	Total Crashes	Fatal Crashes	% Fatal Crashes	Number of Fatalities	Injury Crashes	Number of Injured	Property Damage Crashes
2000	25,489	516	2.024	636	8,798	15,260	16,175
2001	24,644	471	1.911	552	8,296	13,960	15,877
2002	26,707	521	1.951	630	8,926	14,939	17,260
2003	26,459	569	2.150	686	8,863	14,985	17,027
2004	23,361	520	2.226	631	7,758	13,087	15,353
2005	23,369	521	2.229	621	7,652	12,561	15,196
2006	24,296	602	2.478	724	7,963	13,067	15,731
2007	25,517	511	2.003	592	8,280	13,204	16,276
2008	23,113	451	1.951	523	7,312	11,693	15,350
2009	21,826	410	1.878	481	6,846	10,954	14,570
2010	21,375	344	1.609	382	6,479	10,203	14,552
2011	20,559	384	1.868	436	6,225	9,676	13,950
2012	20,094	362	1.802	427	6,203	9,644	13,529
2013	20,264	357	1.762	401	6,234	8,300	13,673
2014	20,202	330	1.634	377	6,167	9,160	13,705
2015	**22,205**	**371**	**1.671**	**424**	**6,698**	**10,128**	**15,136**
TOTAL	369,480	7,240	1.960	8,523	118,700	190,821	243,360

Figure 6 Arizona Total Crashes

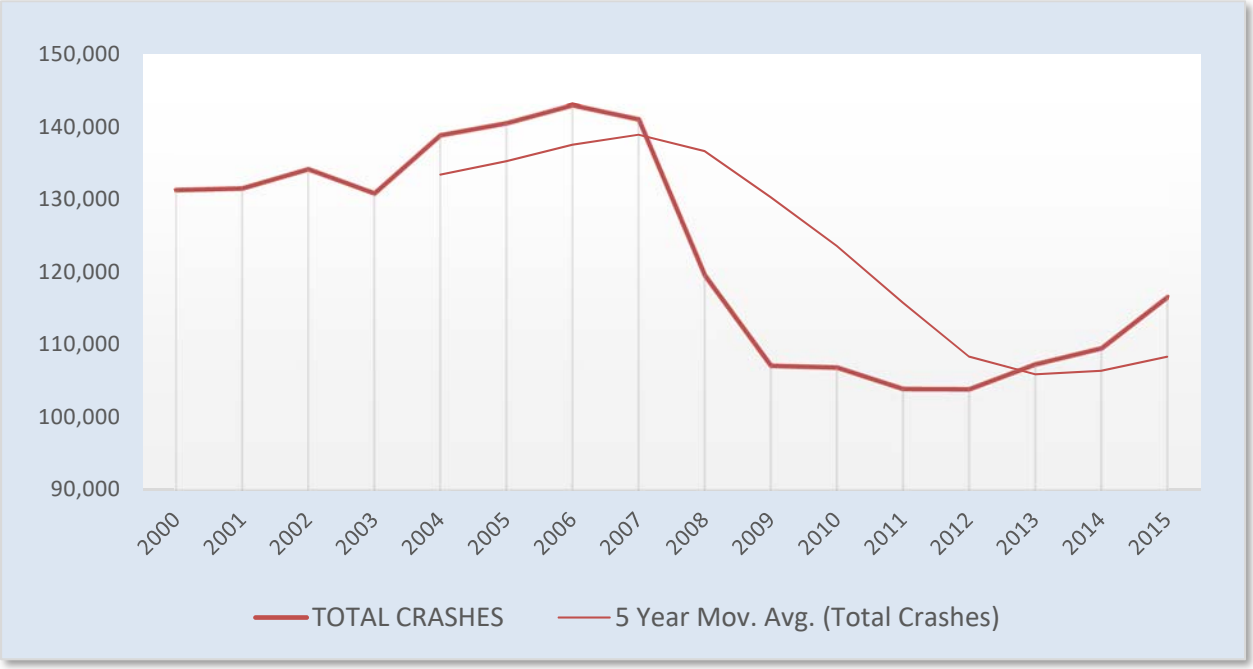
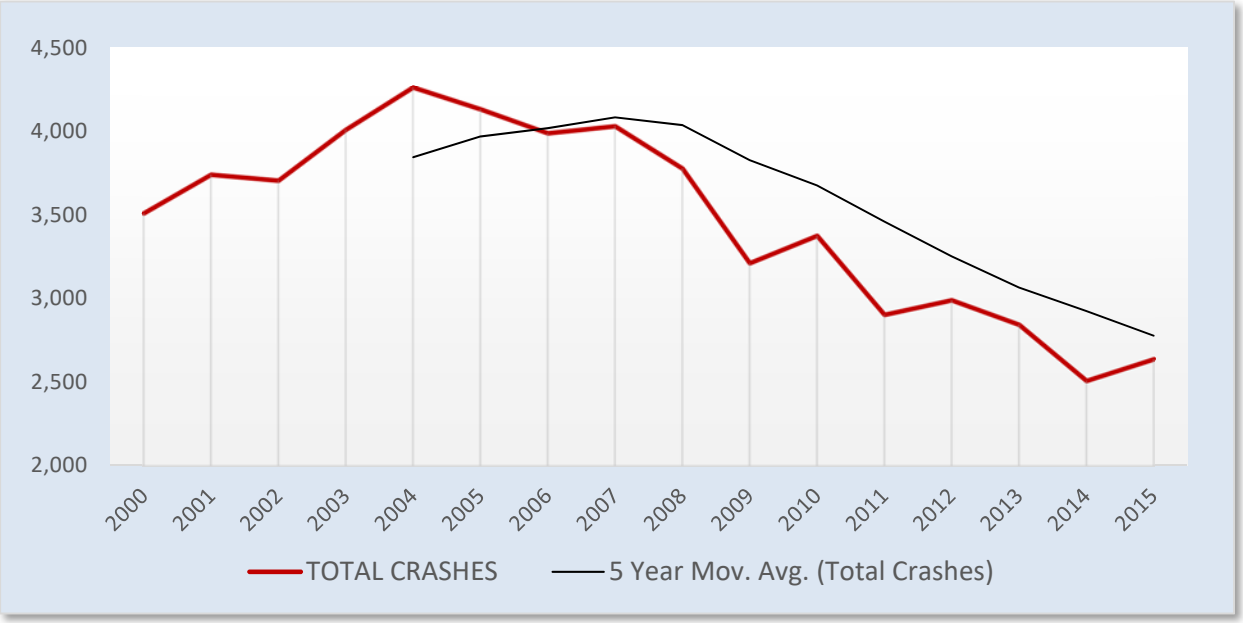


Figure 6 shows a plot of the Arizona total crashes for the past 15 years. The shape of the graph is similar to the plot of the Pima County crashes over the same period. Whereas the County graph shows a consistent decline, the State plot shows a bottoming out in 2011 and a gradual increase until the present.

Overall, the Figure 7 below illustrates the declining crash rate from the year 2000 to 2015. The peak of the crash rate occurs at year 2004 and the 5-year rolling average trend line shows a steady decline in crashes through 2012 and fairly leveled off since. Driver education, safer vehicles, improved facilities, consistent roadway and intersection improvements, as well as economic factors, all contribute to the reduction in fatalities and crashes within the County.

Figure 7 Unincorporated Pima County Total Crashes



In Table 8, the second set of data is for statewide crashes only and compares urban vs rural crash data. TED is considering the separating rural from urban crash data for county roadways to allow a better comparison. The significance of the Rural/Urban divide in traffic safety and comparative analysis was highlighted in the recently published National Highway Traffic Safety Administration's circular *Traffic Safety Facts – 2012 Data: Rural/Urban Comparison (DOT HS 812 050, July 2014)*[2]. The main data take-away from the NHTSA circular is that: "Although 19% of the U.S. population lived in rural areas, rural fatalities accounted for 54% of all traffic fatalities in 2012."

The 2015 Arizona data shows that rural fatal crashes account for 46% of the total fatal crashes, but the number of fatalities are actually at 47% of all traffic fatalities, close to the national rate in the circular. This is expected as highway (whether Interstate or State Route) driving accounts for the majority of rural travel where higher speeds are present. It is not advisable to utilize fatalities over fatal crashes as criteria, because the scale of comparison changes. For example, if there is one bus or van crash that causes eight fatalities.

While urban crashes in Arizona (94,404) accounted for 81% of all crashes, they accounted for only 54% of all fatal crashes (440) occurring in 2015. While rural crashes in Arizona (22,205) accounted for 19% of all crashes, they accounted for 45% of all fatal crashes (371) occurring in 2015)[3].

Figure 8 compares the injury crash trend of Pima County with the State of Arizona crashes. The Arizona injury crashes decreased dramatically from 2007-2009, leveled off from 2010 to 2011 and actually began increasing slightly since 2012. The Pima County injury crashes demonstrate a consistent decline over the past 15 years from 8,798 in 2000 to 6,678 in 2015.

[2] National Highway Traffic Safety Administration circular: http://www-nrd.nhtsa.dot.gov/Pubs/812050.pdf
[3] 2015 Arizona Crash Facts Summary, p. 11.

Figure 8 Injury Crashes Within Pima County Compared to Arizona Injury Crashes

Pima County Crash Trends

Pima County Crash Trends chart a wide variety of data to achieve a better understanding of crash causation and circumstances. The following data sets are charted and discussed in this section:

Vehicle Crashes
Severity Index
Crash Fatalities, Auto, Motorcycle, Bicycle and Pedestrian
Drug, Alcohol, Seat Belts and Speeding
Crash Citations
Common Crash Types at Signalized/Unsignalized Intersections and Roadway Segments
Teen Drivers
Motorcycle Crashes
Bicycle and Pedestrian Crashes
Weather Related Crashes

Vehicle Crashes

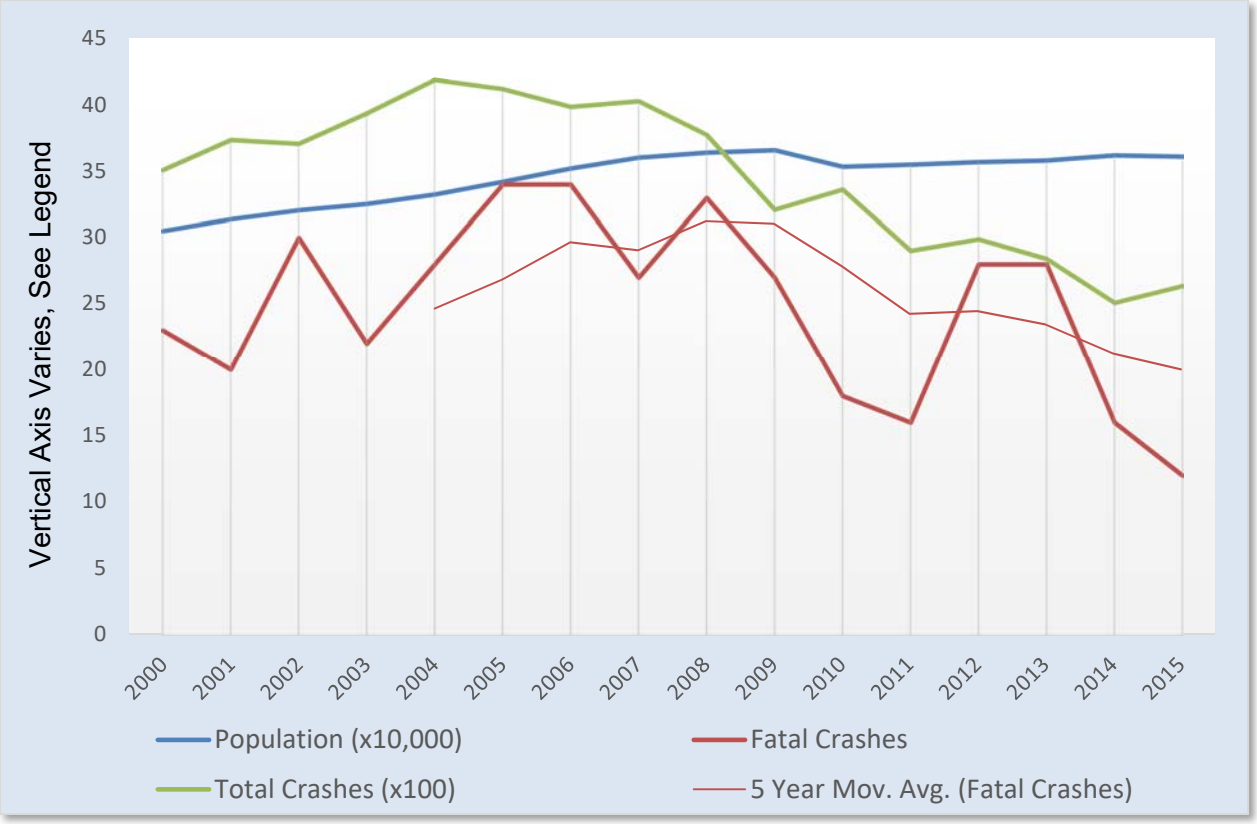
Figure 9 shows three separate trends for Pima County over the past 15 years. The population growth in the area reveals a steady growth rate totaling about 20% over 15 years. The Total Crash rate rose to a peak in 2004 and then steadily declined until the present. Finally, the Fatal Crashes are plotted per year and shows a steady reduction except for the years 2012 and 2013. This plot clearly shows random nature of fatalities from year to year and why it is helpful to use a “moving” 5-year trend line for analysis.

In calendar year 2015, the total number of crashes increased 5.1% from calendar year 2014, from 2,510 to 2,637 crashes. This increase combined with a slight decrease in population increased the crashes per capita rate from 6.93 to 7.30. The reduction in the critical- and fatal-injury per

capita rate is driven by both the decrease in critical- and fatal-injury crash frequency as well as the increase in Pima County population. The severity index for 2015 on county roadways decreased from 1.47 in 2014 to 1.42.

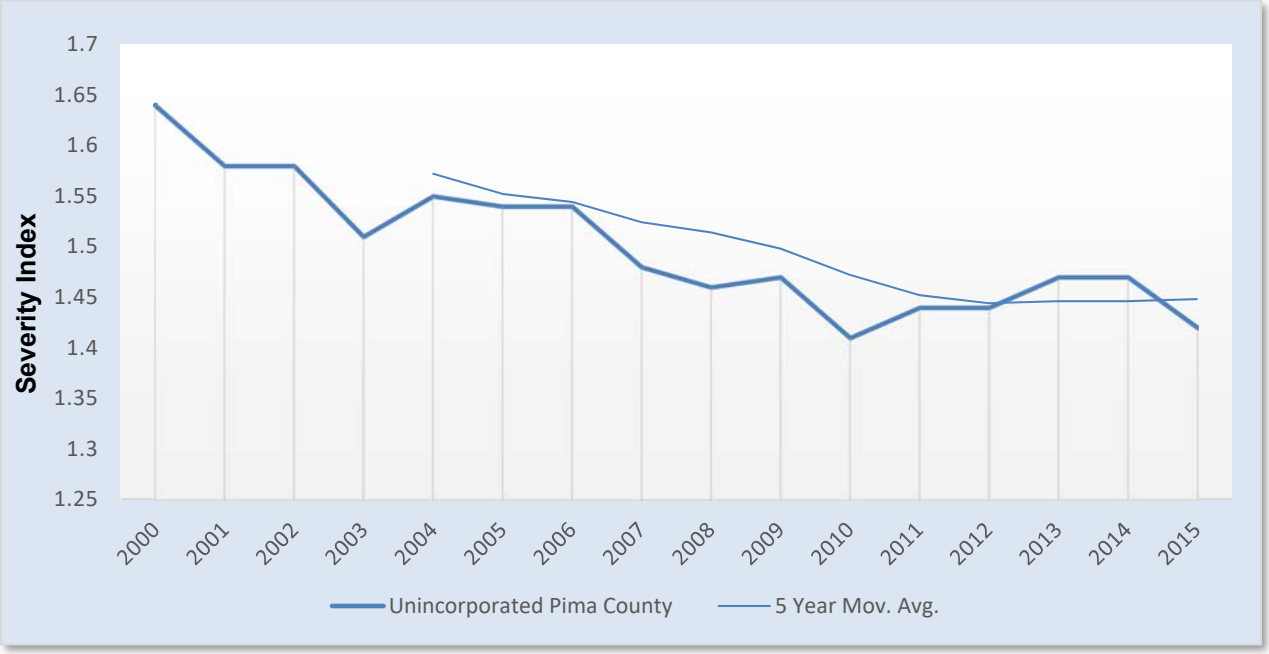
Another statistic for comparison is the percent of fatal crashes, which is simply the number of fatal crashes divided by the total number of crashes. From Table 6, for 2015, Arizona statewide averaged 0.695% fatal crashes while Pima County's facilities performed better and averaged 0.455% fatal crashes.

Figure 9 Population Comparison with Fatal and Total Crashes



The Pima County Crash Severity Index is plotted over the past 15 years in Figure 10 along with its 5-year rolling average trend line. The 5-year rolling trend line shows a consistent reduction in the severity of crashes from 2003 to 2012, then a leveling off until 2015.

Figure 10 Pima County Crash Severity Index



Fatality trends for automobiles, motorcycles, bicycles and pedestrians are graphed below in Figure 11. The 5-year average rolling trend lines show-declining numbers of fatalities over the previous 15 years of data.

Figure 11 Auto, Motorcycle, Bicycle and Pedestrian Fatalities

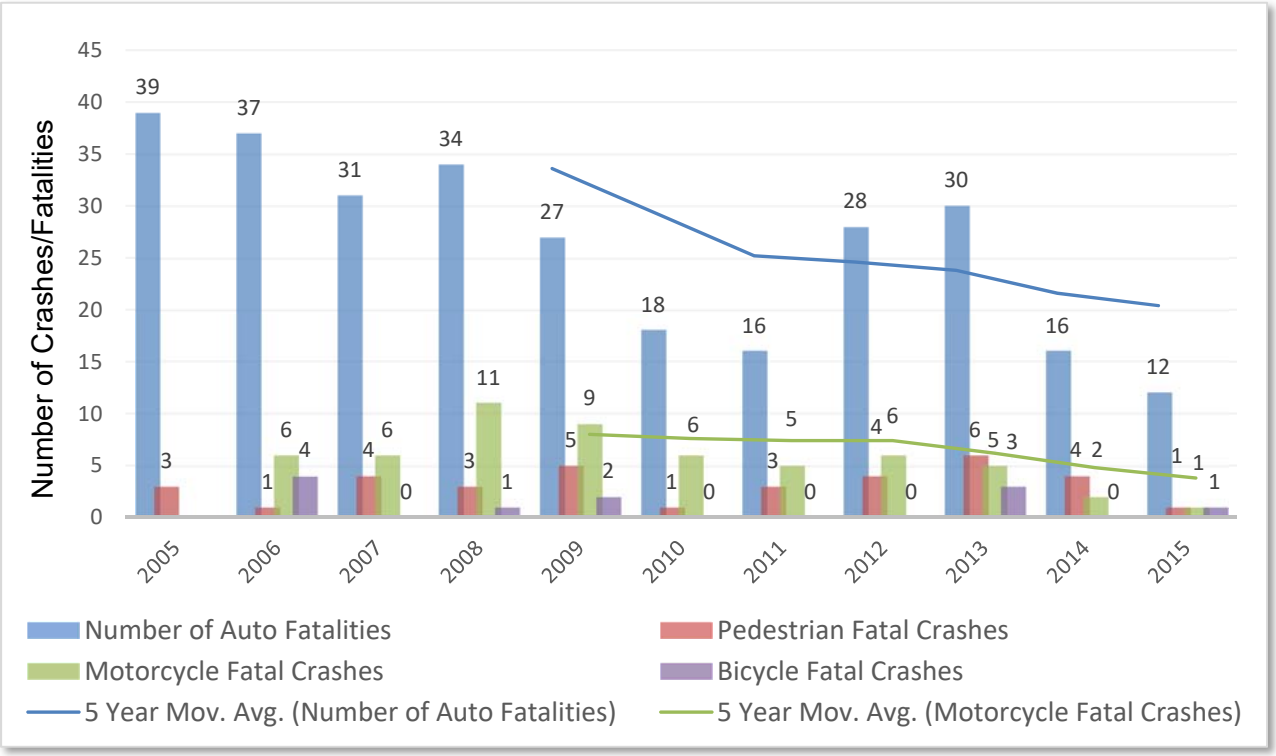


Figure 12 Fatal Crashes Influenced by Drugs/Alcohol, Seat Belts and Speeding

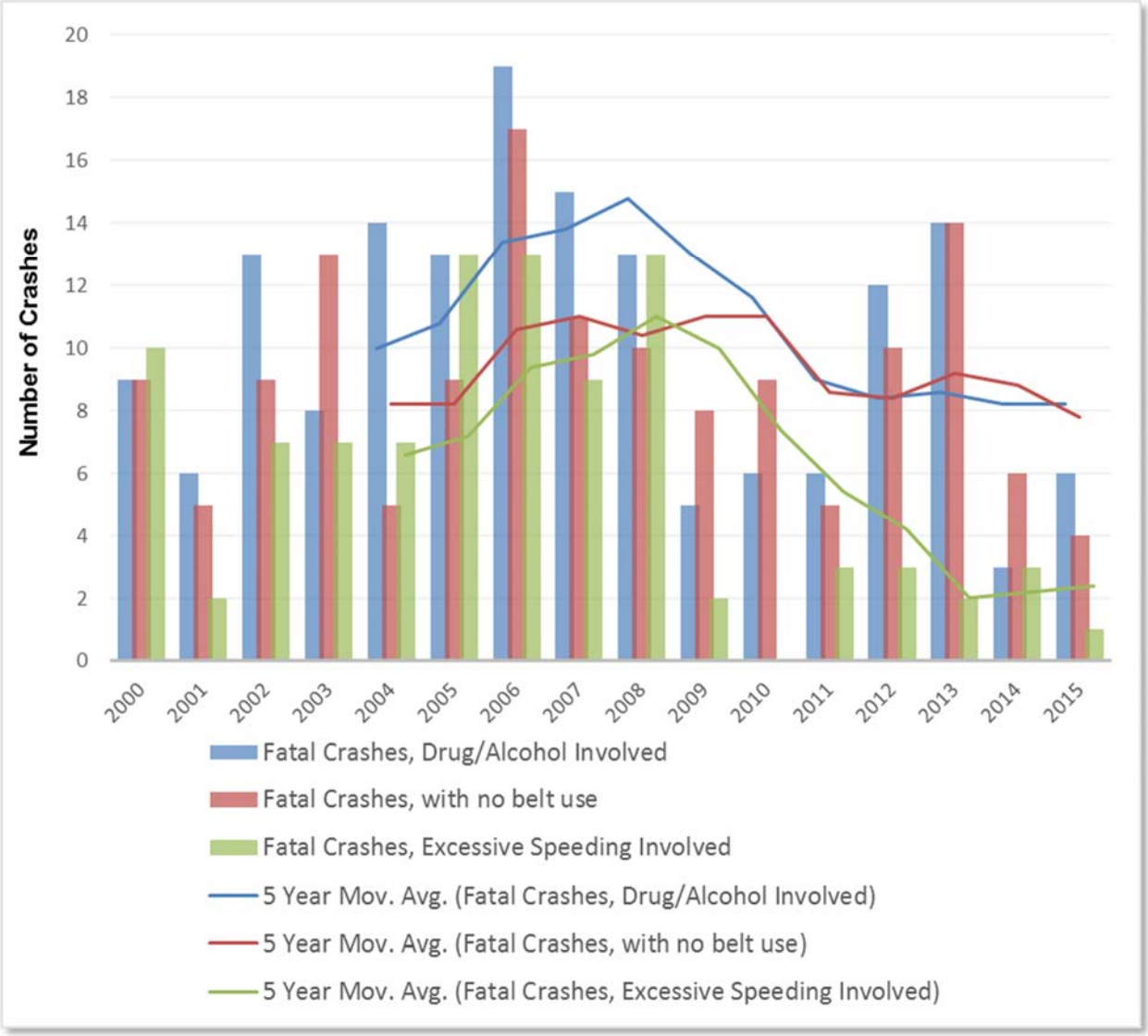


Figure 12 shows the relationships of drug/alcohol, no seat belt use, and excessive speeding with fatal crashes in the County. From the 5-year moving trend lines, the drug/alcohol and speeding citations peaked in 2008 and have been declining since. Even though fatalities have been declining, the no seat belt use 5-year trend does not show improvement with the same level in 2015 as shown in 2004. Seat belt use makes a substantial difference in crash severity, drivers and passengers not wearing seatbelts are 3 times more likely to be injured or killed than those wearing a seat belt.

Figure 13 Crash Citation Data

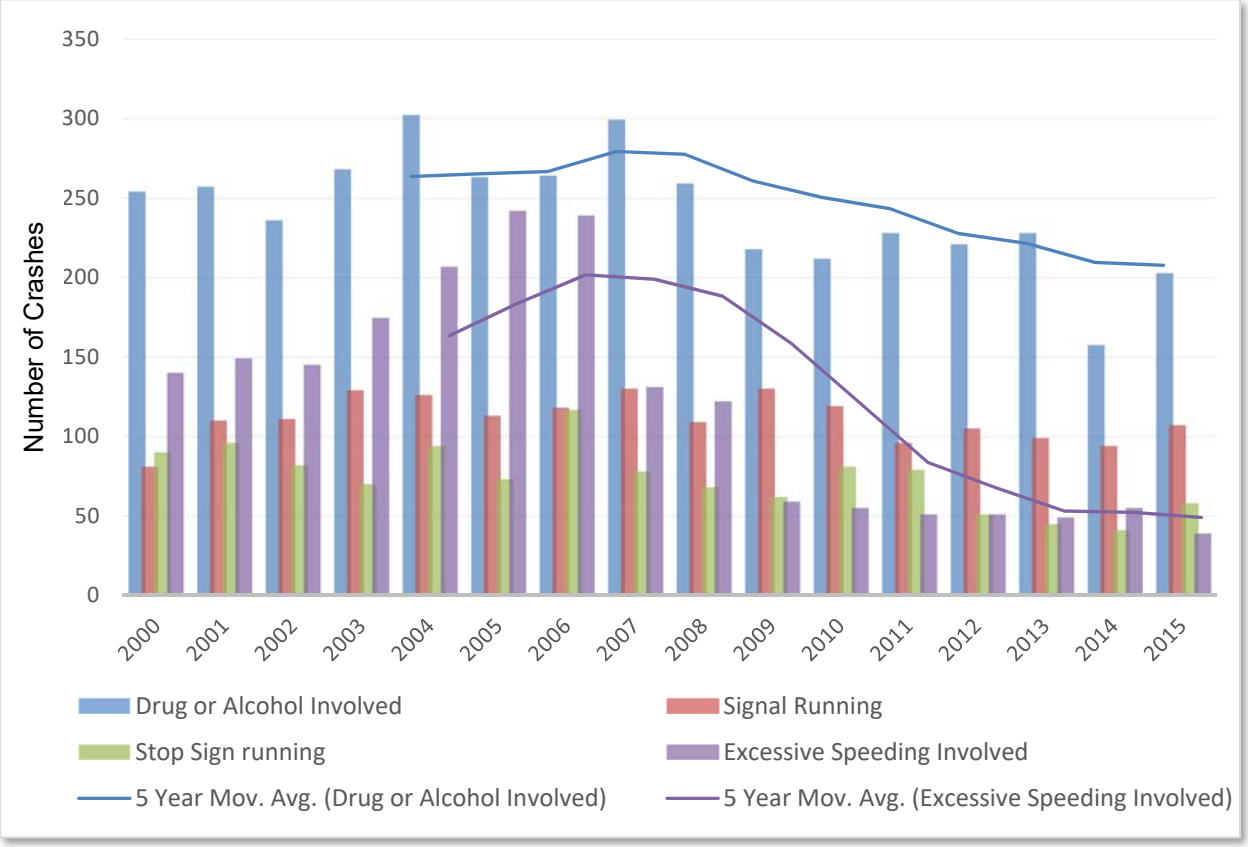


Figure 13 shows the number of citations for all the crashes. The citations include drug/alcohol involvement, signal running, stop sign running and excessive speed. Where stop sign running and signal running have stayed consistent through the years, drug/alcohol involvement shows a steady decline since 2008 and excessive speeding declined dramatically from 2007.

SMS examines collected crash data in a systematic way that includes reviewing types of crashes and where they occur. TED summarizes the 2015 data and tabulates it for the types of crashes at unsignalized intersections, signalized intersections and road or street segment locations. This summary is shown in Table 9. The data shows that the most common type of crash at signalized intersections is the rear end crash. The most common crash for unsignalized intersections is the angle crash.

Generally, crashes listed in the category of roadway departures are the predominant crash type for segments. This category is composed of the following crash types: fixed object, sideswipe, out of control and head-on. The FHWA criteria for roadway departures includes any lane departure crash, hence the inclusion of head-on and sideswipe crashes into that category.

Generated from the data in Table 9, the adjacent pie chart shows the percentage relationships of the locations of crashes. The high 104 volume signalized intersections generate more crashes than the thousands of unsignalized intersections in the County, 27% compared to 23%. Roadway segments, urban and rural generate as many crashes as the intersections combined at 50%. In the future, the County will be able to determine the percentage of crashes rural in nature compared to urban crashes.

Table 9 Common Crash Types in Pima County (2013 to 2015 Crash Data)

Intersections

Unsignalized

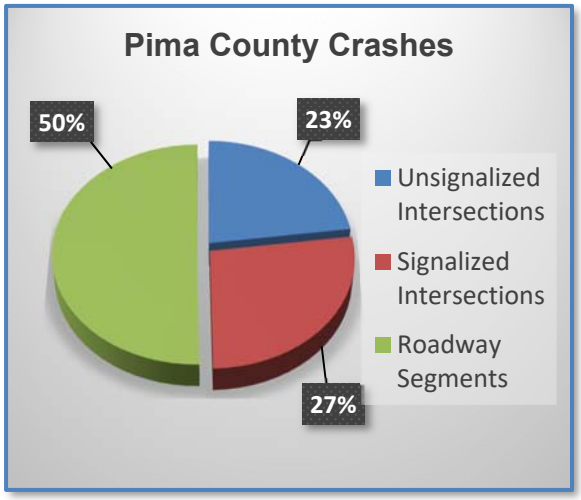
Type of Crash	Count	Percent
Angle	662	38%
Rear End	498	29%
Fixed Object	195	11%
Misc.	187	11%
Turning	131	8%
Out of Control	34	2%
Backing	22	1%
Head-on	5	0%
	1734	

Signalized

Type of Crash	Count	Percent
Rear End	1163	57%
Turning	373	18%
Angle	237	12%
Misc.	147	7%
Fixed Object	77	4%
Backing	31	2%
Out of Control	11	1%
Head-on	4	0%
	2043	

Rural and Urban Segments

Type of Crash	Count	Percent	Total
Lane Departure*	1638		42%
Fixed Object*	735	19%	
Side Swipe*	440	11%	
Out of Control*	374	10%	
Head-on*	89	2%	
Rear End	1071		28%
Misc	596		16%
Angle	316		8%
Turning	116		3%
Backing	97		3%
	3834		100%



*Lane departure crashes also include Fixed Object, Side Swipe, Out of Control and Head-on categories.

Seat Belt Use

For 2015, there were 12 fatal crashes in Pima County, of those 12 crashes, 4 crashes or 33% of the fatalities were not wearing seatbelts. This is a common percentage in line with the past 15 years, where the range for seat belt use in fatal crashes was generally 25% to 50% compliance. In Arizona, you must wear a seat belt if you are in the front seat. That includes drivers. It is also the law that anyone aged 5 to 15 has to wear a properly adjusted seat belt, no matter where they are sitting in the vehicle. Arizona is a secondary seat belt law state, though; meaning that a law enforcement officer will not stop a vehicle for just for a seat belt infraction, there has to be a primary infraction.

Distracted Driving

There are three main types of distraction:

- Visual: taking your eyes off the road;
- Manual: taking your hands off the wheel; and
- Cognitive: taking your mind off driving.[4]

Nationwide in 2014, distracted driving was a factor that killed 3,179 people and injured 431,000 in motor vehicle crashes. Distracted driving activities typically include behavior such as using a cell phone, texting, and eating. Using in-vehicle technologies (such as navigation systems) can also be sources of distraction. While any of these distractions can endanger the driver and others, texting while driving is especially dangerous because it combines all three types of distraction.[5] Arizona currently bans cell phone use (handheld and hands-free) for school bus drivers (Primary law).

Distracted driving is currently not included in Table 6 due to a lack of data. The distracted driving "field" in the crash reports was recently initiated in 2014 and is not routinely used (most forms have no distraction or unknown noted). Prior to that, the only field represented was in the violation field as "inattention". The County has found that there is very limited amount of data currently collected for distracted driving.

Teen Drivers

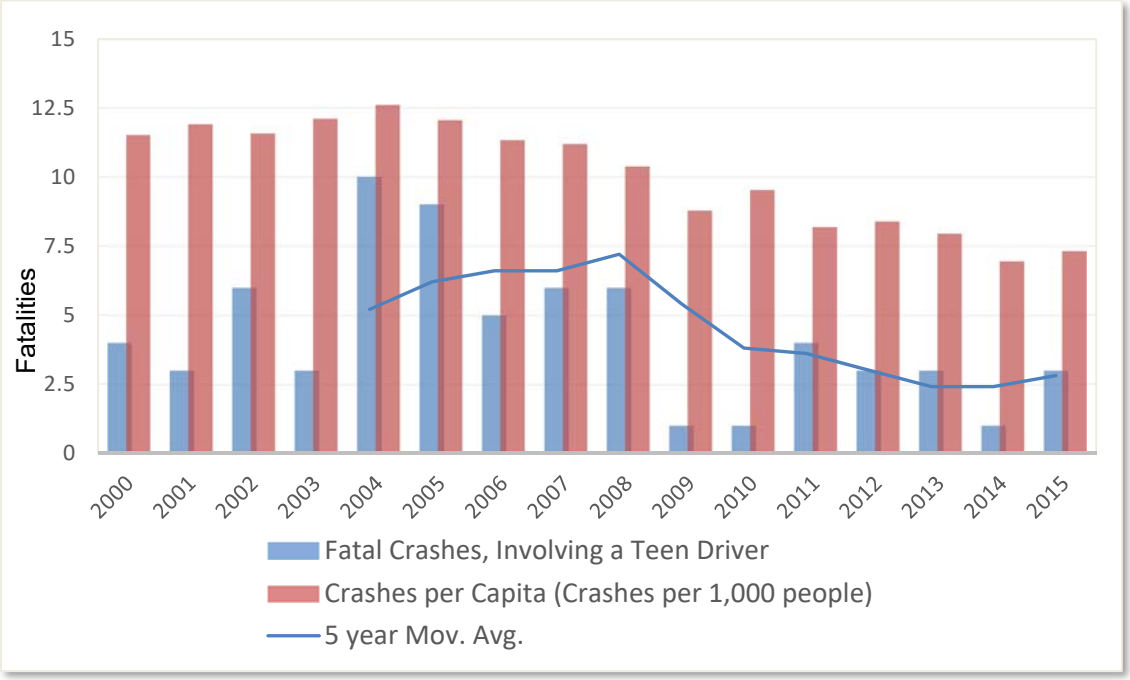
Teens have the highest crash rate of any group in the United States. Nationally about 963,000 drivers age 16-19 were involved in law enforcement-reported crashes in 2013, which is the most recent year of available data. These crashes resulted in 383,000 injuries and 2,865 deaths. A recent video analysis finds that distraction was a factor in nearly 6 out of 10 moderate-to-severe teen crashes, which is four times as many as official estimates based on crash reports.

In Pima County, both categories, Fatal Crashes per 100,000 people and Fatal Crashes involving a teen driver are trending downward on a similar decline.

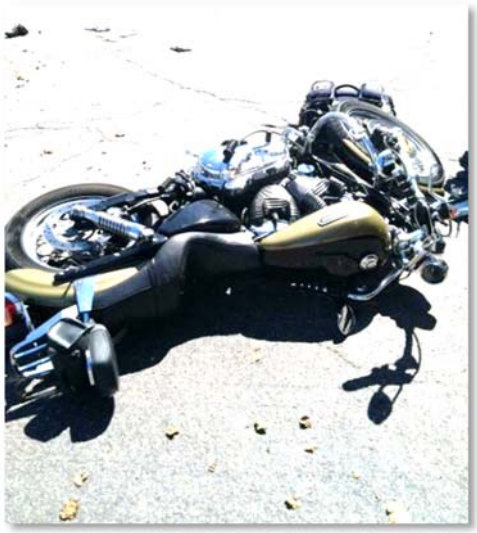
[4] National Highway Traffic Safety Administration. *Policy Statement and Compiled FAQs on Distracted Driving*. [cited 2016 Feb 23]; Available from: http://www.nhtsa.gov/Driving+Safety/Distracted+Driving+at+Distraction.gov/Policy+Statement+and+Compiled+FAQs+on+Distracted+Driving

[5] National Highway Traffic Safety Administration. *Facts and Statistics*. [cited 2016 Feb 23]; Available from: http://www.distraction.gov/stats-research-laws/facts-and-statistics.html

Figure 14 Fatal Crashes Involving a Teen Driver



Motorcycle Crashes

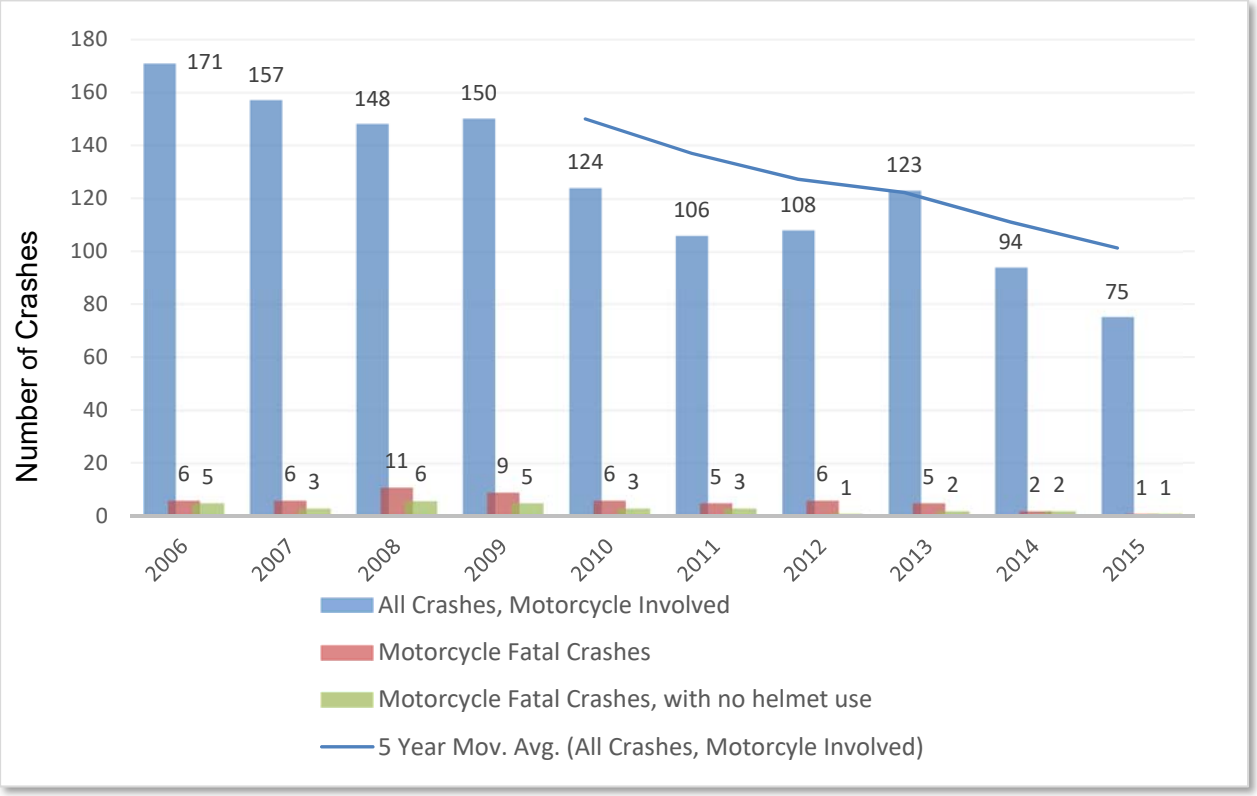


Motorcycles crashes are much less forgiving than an automobile crash because the motorcycle itself offers less protection than a car would in a similar crash. In a crash, motorcyclists are almost 5 times more likely to be injured or killed than motorists in vehicles. Per mile driven, fatality rates for motorcyclists were 26 times that of passenger vehicle occupants in 2013 (NHTSA, 2015). For Pima County the trend indicates a reduction in motorcycles crashes since the high in 2006 of 171 crashes to 75 in 2015. Fatalities have also steadily decreased from a high of 11 in 2008 to 1 in 2015.

In Arizona, only those motorcycle operators and riders under the age of 18 must wear a helmet. Additionally, all riders and operators, regardless of age, must wear protective glasses, goggles, or a transparent face shield, unless the bike is equipped with a windshield.

Motorcycle helmets reduce the risk of head injury by 69 percent and reduce the risk of death by 42 percent, according to a report by the Advocates for Highway and Auto Safety, a pro-helmet safety organization. In 2014, states without an all-rider helmet law saw 10 times more unhelmeted fatalities than states with an all-rider helmet law, according to information from the National Highway Traffic Safety Administration in the Advocates report. Safety is unlikely to be achieved until stricter all-rider motorcycle helmet laws are put into effect. The current Arizona highway and auto safety status was given a “danger” rating in the Advocates report, suggesting Arizona strengthen its laws.

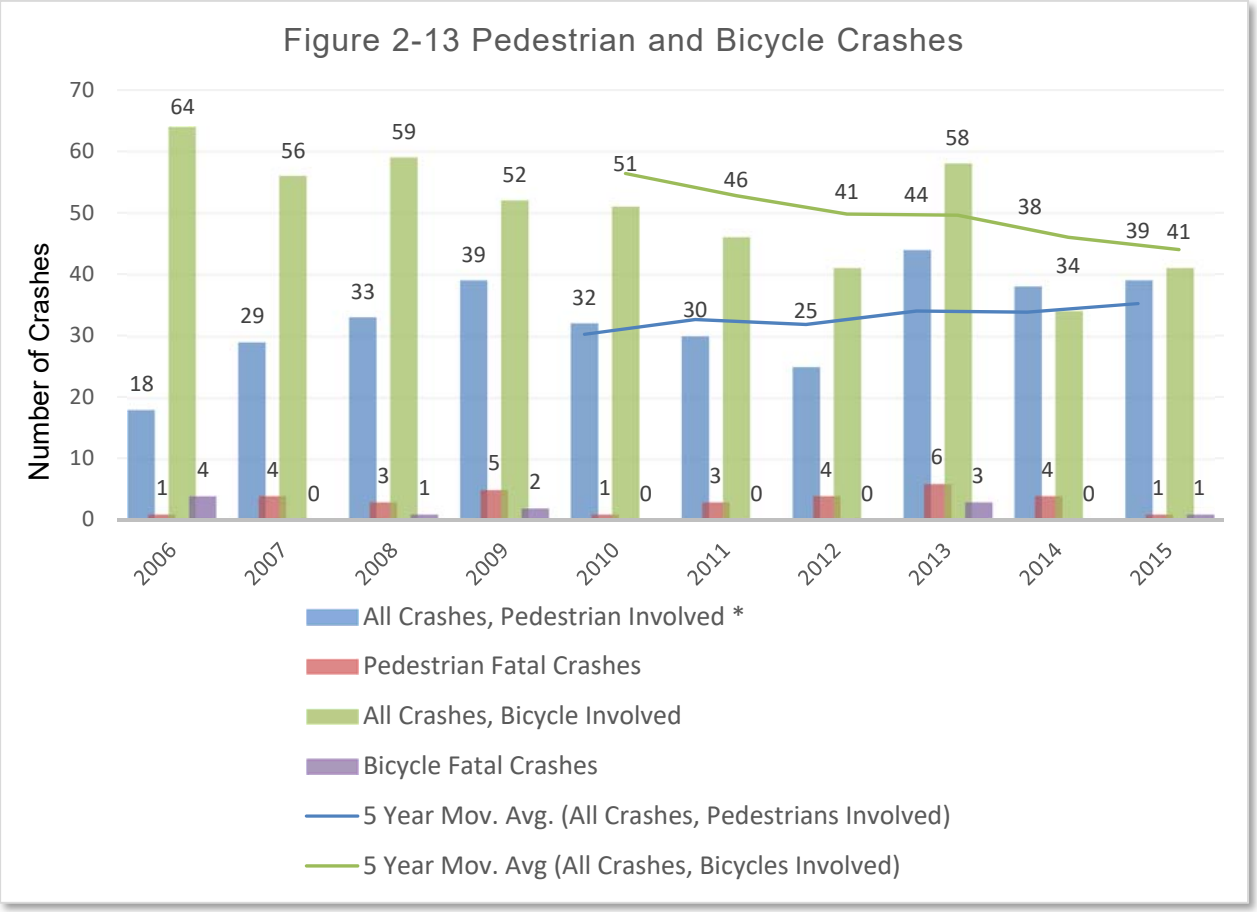
Figure 15 Motorcycle Crashes



Pedestrian/Bicycle Crashes

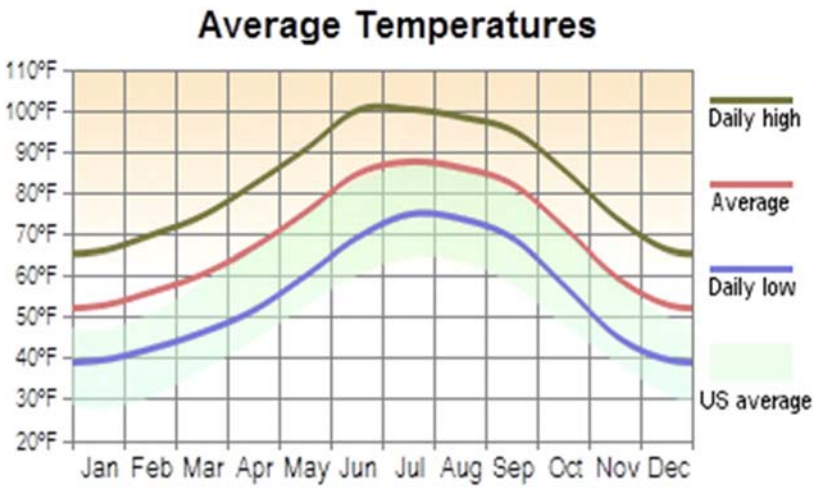
During 2015, there were 39 pedestrian crashes and 41 bicycle related crashes with automobiles in Pima County. Combined, these crashes represent 3 percent of all motor vehicle crashes for that year. From the 5-year rolling average trend line, it is clear that bicycle crashes are in a downward trend from a high of 64 in 2006 to a low of 34 in 2014. However, the pedestrian crash trend is actually rising slightly, from a low of 25 in 2012 to 39 in 2015. Fatalities for bicycles and pedestrians are very rare and random events and actual fatalities vary throughout the years with no discernible trend. Some years there are as many as 5 or 6 fatalities, and other years there are none.

Figure 16 Pedestrian and Bicycle Crashes



Weather Related Crashes

Pima County Climate



Pima County resides in a desert climate with two major seasons, summer and winter; plus three minor seasons: fall, spring, and the North American Monsoon. Tucson averages 11.8 inches (299.7 mm) of precipitation per year, which is more than most other locations with desert climates. A majority of the precipitation and foul weather occurs from mid-July to mid-September during the monsoon season.

<u>Monsoon Related Motorist Hazards</u>

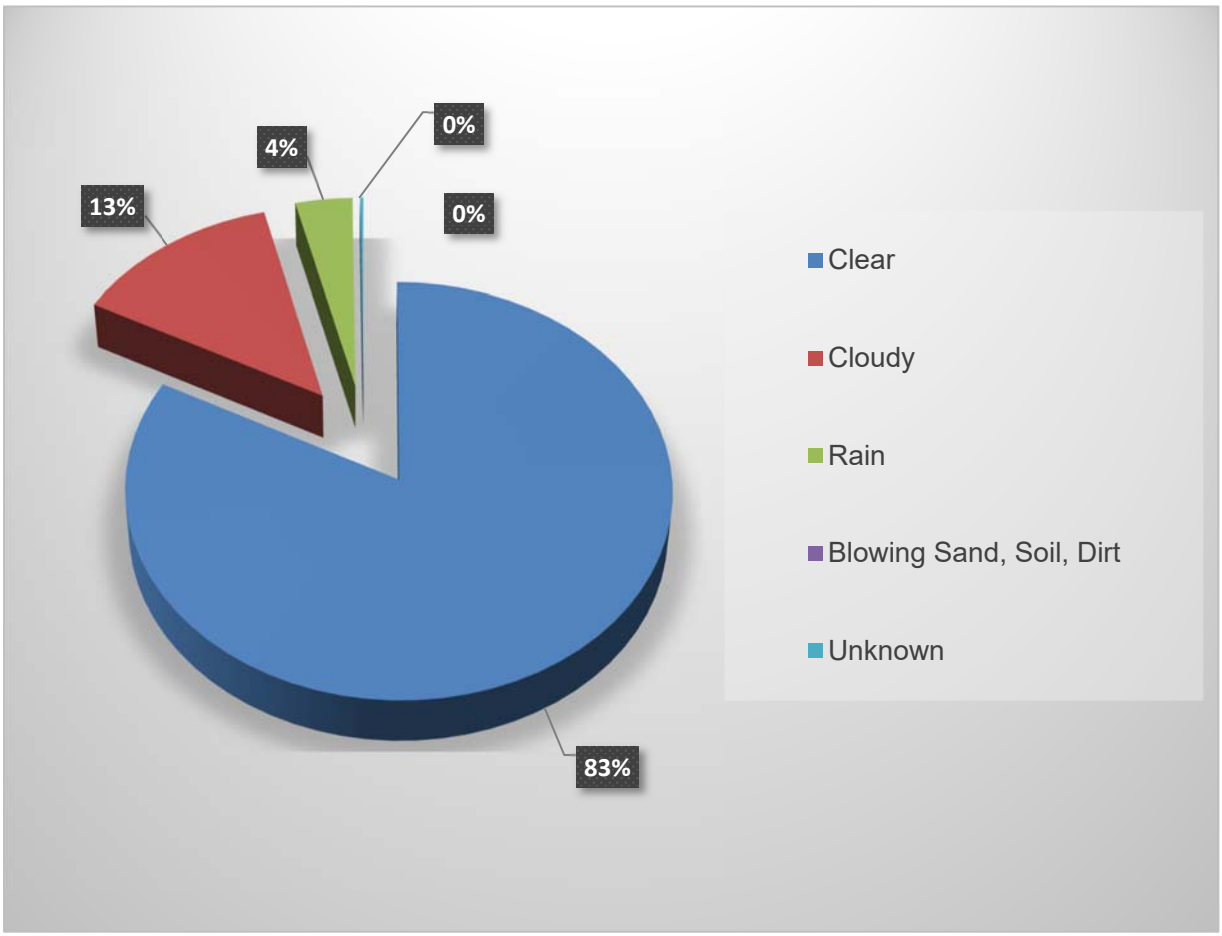
- Flash floods (Dangerous Roadway crossings)
- High winds
- Downed power lines
- Streets flooded with water and debris
- Fast moving deep water in channels
- Hail
- Lightning
- Dust storms
- Reduced visibility
- Mud and rock slides
- Wild fires

Table 10 Weather Related Crashes, tabulates the crashes in Pima County that may have been influenced by weather conditions. The data came from Pima County Sheriff's Department Crash Reports and in many incidents the weather may have been either a minor contributing factor or the largest single contributing factor to the crash. A common weather contributing factor is the lack of visibility brought on by rain, snow, crosswinds, dust storms etc. Drivers sometimes make the mistake of continuing on their route rather than pulling over and waiting for the visibility to improve.

Snow and ice conditions are harder for the motorist to deal with since the ice could be practically invisible and the driver may not realize the slippery situation until it is too late. The same can be said for severe crosswinds where unexpected gusts can catch a motorist by surprise.

As seen in Figure 17 inclement weather does not correlate to an inordinate number of crashes.

Figure 17 Crashes by Weather Type 2015



Code #	Weather Description	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	Clear	2925	3016	3203	3379	3548	3497	3410	3429	3327	2615	2720	2415	2431	2321	2082	2064
2	Cloudy	379	443	369	423	475	492	435	417	320	289	303	215	231	254	215	333
3	Sleet, Hail (freezing rain/drizzle)			17	2	1	2	1					1		3		1
4	Rain	185	264	101	197	227	138	130	153	119	84	114	72	57	58	70	91
5	Snow	7	5	3	2	2		4	14	5	3	2	5	3	7		8
6	Severe Crosswinds	12	8	3	1	4		2	3	2	2	1		2	1		
7	Blowing Sand, Soil, Dirt	1		5	1	2	1	4	1		1	1	1	1	2	1	
8	Fog, Smog, Smoke		4	8	3	2	1	1	12	3			6		1		3
9	Blowing snow																
97	Other										1	1	3		1		
99	Unknown										11	12	9	17	27	9	5

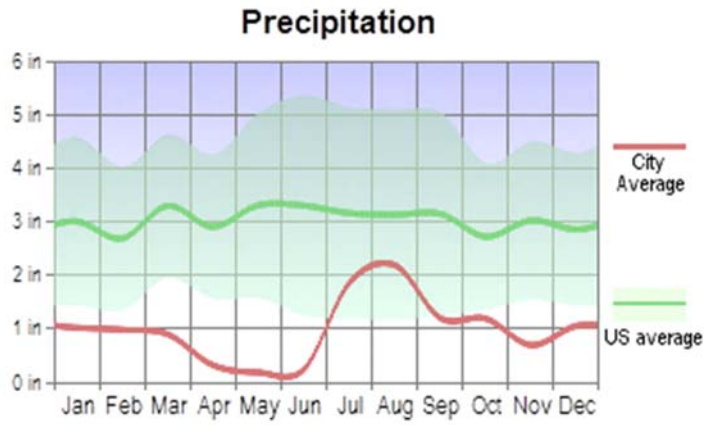
Table 10 Weather Related Crashes 2000-2015

Monsoon Season/Flash Flooding

The most serious weather related danger to motorists in Pima County is flash flooding from the summer monsoons. Brought on by temperatures in excess of 100 degrees Fahrenheit, the monsoon season can begin any time from mid-June to late July. It typically continues through August and sometimes into September. During the monsoon, the humidity is high compared to the rest of the year. It begins with clouds building in the early afternoon followed by intense thunderstorms and rainfall, which can cause flash floods due to the torrential rain and fast runoff. A flash flood is a rapid rise of water in a street, wash crossing or low lying urban area. Flash flood damage and fatalities tend to occur in areas immediately adjacent to washes, arroyos, drainage channels and street crossings. Large areas of the County do not have storm drains, so monsoon rains flood the main roadways, usually for no longer than a few hours which is long enough to trap an unwary motorist.

Arizona traffic code Title 28-910, the so-called "Stupid Motorist Law", was instituted in 1995 to discourage people from entering flooded roadways. If the road is flooded and a barricade is in place, motorists who drive around the barricade can be charged up to $2000 for costs involved in rescuing them. Despite all warnings and precautions, however, three Tucson drivers drowned between 2004 and 2010.

Pima County has over 475-roadway flood crossings of local, minor and major roadways. Despite warning signs and placement of barricades at some sites by Pima County Maintenance & Operations Division, each year's major rain events generate a number of river rescues. These incidents result in both vehicle property damage and injuries to motorists and rescuers. Several sites have multiple documented river rescues.



Twenty-seven locations were identified from a list generated by the Pima County Sheriff's Department and the PCDOT Maintenance & Operations Division. These incident sites were evaluated for consideration of higher level warning devices consisting of solar powered flashing beacons. FHWA Report FHWA-SA-08-011 Desktop Reference for Crash Reduction Factors, page 36, rates the installation of flashing warning beacons as advance warning devices for all accidents with a potential 25-27% crash reduction factor. Five locations were considered as possible locations:

- Overton Road @ La Cholla Blvd
- Wilmot Road @ Sahuarita Road
- Manville Road @ Brawley Wash
- Ft. Lowell Road @ Melpomene Way
- Mark Road @ Jeffrey Road

It only takes two feet of flowing water to sweep most vehicles downstream. Low profile vehicles can be moved even easier.

However, after further consideration it was decided to stay with the current static warning approach. A higher level warning device may be too costly, not only to install, but also to operate. Cost and liability concerns related to vandalism were factors as well.

Roadways in Pima County to avoid during Rain/Flood Events (As posted on the Pima County Website)

• Andrada Road east of Wentworth Road
• Avra Valley Road (all)
• Camino de Oeste from Gates Pass Road to Sweetwater Drive
• Camino Loma Alta at the Rincon Creek
• Camino Verde from Valencia Road to Bilby Road-Black Wash
• CDO Wash at Wilds Road in Town of Catalina
• Contractor's Way (all)
• Country Club Road at the Franco Wash
• Drexel Road just east of Alvernon Way
• Freeman Road between Broadway and Old Spanish Trail
• Ft. Lowell Road from Conestoga Avenue to Melpomene
• Gates Pass Road (all)
• Harrison Road at Pantano Wash
• Houghton Road between Andrada and Sahuarita Road
• Ironwood Hills Drive from Shannon Road to Camino de Oeste
• Kinney Road (all)
• Limberlost Road from Soldier Trail to Homestead Avenue
• Manville Road between Reservation Road and Avra Road
• Mark Road from Jeffery Road to Los Reales Road
• Mission Road from Drexel Road to San Xavier Roads
• Old Spanish Trail Road from Jeremy Wash east to Camino Loma Alta Road
• Old Vail Connection Road at the Franco Wash
• Overton Road at Cañada del Oro Wash
• Pump Station Road (all)
• Rinconada Road south from Andrada to Sahuarita Road
• River Road from Sabino Canyon Road to First Avenue
• Sahuarita Road between Houghton Road and Country Club Road
• Sandario Road (all)
• Silverbell Road from Sweetwater Road to Ina Road
• Snyder Hill Road (all)
• Snyder Road from Kolb Road to Sabino Canyon Road
• Soldiers Trail from Limberlost Road to Thunderbird Trail
• Summit Street at the Franco Wash
• Sunset Road from Camino De Oeste to Saguaro National Monument
• Tangerine Road from the Santa Cruz River to Sweetwater Drive
• Tanque Verde Loop from Tanque Verde Road to Speedway
• Tanque Verde Road from Houghton Road to Redington Pass

• Valencia Road from Ajo Way to Black Wash ¼ miles East of Camino Verde
• Wentworth Road (all)

Dust Storms (Haboobs)

Haboobs are dust storms caused by strong winds flowing downward and outward from thunderstorms. An upward motion on the leading edge of the gusty winds and turbulent motions within the strong winds stirs up the dust into a cloud several thousand feet high. This then creates images of huge walls of dust in the southwestern United States, particularly Arizona. Visibility can be reduced to near zero in a matter of seconds making Haboobs a huge threat to motorists and resulting in the potential for deadly roadway crashes. The strong thunderstorm winds that cause haboobs can also cause tree damage and knock out power.

A dust storm or Haboob approaches Tucson.

Due to the hazards produced by haboobs, the National Weather Service issues dust storm advisories and dust storm warnings to warn the public when one is in progress. If you encounter a dust storm, pull off the road immediately and place your vehicle in PARK, turn headlights and taillights off, and take your foot off the brake. This is because other vehicles may try to follow your taillights, causing them to potentially crash into your vehicle from behind.

Snow and Ice Conditions

Winter weather preparation in Pima County is minimal compared to areas up north; nonetheless, PCDOT does its part to aid driver safety by treating county roads and local bridges with specialized chemicals. In addition, PCDOT has crews on call and ready to address winter weather events, including road closures and snow clean up, and pre-positions snow equipment at the Mt. Lemmon yard for easy access during storm events.

General Hitchcock Hwy to Mt. Lemmon

Anticipating storms, DOT pretreats higher elevation highways, such as the General Hitchcock Highway leading up to Mt. Lemmon, with a chemical freezing point suppressant that includes magnesium chloride. Magnesium chloride helps to prevent the ice bond, allowing snow plows to clear the roads more efficiently. Transportation crews also apply this same anti-icing material to local bridges for the forecasted overnight freezes, each treatment will last several days, sometimes up to one week.

3. SMS Program Accomplishments

HAWK Program

In 2000, the city of Tucson, AZ, developed the High Intensity Activated Cross WalK (HAWK) pedestrian crossing beacon to mitigate the multi-lane/multi-threat crash. The design assists pedestrian crossings, especially for major arterials at minor street intersections. The purpose of a HAWK is to stop vehicles to allow pedestrians to cross the roadway and then permit drivers to proceed as soon as the pedestrians have passed. This application provides a pedestrian crossing without signal control for the side street because signal control on the side street can encourage unwanted additional traffic through the neighborhood. Now an approved traffic control device, the HAWK and its use and operation are detailed in Chapter 4F of the Manual on Uniform Traffic Control Devices (MUTCD).

HAWK Projects in the Design Phase in 2015

PC Project #	Project Location
4RTPAM	Palo Verde Milton and Alvord HAWKS
4TAEGH	Tanque Verde at Emily Grey JHS HAWK
4TASHH	Bowes Rd at Vallarta/Sabino HS HAWK
4TAMAC	Mary Ann Cleveland at Kush Canyon, Cienega HS

Intersection Safety and Operations Program

Beginning in 2014, the County began reviewing unsignalized intersections in the unincorporated rural or semi-rural Pima County areas. The focus being intersection candidates for a roundabout, signal or all-way stop. These intersections were judged to need improvements to address crash (observed or potential) and peak time delay issues. Included in this program were operational issues that had been identified on previous studies and complaints. Some of these candidate locations already had a signal or an all-way stop. In 2015, 30 intersections were analyzed for signal/roundabout criteria. The County reviewed these locations for observed crashes and ranking in the Safety Management System (SMS) report. Additionally, Consideration for present crashes was also evaluated.

Crashes are random and rare events, especially fatal and serious injury crashes, so they are highly subject to a statistical concept called the regression to the mean. Regression toward (or to) the mean is the phenomenon that if a variable is extreme on its first measurement, it will tend to be closer to the average on its second measurement—and if it is extreme on its second measurement, it will tend to have been closer to the average on its first.

Regression to the mean is the natural variation in crash data. If the analyst does not account for regression to the mean, a site might be selected for study when the crashes are randomly high

or overlooked when the site is randomly low. Hence, the fact that one location has a higher ranking or a lower ranking is not necessarily a measurement that one is more or less safe. Rather, it is an indication that crashes are happening and are in need of study. Locations with similar characteristics should be studied at the same time, even if the similar locations have not generated a similar amount of crashes. All conventional cross or 3-way, "T", intersections, for example, have a potential for crashes due to the number and type of conflict points at them.

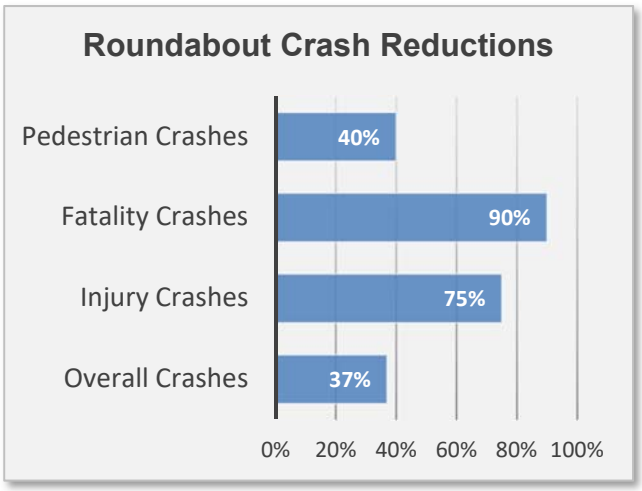
TED prepares a traffic signal warrant analysis for each intersection and narrowed the list of potential projects based on traffic volumes, turning movement volumes, and other considerations. Once the list was narrowed down, cost estimates were produced for a roundabout, signal or other improvement. At selected locations the County conducts traffic model analysis (using Synchro software) of the signal, roundabout and all-way stop alternative to compare in terms of delay. Additionally, at some selected locations the County uses a life-cycle-cost modeling tool (developed by the Virginia Department of Transportation) to compare the life cycle cost of a roundabout vs. a signal. Concept drawings were prepared for the short list of candidate projects.

Roundabout Benefits

Improve safety

Numerous studies have shown that roundabouts are much safer than traditional stop sign or signal-controlled intersections. Roundabouts reduced injury crashes by 75 percent at intersections where stop signs or signals were previously used for traffic control, according to a study by the Insurance Institute for Highway Safety (IIHS). Studies by the IIHS and Federal Highway Administration have shown that roundabouts typically achieve:

A roundabout prevents this typical intersection crash.



Source: Federal Highway Administration and Insurance Institute for Highway Safety (FHWA and IIHS)

- 37% reduction in overall collisions
- 75% reduction in injury collisions
- 90% reduction in fatal collisions
- 40% reduction in pedestrian collisions

There are several reasons why roundabouts help reduce the likelihood and severity of collisions:

- **Low travel speeds**—Drivers must slow down and yield to traffic before entering a roundabout. Speeds in the roundabout are typically between 15 and 20 miles per hour. The few collisions that occur in roundabouts are typically property damage only and cause few injuries since they occur at such lower speeds.

- **No light to beat**—Roundabouts are designed to promote a continuous, circular flow of traffic. Drivers need only yield to traffic before entering a roundabout; if there is no traffic in the roundabout; drivers are not required to stop. Because traffic is constantly flowing through the intersection, drivers don't have the incentive to speed up to try and "beat the light," like they might at a traditional intersection.

- **One-way travel**—Roads entering a roundabout are gently curved to direct drivers into the intersection and help them travel counterclockwise around the roundabout. The curved roads and one-way travel around the roundabout eliminate the possibility for T-bone and head-on collisions.

Reduce delay, improve traffic flow

Contrary to many peoples' perceptions, properly designed roundabouts move traffic through an intersection more quickly and with less congestion on approaching roads. Roundabouts promote a continuous flow of traffic. Unlike intersections with traffic signals, drivers don't have to wait for a green light at a roundabout to get through the intersection. Traffic is not required to stop, only yield, so the intersection can handle more traffic in the same amount of time.

Studies by Kansas State University http://www.ksu.edu/roundabouts/ measured traffic flow at intersections before and after conversion to roundabouts. In each case, installing a roundabout led to a 20 percent reduction in delays. Additional studies by the IIHS of intersections in three states found that roundabouts contributed to an 89 percent reduction in delays and 56 percent reduction in vehicle stops.

Camino Del Sol and Continental Rd roundabout

Less expensive

The cost of building a roundabout and a traffic signal is often very comparable. Where long-term costs are considered, roundabouts eliminate hardware, maintenance and electrical costs associated with traffic signals, which can cost between $8,000 and $10,000 per year.

Roundabouts are also more effective during power outages. Unlike traditional signalized intersections, which revert to a four-way stop or require law enforcement to direct traffic, roundabouts continue to function with traffic the same exact way as under normal conditions.

Less space

A roundabout may need more property within the actual intersection, but often take up less space on the streets approaching the roundabout. Because roundabouts can handle greater volumes of traffic more efficiently than signals, where drivers may need to line up to wait for a green light, roundabouts usually require fewer lanes approaching the intersection.

In 2009, Pima County and RTA constructed a roundabout at Camino Del Sol and Continental Road in Green Valley. Safety has improved dramatically at this location, from 12 crashes in the

five years prior to 1 property-damage-only crash in the five years following improvement. Some Green Valley residents are pleased with the roundabout and indicate that traffic operations are more efficient and the yield control is intuitive and familiar.

However, even with all of these advantages, roundabouts continue to be met by some with skepticism or hostility. When these opinions influence policy this results in an unfortunate and short sighted stumbling block in the implementation of safer, better designed intersections. The facts are that if full realization of safer roads is to be achieved, roundabouts are a necessary part of our roadway network.

Photo Enforcement Camera Program

From 2008 to 2014, Pima County used Photo Enforcement Cameras (PEC) in an effort to control and reduce speeding. The cameras photographed speeding drivers and sent tickets directly in the mail based on their license plate. Vehicle data was compiled and it was determined in February 2013 the program demonstrated in some areas that it was successful in reducing speeding. The data suggested that speeds were reduced, although the differential was small between the before and after data of the PEC installation. The La Cholla location had a network of PEC stations and signals. This network did result in a lower crash rate. Other locations did not have a similar network implementation, and those locations yielded less favorable results. In 2014, Pima County ended its contract with American Traffic Solutions for Photo Enforcement Cameras. The City of Tucson ended their PEC program a year later with the passing of Proposition 201.

Pima County Speed Management Strategic Initiative (PCSMSI)

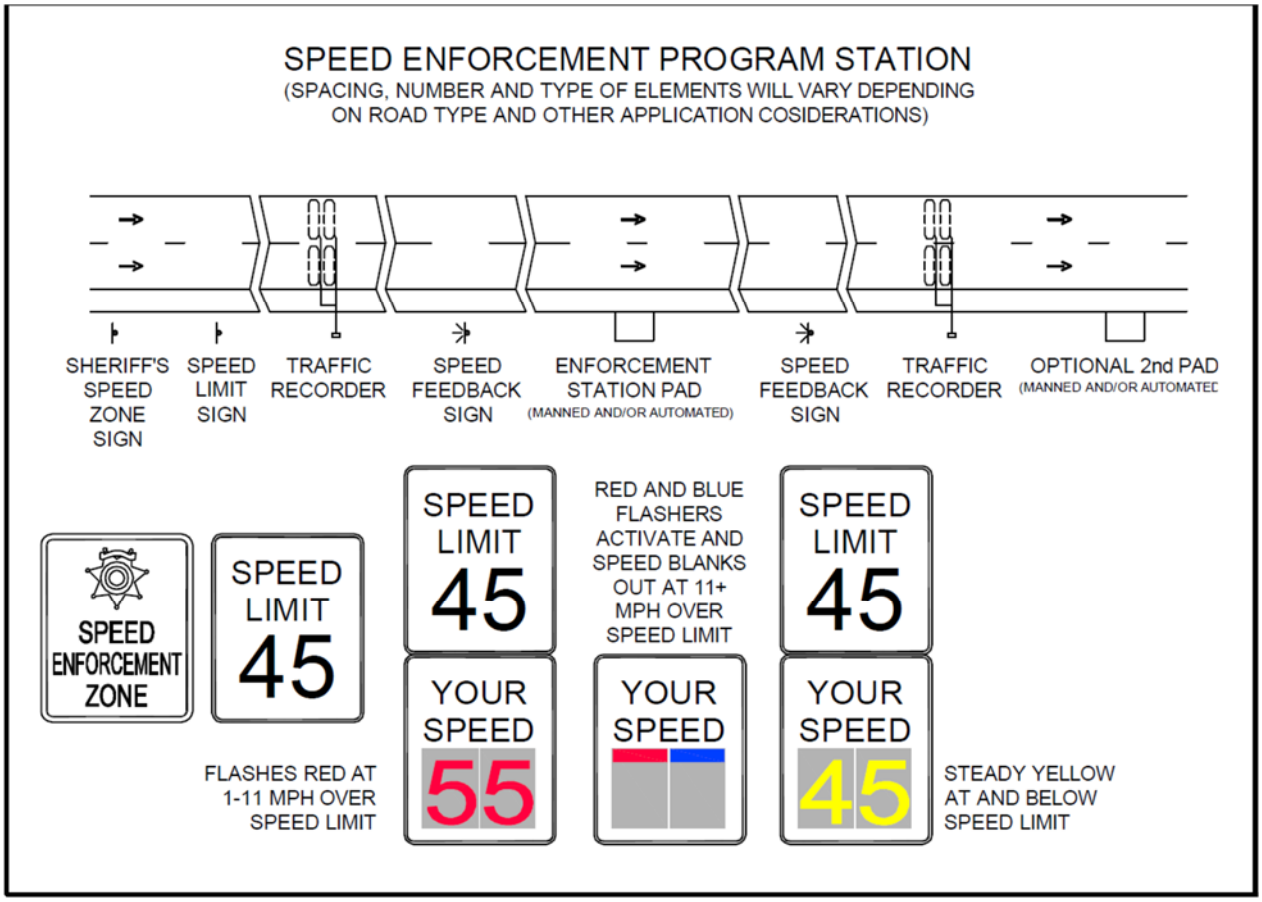
In the time since the Photo Enforcement Camera Program was cancelled, the County has started the Speed Management Strategic Initiative (SMSI) to address speeding. This was done per the request of the County Board of Supervisors.

With the Charter approved in January 2015, this program will measure the effectiveness of speed management within the three-mile corridor between Shannon and Oracle Roads along Ina Road. Pima County will use a combination of education, enforcement and engineering to reduce speeds and therefore hopefully reduce speed related crashes. Primary study components include installations of mid-block test stations consisting of advance warning signs, radar speed feedback signs, and pullout stations for motor patrol enforcement.

The measures of effectiveness will include before and after speed studies, before and after corridor time/delay study, before and after crash studies. The study consultant will provide recommendations on the effectiveness of the technique and a list of possible locations for future installations. Optimum results would include reduction of speeds, management of speeds to near posted limits, no net loss in travel time delay, reduction of crashes and severity both within the mid-block segments and at the intersections (leading to a possible tool for reduction of rear end and sideswipe crashes).

Safety literature such as the USDOT's DOT HS 809 924 Report on Speed Management Strategic Initiative, point out that speed is a factor in one third of all fatal crashes and contributes an

estimated 18% of the total cost of crashes. Drivers who decide to drive faster are accepting a higher probability of a crash, injury or even death in exchange for a shorter trip time. The driver's decision may not adequately consider the risk this choice imposes on other road users. The proposed study looks at the combination of proven speed management tools, including advance warning and enforcement to force traffic to maintain speed within a corridor. The study postulates the managed speed will result in reduced crash rates, reduced severity, without significant reduction in travel delay times.



This study goes one-step beyond the NHTSA initiative of 2005 and the COATS study of 2010 (effective location of radar speed feedback signs), or the test case in Addison County Vermont in 2013 (effectiveness of radar speed feedback signs), by adding travel/delay study, motor patrol enforcement and possible photo enforcement for positive speed management of a corridor. This study is in line with some of the suggested methodology that brought forward at the AZSHSP Safety Summit on November 6, in Task Forces 4 (Speeding and Aggressive Drivers) and Task Force 10 (Special Traffic Zones). The proposed study will supply a data driven approach to PCSD's observations of the speed management achieved by the combination of traffic signals and midblock photo radar locations along River Road.

Roadway Departure Safety Implementation Plan (RDSIP)

In 2012, the Federal Highway Administration (FHWA), in collaboration with ADOT, developed the Roadway Departure Safety Implementation Plan (RDSIP) for Arizona. The RDSIP is in an effort to help prevent occurrence and reduce the severity of roadway departure crashes. Currently ADOT is in the process of systematically implementing low-cost countermeasures on state highways and then eventually local roadways.

FHWA defines a road departure crash as a segment crash that occurs after a vehicle crosses either an edge line or centerline, and leaves the traveled way. An FHWA study determined that 66% of the fatalities on ADOT highways result from road departure crashes; Arizona has become an FHWA focus state for roadway departure fatalities.

Using crash data from 2004-2008, Arizona RDSIP identified low-cost countermeasures for both state highways and local roadways to reduce roadway departure fatalities. The FHWA's recommendation for low-cost countermeasures for Arizona local roads include:

- Centerline and Edge line/Shoulder Rumble Strips and Rumble Stripes
- Alignment Delineation

ADOT and its consultants (AMEC and HDR) have reviewed the RDSIP and have selected rumble strips (centerline and edge line/shoulder rumble strips) as a first countermeasure for implementation. The intent is to deploy them systematically to the ADOT roadways first and then to include local roadways in a later phase.

In 2015, Pima County submitted a prioritized list of 760 miles of roadways that could be candidates for road departure countermeasures. According to the ADOT Project Manager, there are no anticipated projects for Pima County in 2016. ADOT has implemented three rumble strips projects on the state highway system and is starting with Pinal County as the first local project within the RDSIP program.

Neighborhood Traffic Management Program (NTMP)

The Neighborhood Traffic Management Program (NTMP) improves the character of neighborhoods by reducing speeding vehicles and helping to reduce the likelihood of cut-through traffic. Residents may collaborate with Pima County to modify neighborhood streets with traffic calming techniques such as traffic circles, speed humps, traffic islands, and bump outs.

History

Over the years, PCDOT has received hundreds of requests from residents living on local residential streets to address two traffic operational and safety concerns; the most common request is to reduce the speed of traffic (which in some cases is traveling 10 to 15 mph above the 25 mph posted speed limit), the second request is to reduce the number of motorists using particular local residential streets to bypass congestion on the arterial street system ("cut-through" traffic).

Other communities in Arizona and throughout the United States have successfully addressed these problems using neighborhood traffic management programs. In January 1997, the Pima County Board of Supervisors approved the creation of NTMP for the unincorporated area of Pima County.

The purpose of this program is to establish the conditions under which PCDOT and the residents of individual neighborhoods or streets will work cooperatively to develop and finance roadway improvements to resolve or mitigate traffic operational and potential safety problems on local residential streets with posted speed limits of 25 mph. Since 1997, PCDOT has installed approximately 500 Speed Humps throughout Pima County neighborhoods. Table 11 lists the installations that were either completed or active in the process in 2015.

Table 11 NTMP for 2015

Project Number	Subdivision	Street	Status	Date Completed	Speed Humps
40N139	Wildwood Park Subdivision	Cinnamon Drive	Active		

Public Participation

To participate in this program, a neighborhood must:

- Be located in an unincorporated area of Pima County
- Have paved roads maintained by Pima County
- Have a posted speed limit of 25 mph

Basic Program Procedures

1. Request a NTMP information packet. The initial packet contains information about the program, traffic calming, and costs to the neighborhood.
2. After reviewing the initial packet, meet with your neighbors and discuss the information provided. The whole neighborhood must be involved.
3. Set up an initial neighborhood meeting with the PCDOT Traffic Engineering Division. At this meeting, the NTMP is explained in detail.
4. To proceed, circulate petitions given out after the first meeting. At least 60% of the property owners in the traffic input benefit area must show an interest. Send the completed petitions to Pima County Department of Transportation (PCDOT). The petitions will be verified and then your neighborhood will be included in the NTMP.
5. The data collection phase will then be scheduled. This phase involves taking traffic volumes and traffic speeds, and a general review of the area.
6. Results of the data that was collected will be discussed at a second meeting. Several alternatives will be presented. These options may include traffic circles, speed humps, or other traffic calming devices.
7. The neighborhood committee will select a plan. The plan will be approved by the Deputy Director of PCDOT. A petition will be circulated requiring approval of 60% of the property owners. This petition will be validated by PCDOT.
8. Construction of the project will then be scheduled. The neighborhood will pay the contractor when the project is completed.

Dusk to Dawn Public Lighting Program

Sometimes it is desirable and useful to have roadway lighting. PCDOT makes reviews of the possibility of providing lighting, on a case-by-case basis. Typically, PCDOT will provide lighting at signalized intersections, although sometimes also at intersections that may be signalized in the future and are currently stop controlled. Lighting is also sometimes provided at marked crosswalks, or on segments of road. The lighting at signalized intersections is served through the signal cabinet; it is operated and maintained directly the signals and lighting unit. However, there are instances when it is more effective and efficient to have the electrical utility provider (e.g. Tucson Electric Power) provide lighting.

Currently, the County has a multiple-year contract with Tucson Electric Power Co (TEP). This Contract provides PCDOT with the capacity for the installation, operation and maintenance of dusk-to-dawn lighting within PCDOT right of way by TEP.

Pima County added two lights at the intersection of Mona Lisa and Magee to replace the lighting that was removed during the Capital Improvements project and was missed for replacement by the capital improvement plan (CIP) project that rebuilt Magee.

Dusk to Dawn lighting was examined for several potential locations, but none were installed. The following sites were evaluated:

1. Colossal Cave Road - On hold until CIP construction has been completed.

2. Curtis Road west of La Cholla – Lighting along the park and sports complex area

3. Sahuarita & Wilmot – Evaluated but too costly at this time to install due to the unavailability of power. It is anticipated that the Wilmot Road CIP project may enable the possibility of lighting at this intersection to be revisited.

4. Harrison/Bush Hill – evaluated and added to the list

Pima County School Sidewalk Needs Study

In 2014 TED Studies Section performed a system wide inventory of all the schools within unincorporated Pima County. The assessment focused on the determination of which schools had desirable sidewalk/pathway accommodations and which were in need of said accommodations. School classification and functionality were determined and each location was assessed utilizing aerial orthophotos and site visits. There were 105 schools in total with 71 public schools and 34 private/charter schools. At the time the inventory was made, there were 9 high schools, 17 middle schools, 44 elementary schools, and 35 mixed-grade schools. Of the 105 schools, 52 schools were found to have adequate or better Safe Route access and 53 schools were in need of additional accommodations.

Based on the inventory, some additional work was done to further refine the potential need and what might be done to prioritize it in that specific area and within the County as a whole. Results of this work for each District in Pima County are shown in the table below. This list should be considered preliminary. Additional work is needed, not only in assessing the need, but in determining if funding might be developed or found to meet the need. Currently there is little funding available.

Table 12 Pima County School Sidewalk Study

Crashes[6]	School	District	Sidewalk Needed (ft.)
5	Walker Elementary School	Amphitheater	900
11	**Valley View Preschool**	Catalina Foothills	1,700
2	Canyon View Elementary School	Catalina Foothills	2,500
2	Orange Grove Middle School	Catalina Foothills	1,900
1	Manzanita Elementary School	Catalina Foothills	2,000
1	Continental Elementary School	Continental	1,000
2	Centennial Elementary School	Flowing Wells	400
1	Homer Davis Elementary School	Flowing Wells	1,500
2	Hendricks Elementary School	Marana	2,100
1	Quail Run Elementary School	Marana	1,500
1*	Mountain View High School	Marana	1,250
2	Summit View Elementary School	Sunnyside	1,900
2	Chaparral Middle School	Sunnyside	800
5	Pistor Middle School	Tucson	4,075
3	St. Elizabeth Ann Seton Catholic School	Tucson	600
2	Valencia Middle School	Tucson	4,100
2	Robins Elementary School	Tucson	500

[6] Restricted to crash types which may threaten pedestrians, such as roadway departure crashes or loss of control crashes.

Crashes[6]	School	District	Sidewalk Needed (ft.)
1*	Johnson Primary School	Tucson	1,200
1	Sabina High School	Tucson	600
1	**Collier Elementary School**	Tucson	500
1	Miller Elementary School	Tucson	400
3	Old Vail Middle School	Vail	1,800
2	Cienga High School	Vail	3,300
1	Acacia Elementary School	Vail	1,350
1	Corona Foothills Middle School	Vail	1,000
7	Tucson Hebrew Academy	Private	1,400
2	Kino School	Private	1,650
2	Khalsa Montessori School	Private	1,450
1	Al-Huda Islamic School	Private	600
1	Lamb Gate Christian School	Private	500

Crash Data period 1/1/2005 to 12/31/20014
Crash types: fixed object, out of control, pedestrian or animal
* Denotes pedestrian injury
Bold denotes non-pedestrian fatal or incapacitating injury crash

Safe Routes to School (SRTS)

In July 2005, Congress passed federal legislation, as part of SAFTEA-LU that established a National Safe Routes to School (SRTS) program to help improve safety on walking and bicycling routes to school and to encourage children and families to travel between home and school using these modes. The SRTS program provides a tool for communities to make walking and bicycling to school a safe and routine activity.

Incorporated locally by Pima County Ordinance 2009-98 in 2009, SRTS is a multi-faceted program administered by TED which includes educational programs as well as attempts to acquire funding for design and construction of sidewalks, bike lanes and pathways for schools within the County.

Pima County currently conducts a pedestrian safety education campaign in participating elementary and middle schools as part of their SRTS program. Each year, Pima County staff works with an average of 45 schools, providing information and safety education and training to more than 2,400 students.

Additionally, the program attempts to engage parents, teachers, school staffers, transportation officials, law-enforcement officers and school district officials to identify the travel habits of students and develop desirable routes for students to use while walking or bicycling to school. Possible facility improvements, such as the addition of bicycle racks or sidewalk ramps, are identified. Training programs are implemented for teachers and school staffers, along with possibility of enhanced law enforcement measures. Educational and promotional materials reinforce the message of pedestrian and bicycle safety. Information about the program can be found at the Pima County Safe Routes to School webpage.

Table 13 SRTS Infrastructure Activities for 2015

Location	Scope	Progress
Coronado Middle School	Separated Pathway	Construction Completed
Centennial Elementary School	Bicycle and Pedestrian Enhancements	Construction Completed
Manzanita Pedestrian Path	Separated Pathway	Construction Completed
Homer Davis Elementary School	Bicycle and Pedestrian Enhancements	Construction Completed
Mary Ann Cleveland Way and Colossal Cave Road	Added six ft. paved shoulders	Construction Completed
Summit View Elementary School	Separated pathway	Study Started
Old Vail Middle School	Separated pathway	Study Started
Harrison Road/Sabino High School	Bike lane construction	Construction Completed
Mary Ann Cleveland Way	Separated Pathway	Begin Design

Pima County's Americans with Disabilities Act (ADA) Transition plan addresses ADA infrastructure needs by requiring public improvements in the Capital Improvement Program to incorporate ADA facilities in the projects. Quite often, the SRTS projects incorporate ADA changes because they are addressing pedestrian infrastructure (a useable/accessible route, sidewalks, curb ramps, pathways, paved shoulder, etc.)

Go Bike! Bike Safety and Education Program

Pima County SMS provides Bicycle Safety Educators to educate children and adults in the use of bicycles. SMS activities also include planning studies and safety outreach events.

Pima County also produces Bicycle Safety Maps indicating routes, construction projects, and laws. These maps are distributed to bike shops, libraries, outreach events, safety classes, bike rodeos, schools, visitor destinations, etc. This program also produces and develops safety brochures/newsletters on safety factors and projects that affect cyclists (e.g., wrong-way riding, lack of helmet use, lack of bike lights, cell phone use while riding.

Pima County Bicycle & Pedestrian Programs

The Pima County Bicycle and Pedestrian Program is about planning and improving bicycle and pedestrian facilities throughout unincorporated Pima County with the goal of improving safety and access for walkers and cyclists. These efforts include enforcement, encouragement, and evaluation.

This program works in partnership with the Tucson-Pima County Bicycle Advisory Committee, Brad P. Gorman Memorial Bikeway Fund, Pima Trails Association, Pima County Department of Environmental Quality, (PAG), City of Tucson, ADOT, Greater Arizona Bicycling Association, Perimeter Bicycling Association, and other interested.

Pima County is working with other communities to develop “The Loop”, a multi-use facility around metro Tucson, with links to Marana, Oro Valley, and South Tucson and over 100 miles of shared-use path completed. Once the Loop is finished, it will total 131 miles.

With the “Bike Buddy” Program Pima County sponsors, a number of different bike safety classes including classes designed specifically for children and university students. The L.A.B. (League of American Bicyclists)` cycling instructors conduct all classes and provide free bike safety items such as helmets, bike lights, bells, and u-locks with participation.

Bicycle diversion classes are reserved for persons receiving a traffic citation while riding their bike. The City Prosecutor's Office will dismiss a cyclist's civil traffic citation if he or she submits proof of completion of the Bicycle Diversion Program safety class that offered by **EZAZ** Traffic School.

The Bike Buddy program includes personalized, one-on-one support services by experienced bicycle instructors who help people learn to ride if they were never taught as children, provide training that is more advanced for novice cyclists including youth, help folks get their bicycles in good mechanical working order, and assist individuals with finding and using bicycle routes appropriate to their abilities.

When you sign up for the Bike Buddy program, you can receive a free helmet, bicycle U-lock, front and rear bicycle lights, bike bell, and other items to help you get rolling on the roads and paths.

The Bike Buddy program can provide you with the following benefits:

• Individualized, one-on-one assistance with bike selection, bike fit, equipment and clothing suggestions
• Assistance with identifying appropriate bicycle routes for your level of comfort
• Free bike maps and safety guides for cycling in Tucson and Arizona
• Specific training for cycling on different types of bike routes and strategies to improve safety when cycling

• On-street assistance with riding preferred bike routes

• A selection of **one** out of three free items: a free helmet, set of bike lights, or U-lock

• Free bike bell

• Training on how to ride a bike if you have never learned. The program has trained hundreds of people from 5 years old to over 50 years old on how to ride a bike for the first time!

Bicycle/Pedestrian/Vehicle Intersection Conflicts Study (Strategic Bike and Pedestrian Crossing Study)

This draft study evaluates selected bicycle lane and pedestrian crossings at intersections in unincorporated Pima County. Typically those that involve a right turn lane or a ramp-like configuration. The object of the study is to evaluate these locations and then determine what, if anything, needs to be done or modified. Also, the study will have an eye for establishing consistency and for exploring how a given treatment compares to other approaches. A consultant has been hired to conduct this study.

Locations under review:

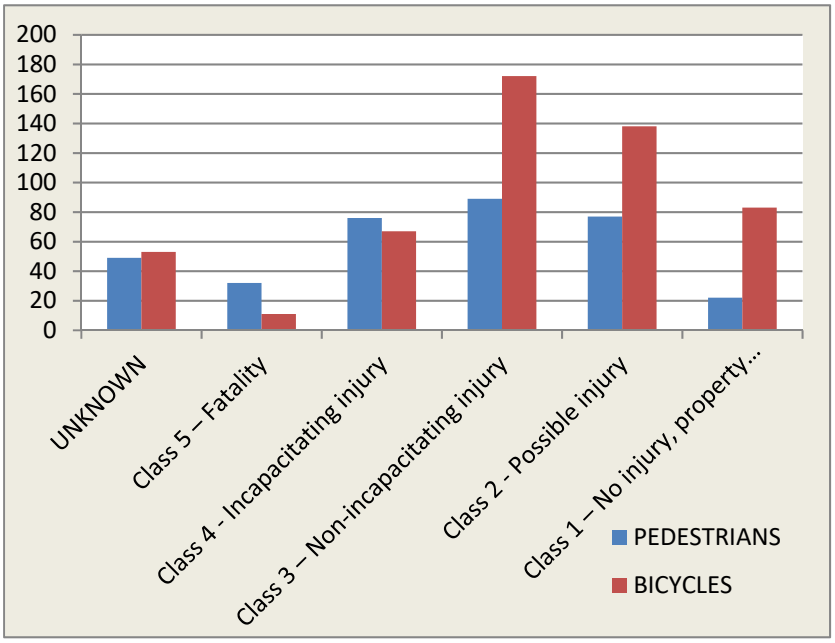
- SB Kolb Road approaching Valencia Road
- WB Sunrise Drive at Skyline Drive
- WB Sunrise Drive approaching Paseo Otono
- NB La Cholla Boulevard north of Magee Road
- WB Magee Road approaching La Cholla Boulevard
- SB Craycroft Road south of Sunrise Drive
- NB Alvernon Way at WB River Road
- NB Palo Verde Road at Alvernon Way
- NB Sabino Canyon Road approaching Kolb Road
- WB Valencia Road approaching Mission Road
- EB Ajo Way Approaching Alvernon Way

This list may be changed as the study progresses. The study is expected to conclude at some time in 2017.

10-Year Pedestrian/Bicycle/Vehicle Crash Study

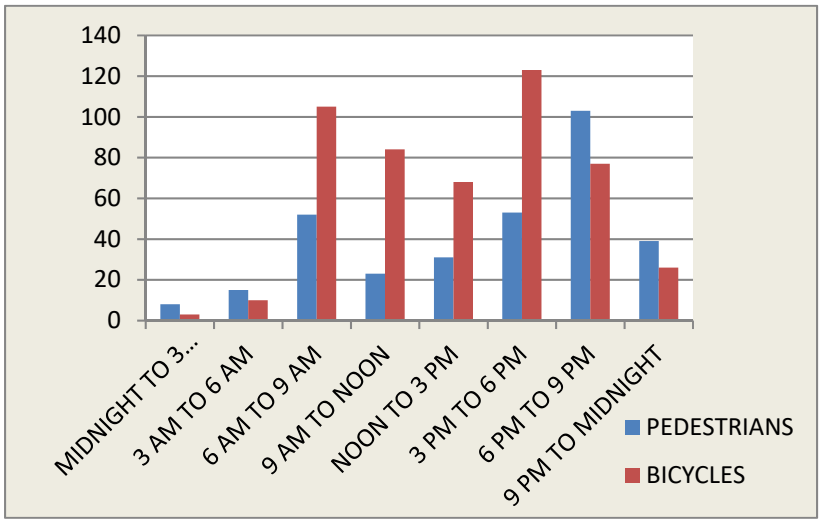
Using crash data compiled by the Pima County Sheriff's Department (PCSD) from 01/01/2006 to 12/31/2015, SMS is beginning a study to analyze the wide variety of crash factors recorded. The following is a sampling of the data examining injury severity and time of day and their influence on the crashes. Other factors analyzed include lighting conditions, alcohol involvement for driver or pedestrian, speed limits, location of pedestrian or bicyclist relative to roadway or crosswalk.

Pedestrian/Bicyclist Crash Injury Severity Chart



As shown in the adjacent chart bicycle crashes outnumbered pedestrian crashes, overall and particularly in the Class 1, Class 2 and Class 3 categories. Generally, bicycles have a much higher "exposure" to vehicles since they ride in and cross traffic lanes, whereas pedestrians typically only cross lanes.

Pedestrian and Bicycle Crashes Time-of-Day Chart



As shown in the adjacent chart bicycle crashes tend to be more prevalent from the hours of 6:00 am to 6:00 pm.

Using crash data compiled from 01/01/2006 to 12/31/2015, Pima County identified the locations with the highest number of crashes.

Ina Road, Valencia Road, and La Cholla Blvd, had the most crashes of this type during this time period.

Intersections by Number of Pedestrian Crashes 1/01/2006 to 12/31/2015

No.	Crashes	Primary Road	Crossroad
1	6	Ina Road	Shannon Road
2	5	Ina Road	Camino de La
3	4	Ina Road	La Cholla Blvd.
3	4	Valencia Road	Cardinal
3	4	La Cholla Blvd.	River Road
3	4	Flowing Wells Road	Wetmore Road
7	3	La Cholla Blvd.	Omar Drive
8	2	La Cholla Blvd.	Sunset Road

Pedestrian fatalities at intersections during this time period indicates the apparent randomness of crashes. The 138 fatalities ocurred at 112 different intersections. The highest intersection being Mission Road and Irvington Road with 5 fatalities in 15 years. Sporadic fatal crashes tend not to follow a trend or pattern related to the location. Complete rankings are shown in Table 5-12.

Roadway segment crashes were quantified and ranked according to the number of crashes, Valencia Road, Ina Road, Palo Verde Road, Flowing Wells Road and Benson Highway were at the top of the list as the roadways with the most crashes during the 10-year period. Road Safety Assessments (RSAs) were performed on Ina Road, Shannon Road to La Canada, in 2013 and Valencia Road, Cardinal Ave. to Camino De La Tierra, in 2012. These documents outlined many safety improvements that were then addressed by Pima County. Complete rankings are shown in Table 5-13.

Roadways Ranked by Pedestrian Crashes 1/01/2006 to 12/31/2015

No.	Crashes	Roadway
1	12	Valencia Road
2	7	Ina Road
2	7	Palo Verde Road
4	6	Flowing Wells Road
5	5	Benson Highway
5	5	Ruthrauff Road
7	4	Orange Grove Drive
7	4	Tetakusim Road
7	4	Wetmore Road
10	3	Avra Valley Road

Intersections Ranked by Number of Bicycle Crashes 1/01/2006 to 12/31/2015

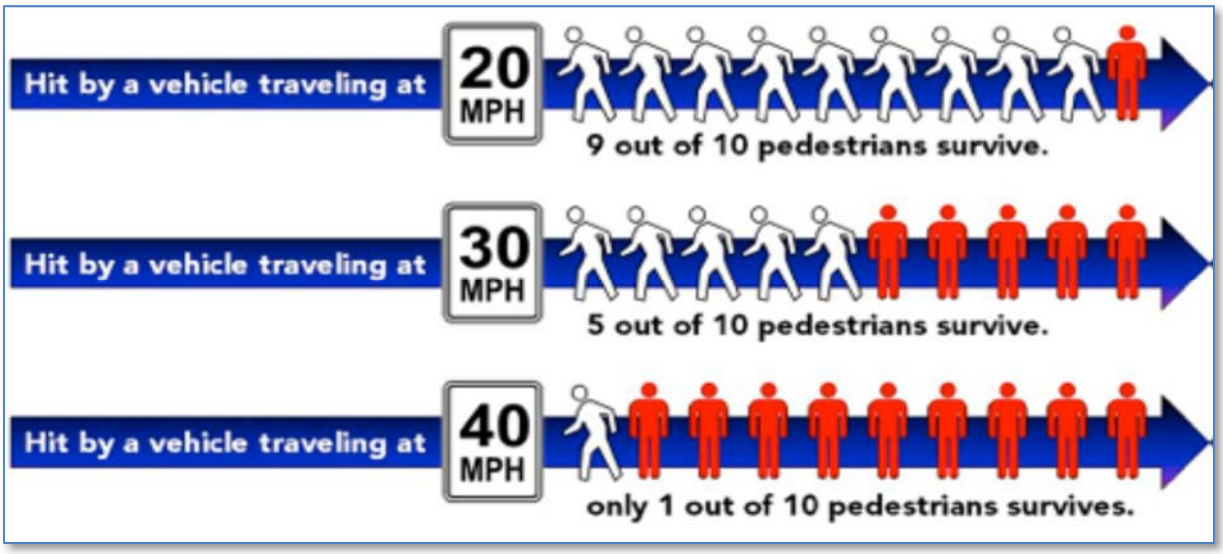
No.	Crashes	Primary Road	Crossroad
1	6	Flowing Wells Road	Wetmore Road
2	5	Hacienda Del Sol Rd	Sunrise Drive
2	5	La Cholla Blvd.	Ruthrauff Road
4	4	Ajo Way	Palo Verde Road
4	4	Camino de La Tierra	Ina Road
4	4	Ina Road	Shannon Road
4	4	La Cholla Blvd.	River Road
8	3	1st Ave/Christie Drive	Ina Road
8	3	La Cholla Blvd.	Orange Grove Road
8	3	Magee Road	Thornydale Road
11	2	1st Avenue	Orange Grove Road

The intersection of Flowing Wells Road and Wetmore Road scored the as the worst intersection for bicycle crashes in the past ten years. This intersection also ranked in third place for pedestrian crashes. This intersection warrants further analysis for possible trends or patterns to the crashes. Complete rankings are shown in Table 5-14.

The adjacent table shows the roadways by the number of crashes over the 10-year period. General Hitchcock Highway, which is a 30- mile long popular bike route with the most bicycle crashes. Ina Road, is second in pedestrian crashes is also second here. Complete rankings are shown in Table 5-15.

Roadways Ranked by Number of Bicycle Crashes 1/01/2006 to 12/31/2015

No.	Crashes	Roadway
1	18	General Hitchcock Hwy.
2	13	Ina Road
3	12	Sunrise Drive
4	11	River Road
5	8	La Cholla Blvd.
5	8	Valencia Road
7	7	La Canada Drive
7	7	Palo Verde Road
9	6	Flowing Wells Road



4. Safety Costs, Funding, Laws and the Future

Vehicle crashes have tragic consequences to those involved. Crashes also involve a quantifiable financial cost, derived from factors such as damage to infrastructure and property, delay caused by the crash or by associated repairs, and loss of income or productivity due to death or injury. There exist a number of different approaches to estimating these costs, and different methodologies vary in what costs they account for, or value placed on intangible costs (such as quality-of-life).

The Cost of Crashes

Currently PCDOT uses the cost of crashes as defined in the 2010 Arizona Highway Safety Improvement Program (HSIP) manual. The HSIP Manual is guided by the Arizona Strategic Highway Safety Plan (SHSP) that has the goal to reduce fatalities and serious injuries on public roads in Arizona. The Arizona Department of Transportation (ADOT) administers both the HSIP and SHSP.

KABCO Severity Scale*	Crash Types	Unit Cost
K	Fatality	$5,800,000
A	Incapacitating Injury	$400,000
B	Non-incapacitating. Injury	$80,000
C	Possible Injury	$42,000
O	PDO	$4,000
	Unknown	$4,000

PDO = Property Damage Only
*KABCO Severity Scale as indicated on Law Enforcement Crash Records

Crash costs by severity level were 2010 year-adjusted as part of the development of the HSIP manual. The HSIP developed these costs using the KABCO Severity scale as shown in the table. Pima County uses the unit costs shown to calculate the benefit/cost ratios for the safety improvement projects, as a tool for comparison. A cost-benefit of 1 or more is generally accepted as a “worthwhile” safety improvement, in an environment of limited resources, not all worthwhile improvements may qualifying for funding. To qualify for HSIP funding the benefit/cost ratio of the proposed project needs to be greater than 1.5.

The costs associated with transportation crashes can be very large. In 2010, The National Highway Traffic Safety Administration, NHTSA estimated the nationwide cost of crashes including economic loss and societal harm, totaled 871 Billion dollars per year. The report went on to state the majority of the crashes were attributed to speeding (24%), drunken driving (23%), and distracted driving (15%).

In the past 15 years in Pima County, there have been 55,442 reported crashes, an average of about 9 to 10 per day. Of this, total 52,690 are in the B, C, O categories, 2,356 are in A, and 396 are K severity or Fatal. Using the FHWA 2009 Comprehensive Crash Costs, the County crash cost burden from 2000 to 2015, tallies up to over $2 Billion.

Traffic Delay

Traffic delay is evident on our highways in the form of congestion, longer trip times, lengthy queues, and intersection control delay. Roadways that are over congested or carrying more traffic than their capacity exhibit higher delays. It should be noted that the majority of trip delay is not attributable to speed (at or near the posted limit), but to gridlock or stop and go conditions which are caused by not enough capacity and intersection control delay. Engineers measure delay by calculating the difference between actual trip time in congestion and the unimpeded free-flow condition. The increase in "time to traverse" can be multiplied by the Annual Average Daily Traffic (AADT), and multiplied by 365, to find the annual delay. Annual delay is representative of the total time lost due to congestion or other delay causes on a given facility.

Americans wasted $124 billion sitting in traffic in 2013…

The LOS of a facility relates to the delay experienced by vehicles traversing the facility, in either total delay for intersections, or delay per mile for roadway segments.

LOS A – Signals operating with low delay, or delays of less than 5.0 seconds per vehicle.

LOS B - Operations with delays between 5.1 and 15.0 seconds per vehicle. This LOS implies good signal timing progression.

LOS C - Operations with delays between 15.1 and 25.0 seconds per vehicle. This LOS witnesses longer signal cycle lengths and fair progression.

LOS D - Operations with delays between 25.1 and 40.0 seconds per vehicle. At this LOS, congestion is noticeable and longer delays may result from a combination of unfavorable signal progression, and traffic congestion.

LOS E - Operations with delay between 40.1 and 60.0 seconds per vehicle. Most drivers consider this LOS unacceptable. This occurs when the roadway or intersection has far greater demand than the intended capacity.

LOS E traffic delay at the N Camino De Oeste and Linda Vista Blvd. 4-way stop intersection, 11/29/2016.

Cost of Delay

The "rule of thumb" is once a vehicle is stopped it takes approximately 2 seconds more or less to get back on track for its trip. Hence there is almost always an advantage to keeping vehicles moving even if it is at a much slower speed. A moving queue is better than a stopped queue

A study commissioned by the Centre for Economics and Business Research (conducted by INRIX Inc., a traffic data and analytics company) concluded that Americans wasted $124 billion sitting in congested traffic in 2013 and congested traffic cost the average household an additional $1,700

a year. Currently, INRIX estimates the average American wastes 111 hours per year in congested traffic that generally increases each year as traffic volumes increase. It is important to note that the standard assumption for a work year is 2,080 hours. In this context, the average delay for a typical American is 5% of a full-time-job, or nearly three working weeks.

Delay Countermeasures

Roundabouts have proven to be a very valid countermeasure for intersection delay. Studies by the Insurance Institute for Highway Safety (IIHS) of intersections in three states found that roundabouts contributed to an 89 percent reduction in delay and 56 percent reduction in vehicle stops (not to mention a 90% reduction in fatalities and a 75% reduction in injury crashes). Corridors with multiple roundabouts have improved capacity and LOS to the point where additional vehicle lane construction can be postponed. The key element of the efficiency and effectiveness of a roundabout is it keeps vehicle queues moving.

Fully actuated or semi-actuated signals that are times to be demand-responsive are shown to also significantly reduce delay. Indirect left turn intersections can also reduce delay. Coordinate signals can reduce delay as well, however, this advantage can be limited if roads do not have sufficient capacity.

Crash Modification Factor (CMF)

A CMF is a statistical measure of the safety effect of a roadway characteristic changed from a default value in isolation of other changes. CMFs are used to make informed cost effective decisions regarding intersection or roadway improvements. Described in Part B of the 2010 Highway Safety Manual (HSM) CMFs are key to comparing safety countermeasures and related elements of design. In general, CMFs are a factor based on research that allows an estimation of the potential reduction in crashes of various types and severities for a future improvement project.

For example:

“Safety Effectiveness of Converting Signalized Intersections to a Roundabout” (CMF 4194 in the CMF Clearing House[7]) has a CMF value of 0.81. This means that if there are currently an average of 100 crashes per year at a given signalized intersection, if a roundabout is constructed the average annual crash rate will be reduced to 0.81 * 100 = 81 crashes, reducing the number of average annual crashes of all types and severities by 19. It is well documented that roundabouts offer significant potential for reducing crashes and injuries as compared to signalized intersections.

CMFs are based on research and are rated by the CMF Clearinghouse on a scale of 1 to 5, with 5 being the highest validity with the least amount of possible error. ADOT requires that only CMFs with a rating of 4 or higher be used when applying for HSIP funding. However, a possible inquiry is not limited by the rating system. The rating, regardless, does not determine everything. It is simply the way FHWA chooses to rate CMFs. It is often up to the engineer to take a closer look at the research on which the CMF is based in order to determine if the CMF is applicable to a given project and the reliability of the data from which the CMF is derived. Engineering judgement is often necessary when

[7] http://www.cmfclearinghouse.org/

using CMFs regardless of their rating. Crash reduction estimating factors are provided for a wide variety of countermeasures, to name a few, such as the addition of shoulders, rumble strips, left-turn lanes, right turn lanes, two-way left turn lanes (TWLTL) center medians, median channelization, speed cameras and radar speed units. The website "CMF Clearinghouse" catalogs the thousands of CMFs used throughout the country and provides their associated background research. The CMF Clearinghouse is funded by the US Department of Transportation and maintained by the University of North Carolina Highway Safety Research Center.

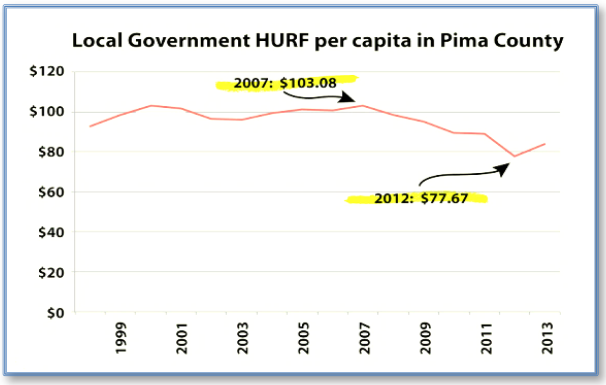
PCDOT uses CMFs in conjunction with the crash history to estimate crash reductions and calculate multiple Benefit /Cost (B/C) ratios to compare alternative improvement projects. The estimating factors used are as shown in the section on Crash Costs. The CMFs of multiple feature changes may be incorporated multiplicatively into a single improvement project.

Project Funding

The recommended roadway and safety improvements require funding sources to be implemented.

There are five major funding sources that SMS utilizes each with various funding mechanisms and programs. Here is a list of these funding sources:

- HURF Funds (Highway User Revenue Fund) — are the main source of operational funding for TED and SMS. These funds enable this Division to fund studies and maintain signs, signals, striping and smaller type improvement projects that may involve a variety of features such as guardrail, sidewalks, lighting, etc. HURF funds are generated through fuel taxes, registration fees, and motor carrier fees. HURF monies are allocated through the distribution breakdown and formulas established at the time of inception. Programs funded with HURF monies have seen reductions due to State Legislative reallocations (e.g. supplementary DPS funding), improved fuel economy, and reduced personal vehicle use during the economic downturn.

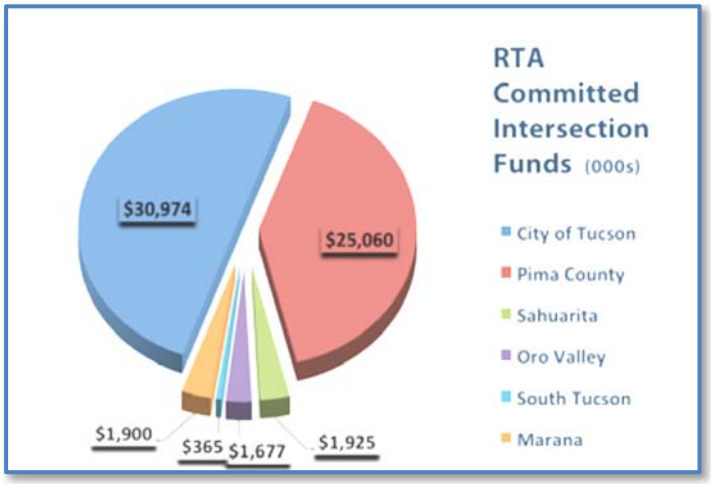


- Bonds — the November 1997 Transportation Bond created 57 different projects related to major roadway, corridor, and safety improvements. DOT-57 is the Safety Improvements Bond that has funded numerous SMS projects since its inception. But now, many of these bond projects have reached the end of the funding period and are no longer available. The Pima County bond programs authorized by voters in 1997, 2004, 2006 and 2014 are on track.

    - 1997 general obligation bond program of $257 million: Substantially Complete.
    - 1997 sewer revenue bond program of $105 million: Complete.

- 1997 transportation (HURF) program of $350 million: 81% projects complete or under construction; 84% of bonds funds spent.
- 2004 general obligation bond program of $582 million: Substantially Complete.
- 2004 sewer revenue bond program of $150 million: Complete.
- 2006 general obligation bond program of $54 million: Complete.
- 2014 general obligation bond program of $22 million: Underway.

- RTA (Regional Transportation Authority) — The Regional Transportation Authority is the fiscal manager of the $2.1 billion plan approved by Pima County voters on May 16, 2006. The RTA Board is comprised of representatives from local jurisdictions in Pima County, including the cities of Tucson and South Tucson, Pima County, the towns of Marana, Oro Valley, and Sahuarita, the Pascua Yaqui Tribe and the Tohono O'odham Nation. RTA provides competitively selected, project specific safety funds available in different categories, including Intersection, Transit Corridor Bus Pullouts, Elderly & Pedestrian, At-grade Rail/Bridge Deficiencies, and Signal Technology. A representative of the Arizona State Transportation Board also serves on the board.



RTA Plan Implementation as of 2016

	Projects Promised	*Projects Completed*
Intersection Improvements	200	163
Pedestrian Crossings	80	48
Bus Pullouts	200	108
Sidewalks	250 Miles	147 Miles
Bike Lanes	550 Miles	244 Miles
Roadway Corridors	35	11 Complete, 8 Partially

- Federal — Per MAP-21, federal monies are distributed to the State DOT, there it is administered through various programs which include, but not limited to the following: Highway Safety Improvement Fund (HSIP), Transportation Alternatives Program (TAP), and the Governor's Office of Highway Safety (GOHS). The HSIP and TAP funds are allocated through a 'discretionary' State program, but a percentage is set-aside for the Pima Association of Governments' (PAG) use in regionally significant projects. The Surface Transportation Program (STP) provides federal funding for various improvement programs including the Railroad/Highway Grade Crossing (RR) program.

All of these funding sources require applications, but some are very stringent as to the nature of the request, the back-up data required, and the amount of planning level work to allow the funds to be awarded and then released. HSIP projects require a Benefit/Cost Ratio greater than 1.5:1 to be considered for funding as well as a two-step process set by ADOT that is very tedious and time consuming. The 1.5:1 ratio is obtained by correlating the number of correctable crashes with the construction cost, per the method outlined in the ADOT HSIP Manual. Incorporating the Benefit/Cost Ratio into all SMS projects helps determine which funding source can be utilized.

Arizona/Pima County Safety Laws

States take the lead in providing safety on their road, licensing drivers, registering vehicles, and establishing and enforcing traffic laws. Different states have different priorities based on their geographical location, climate and resident's preferences. Over the years due to public sentiment (as perceived by political leadership), Arizona has focused on preserving basic personal freedoms of choice rather than vehicle safety legislation (with the notable except of DUI legislation and enforcement). In the future, politics may shift to provide more focus and priority of transportation user safety legislation with goal of placing more focus on substantive responsibility and accountability on roadway users.

An indication of the extent of Arizona safety legislation comes from Advocates for Highway and Auto Safety (Advocates), a national watch dog group for traffic safety policy. Utilizing the research done by NHTSA, the Advocates first examines state laws to determine If they provided positive results. Then Advocates examines 15 state laws in the nation and tracks which states have implemented those laws to promote transportation safety. According to Advocates, based on their January 2016 assessment, out of the 50 states and District of Columbia, Arizona ties for 48th with five out a possible 15 driving laws enacted. As a comparison, 20 States and the District of Columbia have 10 or more laws, and four states have 12 laws. Only two states, Mississippi with 4, and South Dakota with 2, have fewer transportation safety laws than Arizona.

The Advocates examines five main areas of safety legislation:

1. Occupant Protection
2. Child Passenger Safety
3. Teen Driving Graduated Driver License (GDL):
4. Impaired Driving
5. Distracted Driving

1. Occupant Protection:

Arizona requires the use of safety belts, where they are installed, by front seat occupants of a motor vehicle. However, it is a secondary enforcement state which requires the vehicle to be stopped for another "primary" offense before citing a seat belt violation. Unbuckled children under the age of eight who meet a certain height requirement are an exception and may stopped as the primary offense.

In Arizona, only motorcycle operators and riders under the age of 18 are required to wear a helmet. Additionally, all riders and operators, regardless of age, must wear protective glasses, goggles, or a transparent face shield, unless the bike is equipped with a protective windshield.

2. Child Passenger Safety:

Arizona Revised Statute 28-907 states that each passenger between the ages of 5 and 8, and is not more than 4 feet 9 inches tall, shall be restrained in a child-restraint system, or booster seat.

3. Teen Driving Graduated Driver License (GDL):

For Arizona, the teen must be at least 16 years old, have held an Arizona class G permit for at least six months. The teen also needs to complete 20 hours of supervised, behind-the-wheel daytime driving practice and 10 hours of supervised, behind the wheel nighttime driving practice — a total of 30 hours — before applying for graduated driver license.

For the first six months, a teen with a GDL cannot drive between the hours of midnight to 5 a.m. unless one of these conditions is met:

- A parent or legal guardian who has a valid driver license is sitting in the front passenger seat.
- The teen is driving to or from a sanctioned school sponsored activity, sanctioned religious activity, place of employment or family emergency.

A teen with a GDL shall not drive a motor vehicle containing more than one passenger under the age of 18 on a public highway unless one of these conditions is met:

- The passengers are the teen driver's siblings.
- The teen driver is accompanied by a parent or legal guardian with a valid driver license who occupies the front passenger seat.

4. Impaired Driving:

Arizona is a no-tolerance state for driving under the influence, or DUI, this means a driver can be arrested with a blood-alcohol content (BAC) less than the legal limit of 0.08. A standard DUI is classified as driving a vehicle with a BAC of 0.08% or more. The limit drops to 0.04%, for commercial driving and 0%, if the driver is younger than 21 years old.

a. Ignition Interlock Devices (IIDs) for All Offenders

Arizona drivers whose licenses have been suspended or revoked for certain DUI or alcohol-related traffic offenses may apply for restricted licenses. These allow them to use their vehicle with an ignition interlock device.

b. Child Endangerment

When children under the age of 15 years old are in the car, a driving under the influence (DUI/DWI) charge automatically becomes a Class 6 felony DUI charge.

c. Open Container

According to Arizona law, neither the driver nor the passengers can consume liquor or have an open container while riding in a motor vehicle on any public highway or right-of-way of a public highway in the state.

5. Distracted Driving:

There are no state direct restrictions on texting or cell phone use while driving, except for school bus drivers. In Phoenix, Flagstaff and Tucson, drivers are prohibited from text messaging. San Luis and Pima County also ban use of handheld wireless devices.

Summary

According to Advocates, Arizona is trailing other states with their safety legislation and needs the following proven laws help to minimize traffic related fatalities and injuries:

- Primary Enforcement Seat Belt Law (Front & Rear)
- All-Rider Motorcycle Helmet Law
- Graduated Driver's License (GDL) - Minimum Age 16 for Learner's Permit
- Graduated Driver's License (GDL) - 30-50 Hours Supervised Driving Provision
- (Without DE Exemption)
- Graduated Driver's License (GDL) - Nighttime Restriction Provision
- Graduated Driver's License (GDL) - Passenger Restriction Provision
- Graduated Driver's License (GDL) - Cell Phone Restriction Provision (Without S)
- Graduated Driver's License DL - Age 18 Unrestricted License
- All-Driver Text Messaging Restriction

It is unfortunate at present that there is no state process, utilizing state-wide crash data to attempt to quantify how many crashes might be prevented if these additional transportation user safety laws were enacted. In fact, the Arizona Transportation subcommittee recently reviewed a proposed bill to enact a limited motorcycle helmet law. The bill was killed in committee by an 8 to 0 vote. This was in spite of testimony by medical doctors over the consequences suffered by those involved in a crash and not wearing a helmet. Instead the committee determined it was an individual's right to not wear a helmet.

City and County ordinances that supplement State laws:

Pima County Safety Ordinances

<u>Texting while Driving</u>

10.34.020 Prohibited conduct.

May 17, 2016 Texting Ban Ordinance No. 2016- 31

A person may not, while driving a motor vehicle on a highway, manually manipulate a handheld electronic device for any purpose other than to initiate, receive, or engage in voice communication. For purposes of this section, "drive" and "motor vehicle" have the same meaning as those terms are given in Arizona Revised Statutes Title 28, Chapter 1.

(Ord. 2016-31 § 1 (part), 2016)

Bicycle Helmet Use

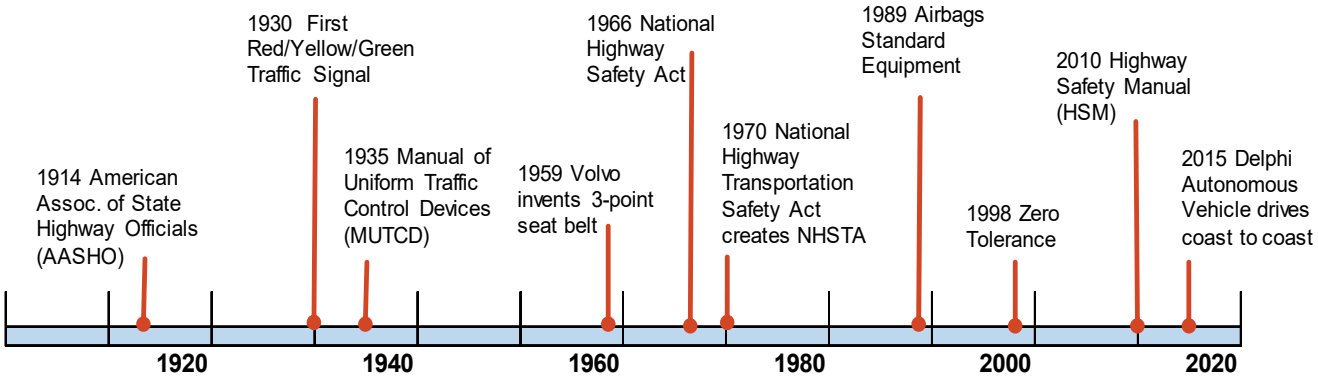
10.43.010 - Requirement for helmet use.

No person under eighteen years of age shall ride a bicycle or be a passenger on a bicycle, ride in a restraining seat attached to a bicycle, or ride in a trailer towed by a bicycle unless that person is wearing a properly fitted and fastened bicycle helmet which meets the current standards of the American National Standards Institute for protective headgear.

(Ord. 1995-12 § 1 (part), 1995)

Traffic Safety Historical Milestones

Depicted below is are some milestone events in substantive traffic safety:



One of the most important milestones in the history of automobile safety was Ralph Nader's book "Unsafe at any Speed." Published in 1965, this book details the many safety shortcomings of Chevrolet Corvair, and questions the automobile manufacturer's lack of safety features. The National Highway Safety Act was passed the very next year in 1966, that set new national standards for automobile and highway safety.

The Future of Traffic Safety – Reducing or Eliminating the Potential for Driver Error

Source: Google

Due to technological breakthroughs with sensors, navigational software and robotics, the future of traffic safety and mass mobility is full of exciting promise. The greatest advancement of traffic safety in history will occur in the next 25 years with the implementation of "drive assisted" and "driverless" vehicles. With the current advent of Advanced Driver-Assistance Systems (ADAS) and the near future of Autonomous Vehicles (AVs) also known as "driverless vehicles" high tech automobiles will revolutionize society. The complete implementation of AVs has the potential to provide the following benefits:

- Reduce crashes by 90%
- Reduce congestion and increase roadway capacity utilization
- Reduce fuel consumption/reliance on fossil fuels/greenhouse gases
- Reduce time wasted due to delay
- Reduce car insurance premiums
- Provide mobility for non-drivers
- Provide added safety for pedestrians/bicyclists
- Infrastructure changes might include reduced lane widths and smaller parking spaces

With the implementation of AVs, emphasis will possibly shift to more focus on better upkeep of existing facilities. Autonomous vehicles strictly follow Traffic laws such as speed limits and stop signs, freeing up law enforcement for more important duties. Rather than human driver error, future crash investigations will focus on software glitches, instrumentation limitations, roadway limitations or defects, and response of artificial intelligence decision making to non-motorized user behavior. According to NHTSA Traffic Safety Facts, February 2015, driver error is a factor in 94% of the current crashes.

Availability of ADAS (Advanced Driver Assist Systems)

ADAS technology, a technological step towards complete AV, is available right now. Virtually all vehicle manufacturers are now implementing many driver-assistance features in current models, with many of the features offered as standard equipment. Some of the many new driver assist features include:

- Back-up/rearview camera
- Parallel parking assist
- Lane-departure warning
- Adaptive cruise control/collision mitigation
- Blind-spot detection/side assist/collision warning
- Built-in navigation system
- Collision warning system with brake control
- Electronic suspension stability control to prevent roll-overs

- Occupant-sensitive/dual-stage airbags
- Emergency brake assist/collision mitigation
- Emergency crash response, automatic notification and vehicle shutdown

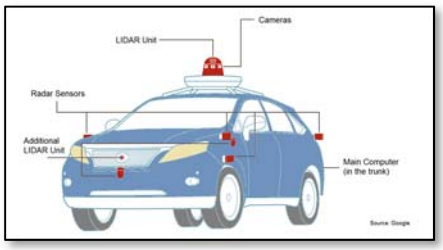
AV Current Testing Phase

Autonomous vehicles are currently being road tested by many companies including Google, Intel, Volvo, Bosch, Uber, Porsche, Tesla, Ford, Mercedes-Benz, Delphi Automotive, Nissan, Audi, Nvidia, BMW, Volkswagen, Toyota and General Motors. Many of the companies have already logged millions of miles of successful testing with relatively few crashes attributed to the AV. Whereas driver assist technology is dependent on human intervention in the case of an impending crash (such as the fatality that resulted when a Tesla autopilot system failed to brake for a truck), fully autonomous vehicles are developed with assumption that human intervention will never be the best course of action when crash avoidance is required. In Arizona, Governor Ducey established a Self-Driving Oversight Committee by Executive Order 2015-09 to promote testing and implementation of autonomous vehicles throughout the state. Because of this Uber moved their testing to Arizona. On February 21, 2017, Governor Ducey rode in an autonomous Uber Volvo in Tempe, AZ.

How an AV Operates

Different companies use different technologies, but in general all AVs use a combination of GPS positioning and sensors to gather real-time information on the surrounding environment and geographic position. Constantly spinning, the Laser Illuminating Detection and Ranging (LIDAR) units use laser beams to generate a 360-degree image of the car's surroundings, and distances are determined from the cameras that use parallax from multiple images to various objects. The cameras also detect traffic lights and signs, and help recognize moving objects like pedestrians and bicyclists. The radar sensors also measure the distance from the car to various obstacles. All the current data from the sensors is sent to the main computer that analyzes and compares the collected data with its stored maps to assess current conditions.

The main computer gathers the new information, compares it with the existing data to determine what is changing. It then adjusts the speed, applies the brakes, or turns, as required to avoid obstacles or hazards, or to maintain the selected route.



Autonomous Vehicle Issues to be Resolved

AVs have many social and technical issues to be resolved in the coming years to allow widespread utilization.

- Acceptance by the public; public confidence may take time to build
- AVs obey the posted speed limits, a large percentage of human drivers do not
- Driving around human drivers, pedestrians and bicyclists that are unpredictable
- Inclement weather obscures the sensors and reduces visibility and data collection
- Changes in the route or detours, AVs currently require a pre-mapped route
- Imperfections in the roadway such as potholes and puddles, missing signs and poorly maintained pavement markings cause misinterpretation
- Ethical and moral decisions in fringe cases of crash avoidance

5. SMS Projects

The following six objectives were established to accomplish the goals stated in Section 1:

1. **Enhance the current prioritization process**. The 2011 American Association of State Highway Transportation Officials (AASHTO) "Green Book" and the 2010 Highway Safety Manual (HSM) help define the requirements of a modern roadway safety system or program. These guidelines have enabled better statistical techniques for analyzing and responding to traffic crashes are continually developed and improved. The near-term objective is to seek to improve the current SMS prioritization process with the goal in mind to help increase the effectiveness of projects and programs. The prioritization process is a procedure to rank projects. The current SMS Project Priority List uses the following criteria to rank all safety projects

    1) Existing Level of Service
    2) Existing Daily Traffic Volume
    3) SMS Priority Index (5 years)
    4) Number of Correctable Crashes (3 Years)
    5) Flooding or Wet Pavement Condition
    6) Pima County Cost
    7) Conforms to Regional Plan (Context Sensitive)
    8) Adds Bicycle Lanes (Combined with #9, provides a Multi-Modal project)
    9) Adds Pedestrian Facilities (Bus Pullouts, Sidewalk, Ped Signals, ADA, etc.)

    The project prioritization process incorporates the use of Crash Modification Factors (CMF) to estimate quantity of correctible crashes. In the coming years the use of predictive modeling, while utilizing the methods detailed in the HSM, will allow a more systematic approach to design and alternatives mitigation. The CMFs are also used to calculate the Benefit/Cost Ratio for Safety Projects.

2. **Establish non-engineering countermeasures**. Recognizing the importance of enforcement and education in traffic safety, the SMS program identifies and implements safety projects and programs in those areas as well.

3. **Establish proactive engineering countermeasures**. This objective places emphasis on consideration of safety elements during the planning and design of new and upgraded roads as well as the operation and maintenance of existing roads. The SMS program tracks road research progress, periodically incorporates research results into the County's planning, and design processes as appropriate.

    For example TED has implemented several of the FHWA's Proven Safety Countermeasures from the *FHWA Guidance Memorandum on the Consideration and Implementation of Proven Safety Measures (07/10/2008 and 01/12/2012)*[8], including roundabouts, countdown pedestrian signal heads, Road Safety Assessments (RSA), paved shoulders with Safety Edge[SM], and pedestrian hybrid beacons (HAWKs).

[8] FHWA 1/12/2012 Memo http://safety.fhwa.dot.gov/provencountermeasures/pc_memo.cfm

4. **Enhance coordination and information flow**. Information flow is facilitated between TED, PCSD, PC Risk Management, PCAO (Attorney's Office) and others. To facilitate this flow of information, TED has and will continue to have monthly meetings with the PCSD to review high crash locations, enforcement activities and to review and discuss other traffic related issues and considerations. Quarterly meetings are held with PCAO and PC Risk Management.

   In January of 2013, FHWA's Central Federal Lands Arizona Access Program put out a call for projects. TED joined with Saguaro National Park (SNP) to generate an application for the program requesting fifty million dollars of funding to improve the safety of the road network that accesses the park. While the TED/SNP partnership did not receive any funding, planning discussions have continued while waiting for the FY 2017 call for projects from the Access Program

5. **Develop an enhanced reporting system.** The current reporting system is periodically improved to provide technical and comprehensive information to TED staff and decision makers and to provide relevant and understandable program statistics to the public. In fact, this version of the SMS Report includes many additional figures and tables. The object of these improvements is to help enhance the ability of this report to communicate the ongoing seriousness of crashes and what might be done to mitigate them.

6. **Provide an SMS program that coordinates with local agencies.** A successful SMS program requires participation, coordination, and cooperation of various agencies; therefore, the SMS program includes coordination of efforts with other agencies to improve traffic safety throughout the region. For example, TED has participated in the PAG/RTA Transportation Working Group, the PAG Pedestrian Task Force, the PAG Pedestrian and Bike Working Group, Tucson Pima County Bike Advisory Committee (BAC), working groups the for ADOT Strategic Highway Safety Plan update, as well as supplying members of PAG's Roadway Safety Assessments, (RSAs) teams.

A recent refinement to the SMS program has been to create a more systemic category program approach to projects. This approach has been termed "Project Buckets". Project Buckets are typically comprised of systematic improvements such as the durable pavement marking upgrades, retroreflective signing replacement, guardrail, paved shoulders, speed management, and rural intersection and segment upgrade programs. The object of the "Project Bucket" idea is to help organize the pending projects in a manner to achieve a more organized and intuitive way to track by category. This in turn will help either achieve or direct funding. In a more systemically balanced manner. The yearly SMS Project List, along with other projects, is then worked into each bucket.

Substantive Safety

Nominal safety vs. Substantive Safety

Highway engineers and stakeholders can improve the quality of their design analysis through better understanding of what constitutes a "safe" design or decision. First, the subject of safety should always be addressed carefully. There is no such thing as a totally "safe" highway; no organization can promise this nor characterize safety in absolute terms as this is impossible to achieve as long as humans are involved. Secondly, properly understood, highway safety is composed of two dimensions, nominal safety and substantive safety.

Nominal safety refers to adherence to design practices, standards, warrants, etc. that are typically judgement base but in reality do not necessarily have any impact on crash causation or severity. Substantive safety refers to actual (or expected) performance as defined by the frequency and severity of crashes. Substantive safety is based on the crash history and is usually measured in the following terms:

- Crash Frequency
- Crash Rate
- Crash Type
- Crash Severity

In the context of design and traffic operations decisions, and specifically with respect to the subject of design exceptions, it is clear that these two dimensions of safety may diverge. A road that is nominally safe may in fact have a poor substantive safety history; and one that is nominally unsafe (i.e., has one or more substandard design features) may perform acceptably. For example, strict adherence to intersection sight distance does not necessarily prevent an intersection crash if a driver is impaired or inattentive and pulls out in front of another vehicle. This crash would have occurred regardless of the sight distance.

The fact that nominal safety and substantive safety are not the same is explainable. Design criteria and design values published by AASHTO are based on many considerations in addition to what might be perceived to be safety. But simply following the criteria does not constitute safe or unsafe. They are standards to design by and help enable consistency. The substantive safety of a road involves many factors, some within the control of a DOT and some not. Licensing and prevailing laws, level and quality of enforcement, maintenance practices, and operating practices of an agency can influence crash causation. In general, drivers usually cause 94% of crashes due to error and many of the crashes are categorized as follows:

- Impairment; (physical, alcohol, etc.)
- Impatience
- Inattention; (includes Distracted Driving)
- Excessive Speed

Integration of design and operational decisions with substantive safety data provides the ability to understand and quantify the potential substantive safety impacts of decisions, including design exceptions that may not fully meet a standard. These tools will eventually lead to a better safety analysis method of the locations be upgraded with a reasonable allocation of resources. PCDOT anticipates this will result in significant changes to how they approach and deliver road safety. TED is continuing to monitor and learn about this and will incorporate these new tools in the coming years. Much recent research and development sponsored by AASHTO, NCHRP, TRB and FHWA have greatly expanded the knowledge base and tools for use in predicting substantive safety effects of design and operational decisions.

Project Selection Process

The purpose of the SMS program is to implement cost effective crash mitigations at intersections and on roadway segments in the unincorporated Pima County roadway system. The primary source of information on the effectiveness of the SMS projects on roadway safety is documented

in the annual SMS update report. The following traffic data is computed from the Sheriff's crash reports:

1. ***Crash Frequency*** – Defined as number of crashes per mile within a roadway segment.

2. ***Crash Rate*** – Defined as number of crashes per million entering vehicles for intersections and per million vehicle miles for roadway segments.

3. ***Severity Index*** - The severity index (SI) of a crash is equal to the total equivalent property damage only (EPDO) divided by the number of crashes.

It is important to note that in order to achieve a SMS and the capability to find and evaluate projects based on crashes requires up-to-date and complete data, not only crash data but traffic volume data. In this regard, TED has a complete Data Group within its Traffic Studies and Data section. The role of this group is to collect and process data in support of the SMS. They also provide data support services for the conduct of traffic studies.

Ranking Method

The step-by-step process to rank signalized intersections, unsignalized intersections, and roadway segments is given below. Note that locations where crash data are available including those under joint responsibility with other agencies will be ranked annually.

This information along with traffic volumes and segment lengths is used to mathematically compute the following criteria for each segment and intersection:

1. Rank in descending order all locations in a category according to the average AADT (i.e., the location with the highest AADT will receive Rank 1).

2. Rank in descending order all locations in a category according to the total number of crashes for intersections and crash frequency for roadway segments.

3. Rank in descending order all locations in a category according to the crash rate.

4. Rank in descending order all locations in a category according to the severity index.

5. Add the ranks from the previous four steps to obtain a location's priority index (PI). Note that more than one location may have the same priority index value within each category.

6. Sort all locations within a category according to the increasing Priority Index initially and by the location name secondly.

7. Assign an ascending rank to each location according to the order derived from Step 6, the most critical locations have the lower PI and thus Rank 1, 2, 3 etc.

Importantly, this ranking system is based on the fact that crashes have occurred at these locations. It is not a measurement or gauge of safety, nor is it a predictor of the potential for future crashes. Crashes are part of a complex system; they are also rare and random events. Hence this ranking system needs to be acknowledged within this

context. It is anticipated that within a few years that observed crash methods like this would be mostly replaced with systems that feature regression models.

Regression to the Mean

The SMS analysis system is straightforward analysis to apply and reliable, however it lacks the ability to fully account for the regression to the mean. Regression to the Mean is a statistical examination of data numbers that estimates if one number is a much higher value than the historical data then the next data period will produce a number closer to the median value.

According to the AASHTO 2010 Highway Safety Manual:

> "Regression to the mean is the natural variation in crash data. If regression to the mean is not accounted for, a site might be selected for study when the crashes are at a randomly high fluctuation or overlooked from study when the crashes are at a randomly low fluctuation."

If regression to the mean is not accounted for in safety data, a fallacy can occur. If a site reports extremely high crashes one year and a project is implemented for mitigation and the crash rate goes down, there is a good possibility the rate would have gone down anyways due the data regressing to the mean value. The SMS system evaluates crash data using a 3- or 5-year rolling average to counteract regression to the mean.

Pima County has had a long term SMS program that has identified the development of systematic programmed safety projects to help account for the regression to the mean. However, adopting more sophisticated regression modelling software as enabled in the AASHTO HSM will be required to fully accomplish this procedure.

Selecting Candidate Projects

Once TED ranks all the locations, a number of top locations from each category are selected using engineering judgement and other considerations for Crash Assessment Reports (CARs). The purpose of the review is to identify potential candidates for the final project list. The screening and selection process:

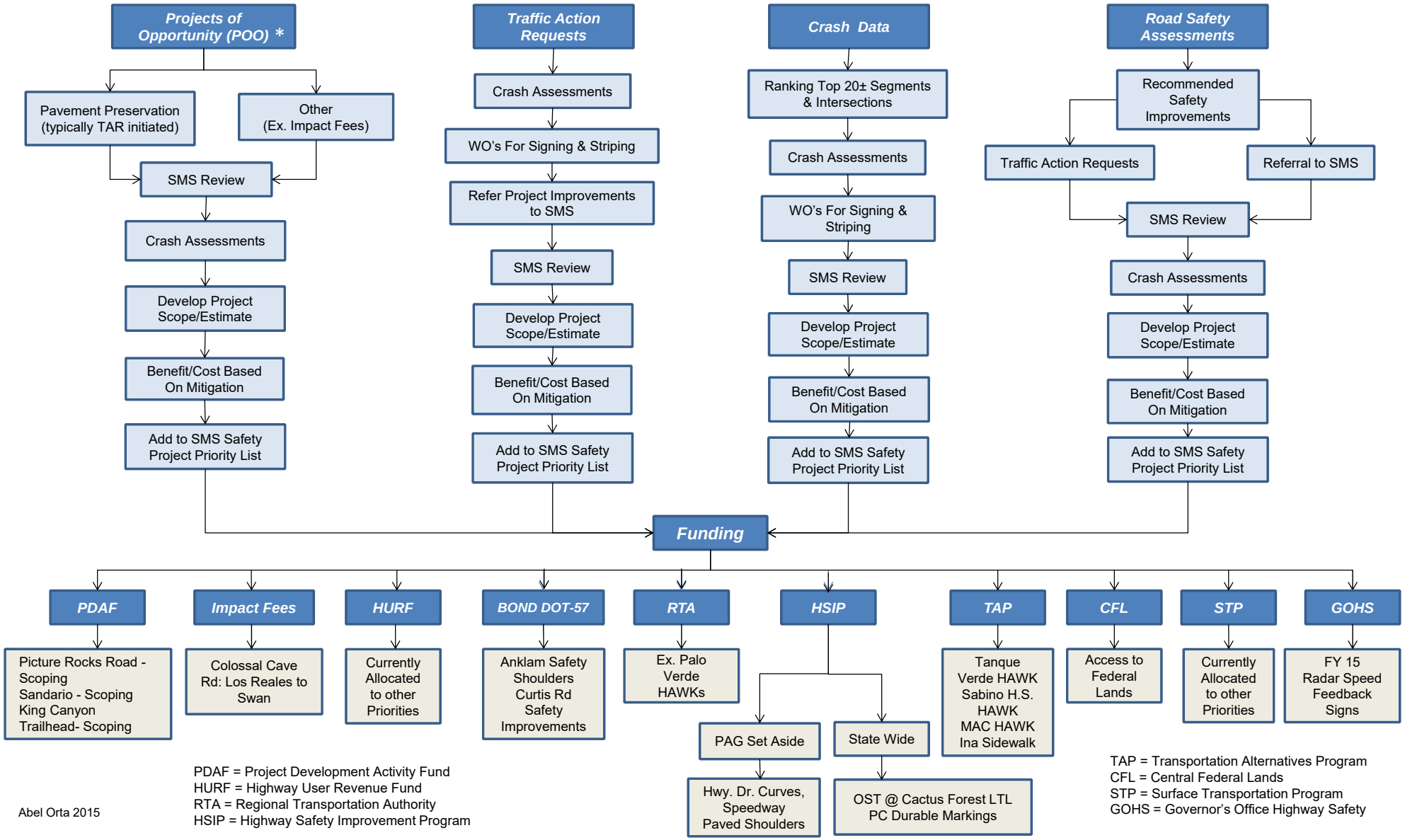
- Typically select the top locations from each category.
- Identify and eliminate locations that belong to on-going projects or are near future projects. For locations that are part of future projects, SMS will first determine whether intermediate improvements are needed before eliminating them from the candidate list.
- Obtain detailed crash data for the candidate locations for the same 5-year period as used in prioritization.
- Prepare collision diagrams to visually spot abnormally high collision types or trends.
- Use systematic analysis of spot crash clusters to identify possible causes. Apply CMFs to determine the effectiveness of a proposed solution, individually or by combining safety improvements. Pertinent information such as the traffic citation, time of crash, and severity is reviewed to verify that the crash patterns can be reduced by engineering or enforcement measures.

- Perform a field review to confirm findings from the crash analyses and review. Additional findings and/or solutions from the field review should be noted.

- If no compelling crash patterns are identified and the field review does not provide any unusual findings, the subject location may be eliminated from the candidate list. Recommendations for facility modifications are provided in the CARs to mitigate the crash rate patterns. TED produces concepts with cost estimates for comparison with the estimate benefit cost savings determined from CMFs. Projects are then ranked according to these benefit/cost ratios whereas the projects that are the most beneficial for the least cost are at the top. The traffic volumes, priority Index, costs, bicycle and pedestrian facilities as shown in Table 19 ultimately establish the final priority of the proposed project.

Depending on available resources, types of improvement, and estimated construction time, all or only some of the screened candidate locations might be selected for the final project list. In addition, new higher priority projects may be substituted into the ranked lists of safety improvement projects, when identified.

Figure 18 SMS Safety Project Development Flow Chart



PDAF = Project Development Activity Fund
HURF = Highway User Revenue Fund
RTA = Regional Transportation Authority
HSIP = Highway Safety Improvement Program

TAP = Transportation Alternatives Program
CFL = Central Federal Lands
STP = Surface Transportation Program
GOHS = Governor's Office Highway Safety

Abel Orta 2015

Projects of Opportunity (POOs)

Not all safety projects go through the SMS selection process as shown on Figure 18. "Projects of Opportunity" or POOs arise when a previously programmed roadway project presents an opportunity to incorporate a safety improvement. A common example is the addition of safety shoulders or a warranted turn lane to a Pavement Preservation project. Typically, SMS provides the design and staking for the improvements. Funding for the safety improvement is generally the DOT 57 Bond. POOs save the County many thousands of dollars in design and programming fees by going straight to construction.

Project	Project Scope	Completed
Harrison Bike Lanes	Construct Bicycle Lanes	Yes
Anklam Road Safety Shoulders	Construct Roadway Shoulders	Yes

Identifying Crash Trend Countermeasures

While there are additional concerns for identifying engineering countermeasures SMS considers the following key questions:

- Does the measure address or mitigate the existing crash problem or an anticipated future problem?
- Will the measure shift the problem to another location?
- How long will it take to implement the measure?
- Do we need intermediate measures?
- Are human and financial resources available to implement, operate and maintain the measure?
- What is the useful life of the countermeasure?
- Does it appear to be cost-effective?

Estimating Benefits and Costs of Potential Projects

The estimation of benefits and costs for engineering projects occurs at two levels within the SMS program. The first is a simplified level using indices for costs, benefits, and effectiveness of a given project. This simplified process is applied to the list of candidate projects for the categories of roadway segments, signalized intersections, unsignalized intersections, and carryover projects. The simplified process is used to reduce the total number of site-specific projects which are analysed in greater detail. It is particularly useful when the identified resources for the next SMS annual program are restricted such that only a few of the longer list of candidate projects in each category can be funded. It is essentially a way to save time and effort by not providing high levels of detail for projects which may not be included in the recommended annual program.

The second, more detailed process for estimating benefits and costs is applied to the final candidate projects selected during the initial priority ranking of crash location reducing the number of candidates in each category to 10. Following identification of countermeasures to be used, SMS makes an engineering estimate of implementation or construction costs as well as an estimate of the anticipated reduction in crashes and/or severity of crashes once a project is implemented. The crash reduction is estimated from appropriate established CMFs. Benefit-to-Cost, (b/c) ratios are developed to elevate projects that provide the highest crash reductions per cost. These costs are considered preliminary since the objective is to provide a reasonable cost

for budgeting the next program cycle. Final construction cost for each project will be estimated once a final design has been prepared.

As a result of these analyses, crash mitigation projects are recommended. Improvements may include signing and marking changes, changes in signal timing or left-turn phasing, or even major reconstruction of the location. Major reconstruction projects are prioritized by estimated crash reduction, project cost, and other variables. These recommended improvement projects then compete with other projects for funding sources to be implemented if and as possible. Due to lack of funding or other priorities projects be implanted after many years, if ever.

Crash Assessment Reports 2015

As described above the Crash Assessment Reports (CARs) are a key component of the Pima County substantive quality process. In 2016, CARs were completed by Studies for 7 intersections and 8 segments utilizing the 2015 Crash Data. These CARs and the associated recommendations are summarized in Table 14 below. TED uses these assessments to develop projects for the prioritization/ranking process described herein.

Table 14 2015 Crash Assessment Summary

This is new for this SMS Year. What follows is a short summary of what CARs were evaluated.

Unsignalized Intersections:

Brahma Road at Sahurito Road
Crash History
There were 5 crashes in the past 5 years, with no crashes involving pedestrians or bicycles. Three crashes were SB LT hitting WB vehicles. One crash involved an EB/EB LT rear end. 40% of all crashes occurred at night.
Recommendations
The Brahma Road street sign be upsized to 9 inches. Due to the mailboxes located within the clear zone, the red directional marker on the stop sign should be changed to yellow and vertical hazard markers be installed at each end of the mailboxes.
Follow-up
A Work Order was submitted for the recommendations.

Escalante Road at Old Spanish Trail
Crash History
There were 11 crashes in the past 5 years. Five crashes (45%) were NB rear ends involving a left turn. Speed was a factor in 55% of the crashes. 9% of all crashes occurred at night.
Recommendations
Refresh the stop line on Escalante Road. Upsize the Escalante street name sign to 9". Replace the existing fading Deer Crossing Sign. Evaluate pavement for maintenance. Examine adding a NB LT turn lane to Old Spanish Trail.
Follow-up
Work orders were submitted for the signing, marking and pavement repairs. SMS will examine adding illumination. (B/C= 1.21 Illumination, B/C=0.35 NB LT turn Lane)

Michigan Street/Coach Drive at Palo Verde Road
Crash History
There were 7 crashes in the past 5 years. Five crashes (71%) involved SB vehicles, with 43% of all crashes occurring at night.
Recommendations
No recommendations
Follow-up
2013 RSA Recommendations for ADA improvements will be addressed in a future project. Trim vegetation in NW corner of intersection for SD and SW corner at the bus turnout. Guardrail in SW corner has been struck needs maintenance to examine crashworthiness. Refresh stop bar marking. Work Order has been referred to Operations.

Alvernon Way at Michigan Street
Crash History
There were 6 crashes in the past 5 years. SB traffic was involved in 5 of the 6 crashes. One crash involved a bicycle in a multi-use lane. 14% of all crashes occurred at night.
Recommendations
Install advance street name signs in the median for NB/SB vehicles. Upsize current street name signs to the 9" standard.
Follow-up
SD hampered by vegetation needs trimming NW and SE corners of Michigan Intersection.

Signalized Intersections

La Cholla Blvd at Orange Grove Road
Crash History
82 Crashes in the past 5 yrs. 72% of the crashes were rear ends. A fatality occurred when a bicyclist was rear-ended. The intersection is illuminated.
Recommendations
No recommendations
Follow-up
Refresh left turn skip striping. SMS to review bicycle merge lane markings. SMS to examine adding pedestrian refuge islands in the NE, SE and SW quadrants. The NW quadrant does not have the extra space available.

W River Road and N La Canada Drive
Crash History
There were 99 Crashes in the past 5 yrs., 65% were rear end crashes. 51% of the crashes involved speeding. The intersection is illuminated.
Recommendations
Refresh striping, bull noses and replace missing RPMs.
Follow-up
Work orders submitted for recommendations. Refresh left turn skip striping.

River Road at Swan Road
Crash History
There were 42 Crashes in the past 5 yrs. 67% were rear end crashes. 76% of the crashes were in the NB/SB direction on Swan Road. The intersection is illuminated
Recommendations
Install a "Be Prepared to Stop" beneath the existing W3-3 signs. Refresh all pavement markings on Swan Road.
Follow-up
Work orders were submitted for the marking work. Add a flashing beacon to the new "Be Prepared to Stop" signs. Review pedestrian refuge island in NW quad.

Low Volume Roadway Segments (< 10,000 VPD):

Roller Coaster Road: La Canada to Oracle Road
Crash History
There were 19 crashes in the past 5 yrs. Speeding citations were issued in 11 crashes. 63% of all crashes occurred at night.
Recommendations
Reduce the entire roadway speed to 25 mph and remove excess signage. Install speed humps with flashing yellow beacons at certain locations to help control speeds. Short segment lighting is being considered from Grande Ave. to Linda Road and meets warrants. A Work order was submitted to repair the guardrail on the North side of the road between Linda Pl and Linda Rd.
Follow-up
SMS accepts recommendations

Thornydale Road: Lambert Lane to Camino del Norte
Crash History
There were 16 crashes in the past 5 yrs. 7 were NB rear ends. 1 crash occurred at night.
Recommendations
Evaluate a TWLTL along this full segment.
Follow-up
SMS is evaluating a TWLTL design for this segment. (B/C = 4.3)

Rudasill Road: Oracle Road to 1st Avenue
Crash History
There were 9 Crashes in the past 5 yrs. 6 crashes occurred at night.
Recommendations
Refresh pavement markings. Install short segment lighting along the segment or at least 100 to 230 E is being considered. Implement the plan to realign Rudasill Rd at Genematas Dr.
Follow-up

Work orders submitted for the marking work. SMS to reexamine 2003 project to realign Rudasill and Genematas Intersection. SMS to examine interim lighting at Genematas intersection.

Camino de Oeste: Cortaro Farms Road to Linda Vista Blvd
Crash History
There were 33 Crashes in the past 5 yrs. 10 crashes involved speeding. 50% of intersection crashes occurred at Bald Eagle Av and Camino De Oeste. No fatalities were recorded along this segment dating back to 1990. 21% of all crashes occurred at night.
Recommendations
Upgrade RPMs and street signs. Install sidewalk and ramp access along both sides of the segment per the PAG 2014 Regional Pedestrian Plan. On regional County Bike Plan as a key connector, recommend paved shoulders due to the 2 bicycle crashes.
Follow-up
Work orders have been prepared and submitted. SMS to examine adding paved shoulders and possibly guardrail to this segment.

High Volume Roadway Segments (> 10,000 VPD):

N Flowing Wells: W Edgewater Drive to W Wetmore Road
Crash History
There were 47 Crashes in the past 5 yrs. 15 were rear ends. 8 involved bicyclists and 5 involved pedestrians. Speeding was a factor in 16 of the crashes. 30% of all crashes occurred at night.
Recommendations
Replace ped warning signs with combination pedestrian/bicycle warning signs. Recommend examining raised medians for access control.
Follow-up
A WO was issued to install a speed limit sign north of Wetmore Road for NB traffic. SMS to examine raised medians from Sol Place to Buena Tierra Place (1500 ft.) for access control. B/C 10.4

Orange Grove Road: Oracle Road to 1st Avenue
Crash History
There were 40 Crashes in the past 5 yrs. 24 of the crashes were rear ends. 14 of the crashes involved the driveways for the shopping center. 10% of all crashes occurred at night.
Recommendations
Evaluate the business driveways at the W end of the segment for the shopping center to determine if turn restrictions are needed.
Follow-up
SMS will do as recommended and examine adding a “propeller” island to the median at the mall. Examine length of lane drop taper. (B/C 6.72)

Thornydale Road: Massingale Road to Magee Road
Crash History
There were 32 Crashes in the past 5 yrs. 15 involved excessive speed, 14 involved distracted driving. 38% of all crashes occurred at night.
Recommendations
Speed Study for NB Thornydale to determine if additional enforcement would be beneficial. Upgrade street signs to 9”.
Follow-up
SMS to examine a median extension at Quasar to control left turns from both directions.

Nogales Highway: Lumber Street to Old Nogales Highway
Crash History
There were 67 crashes in the past 5 yrs. NB traffic was involved in 63% of the crashes. 25 of the crashes involved speeding. 31% of the crashes occurred in dark conditions.
Recommendations
Trim vegetation and install speed limit sign S of the Nogales Hy, and Old Nogales Hy intersection facing SB. Evaluate TWLTL for the remainder of the segment. Conduct an access control study and RSA for this segment. Implement additional speed enforcement along his segment when possible.
Follow-up
A work order was submitted for the vegetation trimming and signing work. SMS to examine access control, TWLTL and ROW fencing to reduce animal collisions. SMS initiated a Road Safety Assessment (RSA) for this roadway segment.

Ina Road: Meredith Blvd to Shannon Road
Crash History
There were 105 Crashes in the past 5 yrs. 80% were rear end crashes. 62% of the crashes involved speeding. 18% of all crashes occurred at night.
Recommendations
Consider installing sidewalk and ADA ramps along this segment as recommended in the PAG 2014 Pedestrian Plan. This would include extending the concrete apron at the corners of Ina Road and Camino De La Tierra for better push button access.
Follow-up
Work orders will be generated for the concrete apron extensions and the pavement rehabilitation at Camino de La Tierra.

Benefit/Cost Ratio Follow-Ups 2015

Traffic studies and crash assessments referred to SMS for project consideration are assessed using the methods outlined in the March 2010 Arizona Highway Safety Improvement Program (HSIP) Manual. PCDOT completed planning level engineering work to determine a construction cost. The expected benefit of reducing the crashes is calculated and compared to the construction cost. The Table below shows the B/C Ratios for the recent projects developed from CARs.

Table 15 Crash Assessment Projects Ranked by Benefit/Cost Ratio

Rank	Project Name	Project Scope	Construction Cost	B/C Ratio
1	Valencia Rd: Camino de la Tierra to Cardinal Ave	Construct Median Island to Control left turns	$30,000	177.00
2	Ajo Way/Alvernon Intersection	Install flashing beacons on Alvernon	$12,830	94.56
3	Valencia Rd: Camino de la Tierra to Cardinal Ave	Construct positive offset left turn lane, median island and right turn lane for Chase Bank	$229,000	35.20
4	Catalina Highway/Houghton Rd Int.	Install flashing beacons	$12,830	16.00
5	La Cholla Blvd: River Rd to Rudasill	Sunset Rd Int. median island to eliminate lt turns	$50,000	15.15
6	Cardinal Avenue/Valencia Road	Dynamic Feedback Signs	$20,000	11.76
7	Flowing Wells: Edgewater to Wetmore	Construct raised median to replace TWLTL	$120,000	10.4
8	Catalina Highway/Snyder Rd Int.	Install flashing beacons	$12,830	7.58
9	Orange Grove Rd: Oracle to 1st Ave	Construct Median Island to Control left turns	$50,000	6.72
10	La Cholla Bl-Zarragoza/Walmart Intersection	Channelized median Island to control left turns	$50,000	5.68
11	Thornydale Rd: Lambert Lane to Camino del Norte	Construct Two Way Left Turn Lane (TWLTL)	$2,750,000	4.30
12	Benson Hwy/Palo Verde Rd	Construct positive offset lt turn lane	$74,000	2.32
13	Bopp Rd: Tucson Estates to Kinney	Illumination at Tucson Estates Int.	$25,000	1.59
14	Linda Vista: Camino de Oeste to Thornydale	Relocate HAWK east and school access west, add median, signal and Arthur Pack access	$1,123,900	1.54
15	Picture Rocks/Sandario Int.	Roundabout	$821,000	1.06
16	Mission Rd: Helmet Peak to Pima Mine	Construct 6 ft. shoulders and 2 " overlay	$2,560,000	0.99
17	Valencia Rd: Cardinal Ave. to Mission Rd.	Roadway widening from 4 to 6 lanes	$1,650,000	0.63
18	Mary Ann Cleveland: Red Iron Trail to Colossal Cave Road	Construct Two Way Left Turn Lane (TWLTL)	$1,200,000	0.61
19	Tanque Verde: Houghton to Tanque Verde Loop	Construct Two Way Left Turn Lane (TWLTL)	$749,000	0.53
20	Benson Hwy: Country Club Rd to Palo Verde Rd.	Sidewalks, raised curb, driveway aprons and water harvesting basins	$717,000	0.39
21	Shannon Road: Magee Rd to Overton Road	Construct Two Way Left Turn Lane (TWLTL)	$367,000	0.38

Rank	Project Name	Project Scope	Construction Cost	B/C Ratio
22	Camino de Oeste/Linda Vista Blvd	Roundabout	$836,000	0.31
23	Catalina Hwy,/Houghton Road Int.	Roundabout	$860,000	0.29
24	Driscoll Mtn./Mary Ann Cleveland	Install HAWK	$221,231	0.08
25	Speedway Blvd: Freeman to Wentworth	Construct 6 ft. shoulders and 2" overlay	$1,250,000	0.03

Current and Proposed FY 16/17 Safety Projects

These projects were identified from the FY14/15 Project Priority List for funding and execution in FY15/16. Brief scopes, estimated costs, and anticipated schedules for these projects are shown in the Table below.

Table 16 Proposed SMS Projects for FY 2015/2016

Project	Proposed Action	Funds	Design Cost	Constr. Cost	Anticip. Year
Roundabout Program	Design/promote roundabouts	TBD	$200,000		Ongoing
HAWK Program					
Palo Verde HAWK at Alvord & Milton	Install HAWKs	TBD	HURF OP	$380,000	2015-16
Flowing Wells at Wabash HAWK	Install HAWK	DOT-57	HURF OP	$130,000	2015
Advanced Warning Flashers Safety Program	Install advance warning flashing beacons at selected locations	DOT-57	HURF OP	$100,000	2016-17
Julian Wash Safety Improvements	Safety and Guardrail	DOT-57	$73,000	$115,000	2016-17
Sign Post Replacement Program	Reinstall all County signs with square tube breakaway posts	DOT-57	HURF OP	$100,000	Ongoing
Driver Feedback Speed Signs (DFSS)/Enforcement Pads	Installation	DOT-57 /GOHS		$100,000	Ongoing
Motor Pull-Outs and Concrete Work	Install concrete pullouts for motor-patrol officers		In-House	$154,000	Ongoing
Safety Management System Upgrade	Software procurement & annual data management				Ongoing
Projects of Opportunity (POO)					
Harrison Bike lanes	Bike lanes/safety shoulders			$60,000	2016
Anklam Road Safety Shoulders	Construct roadway shoulders and Guardrail	DOT-57	$100,000		2016

Speedway Blvd: Painted Hills to Camino de Oeste	Construct paved shoulders	HSIP Applic.	$90,000	$1M	2016-17
Bicycle and Pedestrian Safety Program	Promote safety		$28,000		Ongoing
Safety Projects					
Old Spanish Trl/Cactus Forest Rd	Pavement Preservation	HSIP Applic.	$57,000	$345,000	2016
Curtis Road Safety Improvements	Speed Management	DOT-57	$119,000		2017
Battery Back-Up Units	At Traffic Signals and HAWK Beacons				2015
Battery Replacement	Ongoing safety program to replace aging batteries	Operating			2015
Enhancement of Wireless Communication System	Systematic upgrades	HURF OP or other			2015

OP = Operating per HURF
DOT-57 = Bond funded through HURF Revenue
Other = RTA, DOT HURF bond fund

Started or Completed Safety Projects 2015

Multiple safety projects were started, completed or on going in 2015 and are described in the Table below.

Table 17 Pima County Projects Started or Completed in 2015

Project Description	Scope	Progress
Projects of Opportunity (POO)		
Los Reales Sorrel to Cardinal Widening	Added Safety Shoulders, Pavement Preservation	Construction Complete
RTA		
La Canada: River Road to Ina Road	Add lanes, raised median, drainage, pedestrian amenities	Construction Complete
La Cholla: Magee to Overton	Roadway widening	Construction Complete
Orange Grove Camino de La Tierra to La Cholla	Roadway widening to 5-lane with TWLTL, shoulders	Construction Complete
Homer Davis Elem. Bicycle & Pedestrian Enhancement	Bike and pedestrian Enhancement Project	Construction Complete
Palo Verde, Milton/Alvord HAWKs, Sidewalk	Install two HAWKS and Sidewalk	Design Started
DOT 57		
Curtis Road Safety Improvements	Speed Management Improvement	Studies Started
Motor Pullouts and Concrete Median Modifications	Construct Motor Patrol pullouts for County Sheriff's Dept.- Speed Mgmt	Studies Started
ITS Upgrades	Signal Cabinets, LED lamps, Video detection	Ongoing
Sign Post Upgrades	Replace County sign posts with square breakaway posts	Ongoing

Project Description	Scope	Progress
TAP		
Bowes Rd/Vallarta Dr Sabino High School	Install HAWK	Design Started
Mary Ann Cleveland at Kush Canyon/Cienega HS	Install HAWK, Transferred to CIP	Design Started
Tanque Verde, Emily Gray School	Install HAWK	Design Started
HSIP (Applications)		
Speedway Blvd: Painted Hills to Camino de Oeste	Added shoulders, alignment improv. HSIP funding requested	Studies Started
S. Camino de La Tierra: Curtis Rd/Shannon to Emerald, Highway Dr. - Emerald to Sunset	Realign to install paved shoulders and improve superelevations in 2 curves	Studies Started
PAG Area wide Signing and Striping Upgrade	Eligibility Requested	Studies Started
County Wide Pavement Markings Program	Eligibility Requested	Studies Started
Active Projects - 5 Year Plan		
Harrison Road Bike Lanes: Sabino HS/Cat Hwy.	Added Bicycle Lanes	Design Started
Valencia Rd: Alvernon to Wilmot	Widening 4 to 6 lanes	Construction Started
Valencia Rd: Wilmot to Kolb	Widening 4 to 6 lanes	Design Complete
Aerospace Parkway (Hughes Access Relocation)	Access relocation	Construction Started
Shannon Road at Ina Road	Construct NB Right turn lane	Studies Started
Cardinal Ave: Los Reales to Valencia	Construct TWLTL	Studies Started
River Road East of Swan	Improve drainage, widen shoulders imp.	Studies Started
Ina Road: Shannon to La Canada	Sidewalks	Studies Started

Before-After Studies

As part of the criteria for various funding sources of safety projects, a study to determine the effectiveness of treatments is required. In previous years, TED Studies and the SMS group analyzed a list of approximately 150 projects. For this report, the analysis assess seven SMS projects and seven Capital Improvement Projects (CIP).

An analysis of the data reveals that for the 14 projects studied the crash rate increased for three projects, decreased for seven projects, and did not significantly change for four projects. The severity rate increased for two projects, decreased for four projects, and did not significantly change for seven projects. Table 18 shows the Before-After Studies comparison.

Table 18 Summary of Before and After Studies for SMS and CIP Projects

Location	Improvements	Funding Program	Construction Dates		Study Years	Traffic Study Data Period			Crash History									
			Begin	End					Property Damage Only (PDO)	Class 2 and 3 Injuries	Class 4 + Fatal Injuries	Total Crashes	Segment Length	Daily Volume	Crash Rate	Severity Index	Crash Rate Change	Severity Index Change
Safety Management System Projects																		
Alvernon Wy and Valencia Rd Intersection	Traffic Signal with Dual Left Turn Lanes	RTA	Jul-11	Nov-11	3	Before	Jun-08	Jul-11	23	11	0	34	N/A	50,589	0.61	1.32	+8%	+0.05
					3	After	Nov-11	Dec-14	20	12	0	32		44,071	0.66	1.38		
Camino de Oeste: Los Reales Rd to Valencia Rd	Two Way Left Turn Lane	RTA	Apr-12	Jan-13	3	Before	Mar-09	Apr-12	5	4	1	10	1.00 mi	7,686	118.82	1.88	-47%	+0.68
					3	After	Jan-13	Feb-16	1	3	1	5		7,184	63.56	2.56		
Capital Improvement Program Projects																		
Bowes Rd at Sabino High School	HAWK Crosswalk	TAP	Aug-13	Aug-13	3	Before	Jul-10	Aug-13	4	0	1	5	0.40 mi	2,313	493.54	1.96	-69%	-0.96
					3	After	Aug-13	Sep-16	2	0	0	2		2,994	152.51	1.00		
Catalina Hy, Tanque Verde Rd to Houghton Rd	Road Widening from 2 Lane to 4 Lane with Multi-Use Lanes	DOT-27	Apr-10	Jul-11	3	Before	Mar-07	Apr-10	1	2	0	3	2.10 mi	9,408	13.87	1.67	+77%	-0.47
					3	After	Jul-11	Aug-14	4	1	0	5		8,857	24.55	1.20		
Magee/Cortaro Rds: Thornydale Rd to Mona Lisa Rd	Road Widening from 2 Lane to 4 Lane Divided Arterial, with Bike Lanes, Sidewalks	RTA	Oct-11	Jun-13	3	Before	Sep-08	Oct-11	27	17	4	48	1.80 mi	18,802	129.53	1.75	-35%	-0.45
					3	After	Jun-13	Jul-16	18	8	0	26		15,761	83.70	1.31		
La Cholla Bl: River Rd to Ruthrauff Rd	Road Widening from 2 Lane to 6 Lane Divided Arterial, with Bike Lanes, Sidewalks		Jul-09	Jul-11	3	Before	Jun-06	Jul-09	39	16	1	56	0.75 mi	22,453	303.70	1.37	-77%	+0.34
					3	After	Jul-11	Aug-14	7	3	1	11		19,578	68.41	1.71		

NOTE: Segment Crash Rate = CR = 100,000,000 * C / (365 * N * V * L)

Intersection Crash Rate = CR = 1,000,000 * C / (365 * N * V)

Severity Index = SI = (5.8 * (Class 4 + Fatalities) + 2 * (Class 2 + Class 3) + PDO) / Total Crashes

Often crash rates or severity rates increase after a safety project has been constructed; the reason is due to the nature of crashes. Simple comparisons of before-after crash data do not take into account all the factors within the calculation of the crash rate or the severity rate. These simple before-after analyses provide some level of comparison, but are generally not regarded as the final word in the value of a safety project. There are several reasons for this, but the most apparent is that crashes are infrequent and comparing one intersection to another by using rate comparisons does not take this infrequency into account. Inimitable

Another chief reason is that some crash mitigations, such as installing traffic signals, tend to increase the crash rate at a location and decrease the crash severity. This is because traffic signal installation generally decreases the more severe right angle crashes while often increasing rear end crashes. Also, simple before-after comparisons account for all crashes, not just the type of crash that the safety project was constructed to mitigate. In the example of installing a traffic signal, if you had a crash that resulted in a fatality but was not related to the installation of a traffic signal, a simple analysis would indicate that the installation of the traffic signal caused the severity rate to increase, though it was not related to the installation of the signal.

After safety projects are constructed, the Studies and SMS sections continue to monitor locations, as possible, for crash rates and severity rate increase and then perform a study to determine what might be causing the increase. Sometimes the nature of the improvement decreases driver discomfort and drivers increase their speed. In that case, a recommendation for increased enforcement may be required.

It is important to note that “simple” Before-After Studies are a method to evaluate safety projects. However, as already discussed in this section it is not accurate as we might hope and better methods are needed. TED is researching new methods and analysis software to be implemented in the future.

Safety Project Priority List

The current list of safety projects and their associated priority, ranked per the criteria established in Section 4, is included in Table 19. The priority ranking needs to be viewed in the context of the information and data used to develop it. This ranking should not be regarded as a grade of safety. It is simply a method to rank and distinguish projects in an organized method. The actual safety merits of each project varies and in many instances a higher ranked project may be postponed in favor of a lower ranked project based on circumstances, engineering judgment and funding.

Table 19 2015 SMS Safety Project Priority List

Proposed Project	Priority Rank	Existing LOS	SCORE	Reduces Congestion (Y/N)	SCORE	2015 Existing ADT	SCORE	TED Priority Index Rank (3yrs)	HAWK Signal (P/S/N) Pedestrian/School/None	SCORE	No. of Correctable Crashes (3yrs)	SCORE	Crash Severity Index (3 yrs)	SCORE	Flooding/Wet Pavement (Y/N)	SCORE	Total Project Cost	Pima County Cost	SCORE	Benefit Cost Ratio Information Only	Cost Effectiveness Ratio (Cost/Correctable Crashes)	SCORE	RTA Regional Corridor (Y/N)	SCORE	Adds Bicycle Lanes (Y/N)	SCORE	Adds Pedestrian Facilities (Y/N)	SCORE	TOTAL SCORE	Proposed Fiscal Year	Comments
		Congestion						Safety									Cost						Bicycle/Pedestrian								
Ajo Way/Alvernon Way Int.- Flashing Beacons	**1**	C	15	N	0	53206	20	**6**	N	39	11	21	**1.60**	0	N	0	$12,830	$12,830	50	94.6	1	15	N	0	N	0	N	0	**160**	TBD	
Cardinal Ave./Valencia Road int.-Dynamic feedback signs	**2**	C	15	N	0	40610	15	**2**	N	40	4	9	**1.41**	0	N	0	$20,000	$20,000	50	11.8	5	15	N	0	Y	10	N	0	**130**	TBD	
Mary Ann Cleveland Way/Driscoll Mountain-HAWK Crossing	**3**	B	10	N	0	8770	3	**66**	S	60	2	4	**1.25**	0	N	0	$221,231	$221,231	45	0.1	101	0	N	0	N	0	Y	10	**128**	TBD	
Valencia Road: Cardinal Ave to Mission Road - widen to 6-lanes	**4**	E	25	Y	15	37085	14	**5**	N	39	7	14	**1.37**	0	N	0	$1,650,000	$1,650,000	25	0.7	236	0	Y	5	Y	10	Y	10	**128**	TBD	
Valencia Rd: Camino de la Tierra to Cardinal Ave, Median island	**5**	C	15	N	0	28796	11	**1**	N	40	9	17	**1.66**	0	N	0	$30,000	$30,000	50	177.0	3	15	N	0	Y	10	N	0	**126**	TBD	
Linda Vista: Camino de Oeste to Thornydale	**6**	C	15	N	0	10675	4	**28**	S	60	4	8	**1.55**	0	N	0	$1,123,900	$1,123,900	25	1.5	281	0	N	0	N	0	Y	10	**114**	TBD	
La Cholla Blvd River Rd to Rudasill-Median island at Sunset Rd	**7**	B	10	N	0	25626	10	**29**	N	35	3	6	**1.56**	0	N	0	$50,000	$50,000	50	15.2	18	15	Y	5	N	0	N	0	**109**	TBD	
Benson Hwy/Palo Verde Rd Int. - offset left turn lanes	**8**	C	15	N	0	26999	10	**35**	N	34	5	10	**1.53**	0	N	0	$74,000	$74,000	50	2.3	15	15	N	0	N	0	N	0	**109**	TBD	
Cortaro Rd /Ina Intersection - add LT lane from EB Ina to Cortaro	**9**	B	10	Y	15	8847	3	**31**	N	34	2	4	**3.65**	15	N	0	$150,000	$150,000	45		85	15	N	0	N	0	N	0	**108**	2019	
La Cholla Blvd/Zarragoza-Walmart Int.-channelized median	**10**	C	15	N	0	22650	9	**66**	N	28	1	2	**1.40**	0	N	0	$50,000	$50,000	50	5.7	50	15	Y	5	N	0	N	0	**106**	TBD	
Roller Coaster/Lulu Walker School, add turn lane	**11**	A	5	Y	15	1402	1	**5**	N	39	0	0	**2.26**	10	N	0	$60,000	$60,000	50		-	0	N	0	N	0	N	0	**105**	2022	
Ina Road-West of Wade Rd; New Drain Structure, Imp Vert Geo.	**12**	A	5	N	0	350	0	**33**	N	34	1	1	**3.40**	10	Y	10	$170,000	$170,000	45		258	0	N	0	N	0	N	0	**104**	2019	
Valencia Rd: Camino de la Tierra to Cardinal Ave-offset lt turn lane, median	**13**	B	10	N	0	10784	4	**1**	N	40	20	39	**1.66**	0	N	0	$253,000	$253,000	40	35.2	13	15	N	0	Y	10	N	0	**104**	TBD	
Flowing Wells: Edgewater to Wetmore, Raised Medians	**14**	B	10	N	0	18553	7	**1**	N	40	8	16	**1.93**	0	N	0	$120,000	$120,000	45	10.4	15	15	N	0	N	0	N	0	**102**		
Drexel Rd: Cardinal Ave to Mission Rd, (TWLTL) and 6' paved shoulder	**15**	C	15	Y	15	12033	5	**69**	N	27	6	11	**1.50**	0	N	0	$750,000	$750,000	35		134	0	N	0	Y	10	Y	10	**102**	2018	
Orange Grove: Oracle to 1st Ave, Median Island	**16**	C	15	N	0	22456	8	**92**	N	23	6	12	**1.21**	0	N	0	$50,000	$50,000	50	6.7	8	15	Y	5	N	0	N	0	**101**	2018	
Arivaca Road at various locations; Install guardrail	**17**	A	5	N	0	621	0	**8**	N	39	3	5	**2.15**	10	N	0	$250,000	$250,000	45		96	15	N	0	N	0	N	0	**99**	TBD	
River Road East of Swan; Drainage, Widen Shoulder, Geo Improvements	**18**	C	15	Y	15	11199	4	**86**	N	24	5	10	**1.34**	0	Y	10	$1,500,000	$1,500,000	25		300	0	N	0	Y	10	Y	10	**98**	2018	
Los Reales Road/Swan Road - Roundabout	**19**	C	15	Y	15	9185	3	**35**	N	34	5	10	**1.50**	0	N	0	$591,000	$591,000	35		121	0	N	0	N	0	Y	10	**97**	TBD	
Thornydale Road: Lambert Lane to Camino del Norte, TWLTL	**20**	A	5	N	0	7495	3	**6**	N	39	3	6	**2.09**	10	N	0	$2,750,000	$2,750,000	20	4.3	917	0	N	0	Y	10	Y	10	**97**		
Cardinal Avenue: Los Reales to Valencia; portion of TWLTL	**20**	B	10	Y	15	6787	3	**90**	N	23	1	2	**1.36**	0	N	0	$42,500	$42,500	50	18.1	53	15	N	0	Y	10	N	0	**96**	TBD	
Catalina Highway/Houghton Road Int.-flashing beacons	**21**	B	10	N	0	9179	3	**47**	N	31	2	4	**1.17**	0	N	0	$12,830	$12,830	50	16.0	6	15	N	0	N	0	N	0	**95**	TBD	
Catalina Highway/Snyder Road Int.-flashing beacons	**22**	A	5	N	0	3182	1	**12**	N	38	2	4	**1.33**	0	N	0	$12,830	$12,830	50	7.6	6	15	N	0	N	0	N	0	**94**	TBD	
Catalina Hwy, M.P. 1.4; Guardrail	**23**	A	5	N	0	1429	1	**12**	N	38	3	6	**1.69**	0	N	0	$50,000	$50,000	50		17	15	N	0	N	0	N	0	**93**	TBD	
Picture Rocks/Sandario-Roundabout	**24**	B	10	Y	15	10143	4	**3**	N	40	5	10	**1.83**	0	N	0	$821,000	$821,000	30	1.1	168	0	N	0	N	0	Y	10	**93**	TBD	
Linda Vista: Hartman to Camino de Oeste-illumination at Blue Bonnet	**25**	A	5	N	0	6563	2	**27**	N	35	1	2	**1.63**	0	N	0	$25,000	$25,000	50	0.9	21	15	N	0	N	0	N	0	**93**	TBD	
Tanque Verde: Houghton to Tanque Verde Loop-TWLTL	**26**	C	15	Y	15	9758	4	**63**	N	28	2	3	**2.29**	10	N	0	$749,000	$749,000	35	0.5	468	0	N	0	N	0	N	0	**92**	TBD	

Table 19 2015 SMS Safety Project Priority List (Con't)

Proposed Project	Priority Rank	Existing LOS	SCORE	Reduces Congestion (Y/N)	SCORE	2015 Existing ADT	SCORE	TED Priority Index Rank (3yrs)	HAWK Signal (P/S/N) Pedestrian/School/None	SCORE	No. of Correctable Crashes (3yrs)	SCORE	Crash Severity Index (3 yrs)	SCORE	Flooding/Wet Pavement (Y/N)	SCORE	Total Project Cost	Pima County Cost	SCORE	Benefit Cost Ratio Information Only	Cost Effectiveness Ratio (Cost/Correctable Crashes)	SCORE	RTA Regional Corridor (Y/N)	SCORE	Adds Bicycle Lanes (Y/N)	SCORE	Adds Pedestrian Facilities (Y/N)	SCORE	TOTAL SCORE	Proposed Fiscal Year	Comments
		Congestion						Safety									Cost						Bicycle/Pedestrian								
Bopp Rd/Donald Ave. - Roundabout	**27**	B	10	Y	15	6698	3	**5**	N	39	4	8	**1.97**	0	N	0	$770,000	$770,000	30		183	0	N	0	N	0	Y	10	**92**	TBD	
Benson Hwy: Country Club Rd to Palo Verde Rd. -sidewalks, curb and drainage features	**28**	B	10	N	0	7616	3	**9**	N	39	1	2	**1.75**	0	N	0	$921,000	$921,000	30	0.4	921	0	N	0	N	0	Y	10	**91**	TBD	
Camino de Oeste/Linda Vista Blvd Int.-Roundabout	**29**	B	10	Y	15	11039	4	**31**	N	34	6	13	**1.00**	0	N	0	$836,000	$836,000	30	0.3	133	0	N	0	N	0	Y	10	**89**	TBD	
Shannon Rd, Magee Rd to Overton Rd-TWLTL	**30**	B	10	Y	15	7896	3	**29**	N	35	1	2	**1.40**	0	N	0	$367,000	$367,000	40	0.4	306	0	N	0	N	0	N	0	**88**	TBD	
Bopp Rd/Kinney Rd - Roundabout	**31**	A	5	Y	15	13813	5	**69**	N	27	4	8	**1.20**	0	Y	10	$2,307,000	$2,307,000	20	0.1	577	0	N	0	Y	10	Y	10	**87**	2020	
Bopp Rd: Kinney to San Joaquin; Widen, Drain Imp, Shoulders	**32**	B	10	Y	15	5354	2	**136**	N	15	3	6	**2.20**	10	Y	10	$3,000,000	$3,000,000	20		938	0	N	0	Y	10	Y	10	**87**	2020	
Bopp Rd, Tucson Estates to Kinney-illumination at Tucson Estates	**33**	B	10	N	0	5343	2	**136**	N	15	0	1	**2.20**	10	N	0	$25,000	$25,000	50	1.6	-	0	N	0	N	0	N	0	**87**	TBD	
Picture Rocks Rd at 7200 West; Drain Str, Geo Improvements	**34**	B	10	N	0	6700	3	**14**	N	38	0	0	**1.45**	0	Y	10	$1,250,000	$1,250,000	25		-	0	N	0	N	0	N	0	**85**	2021	
Catalina Hwy,/Houghton Road Int.-Roundabout	**35**	B	10	Y	15	9179	3	**47**	N	31	4	8	**1.17**	0	N	0	$860,000	$860,000	30	0.3	205	0	N	0	N	0	Y	10	**85**	TBD	
Los Reales: Cardinal to Sorrel; Install TWLTL	**36**	B	10	Y	15	7613	3	**19**	N	37	2	3	**1.35**	0	N	0	$730,000	$730,000	35		456	0	N	0	N	0	N	0	**84**	TBD	
Thornydale Rd: Cortaro Farms to Overton; widening 3- to a 5-lane	**37**	E	25	Y	15	19959	8	**23**	N	36	8	15	**1.22**	0	N	0	$10,208,707	$10,208,707	5	0.2	1343	0	N	0	Y	10	N	0	**83**	TBD	
Speedway Blvd: Freeman to Wentworth-6' shoulders and overlay	**38**	A	5	Y	15	1617	1	**44**	N	32	0	1	**2.20**	10	N	0	$1,250,000	$1,250,000	25	0.0	-	0	N	0	Y	10	N	0	**83**	TBD	
Mission Rd: Helmet Peak to Pima Mine-6' shoulders and 2" overlay	**39**	A	5	Y	15	960	0	**16**	N	37	1	2	**2.33**	10	N	0	$2,560,000	$2,560,000	20	1.0	3200	0	N	0	Y	10	N	0	**83**	TBD	
Tanque Verde Rd/Tanque Verde Loop Rd - Roundabout	**40**	C	15	Y	15	11925	4	**75**	N	26	3	6	**1.25**	0	N	0	$1,351,000	$1,351,000	25		483	0	N	0	N	0	Y	10	**81**	TBD	
Speedway Blvd: Camino De Oeste to Painted hills Rd. - Safety Shoulders	**41**	A	5	Y	15	2486	1	**6**	N	39	2	5	**2.46**	10	N	0	$1,100,000	$1,100,000	25		458	0	N	0	N	0	N	0	**80**	TBD	
Thornydale Rd: Linda Vista Blvd to Camino Del Norte - Shoulders	**42**	B	10	Y	15	7985	3	**49**	N	31	3	6	**1.12**	0	N	0	$1,350,000	$1,350,000	25	1.1	422	0	N	0	Y	10	N	0	**79**	2019	
Camino Loma Alta/Colossal Cave Road - Roundabout	**43**	B	10	Y	15	7936	3	**87**	N	24	3	6	**1.00**	0	N	0	$877,000	$877,000	30		313	0	N	0	N	0	Y	10	**77**	TBD	
Mary Ann Cleveland: Red Iron Trail to Colossal Cave Road-TWLTL	**44**	B	10	Y	15	8197	3	**34**	N	34	5	10	**1.35**	0	N	0	$1,200,000	$1,200,000	25	0.6	231	0	N	0	N	0	N	0	**72**	TBD	
Sandario Rd: Ina to Emigh, Add TWLTL	**45**	A	5	Y	15	4310	2	**138**	N	14	2	3	**1.33**	0	N	0	$800,000	$800,000	30		500	0	N	0	Y	10	Y	10	**71**	2019	
Lambert Lane/Pecos at Camino De La Tierra -Roundabout	**46**	C	15	Y	15	14546	5		N	0	1	1		0	N	0	$1,600,000	$91,200	50	7.9	2759	0	N	0	N	0	N	0	**70**	TBD	
Manville Rd: Sandario Rd to Central Arizona Project (CAP) Canal -roadway widening	**47**	A	5	Y	15	1045	0	**64**	N	28	1	2	**2.36**	10	N	0	$1,350,000	$1,350,000	25		1350	0	N	0	N	0	N	0	**69**	TBD	
Davis Ave: Ruthrauff to Curtis; Add street lights	**48**	A	5	N	0	5547	2		N	0		0		0	N	0	$75,000	$75,000	50		-	0	N	0	N	0	Y	10	**67**	TBD	
Swan Road at Cindrich Street; Street Lighting, Shoulder Widening	**49**	A	5	Y	15	3000	1		N	0		0		0	N	0	$300,000	$300,000	40		-	0	N	0	Y	10	Y	10	**66**	2023	
Bear Canyon: Indian Canyon-Collier School continuous left turn lane	**50**	A	5	Y	15	6314	2	**170**	N	8		0	**1.75**	0	N	0	$300,000	$300,000	40		-	0	N	0	Y	10	N	0	**66**	2019	
Rudasill Road/Tula Lane; Drain Str, Sh Widening, Geo Imp	**51**	A	5	Y	15	1222	0		N	0		0		0	Y	10	$300,000	$300,000	40		-	0	N	0	Y	10	N	0	**65**	2022	
Tanque Verde Rd at Wentworth Rd; Imp Vert Align, Shldr Widening	**52**	B	10	Y	15	6472	2		N	0	1	1		0	N	0	$350,000	$350,000	40		583	0	N	0	Y	10	N	0	**62**	2022	
Picture Rocks Rd: SNP Boundary (West) to Sandario Rd - widen to 3-lanes and drainage improvements.	**53**	B	10	Y	15	5969	2	**27**	N	35	6	12	**1.45**	0	Y	10	$8,700,000	$8,700,000	5		1500	0	N	0	N	0	N	0	**62**	TBD	

Table 19 2015 SMS Safety Project Priority List (Con't)

Proposed Project	Priority Rank	Existing LOS	SCORE	Reduces Congestion (Y/N)	SCORE	2015 Existing ADT	SCORE	TED Priority Index Rank (3yrs)	HAWK Signal (P/S/N) Pedestrian/School/None	SCORE	No. of Correctable Crashes (3yrs)	SCORE	Crash Severity Index (3 yrs)	SCORE	Flooding/Wet Pavement (Y/N)	SCORE	Total Project Cost	Pima County Cost	SCORE	Benefit Cost Ratio Information Only	Cost Effectiveness Ratio (Cost/Correctable Crashes)	SCORE	RTA Regional Corridor (Y/N)	SCORE	Adds Bicycle Lanes (Y/N)	SCORE	Adds Pedestrian Facilities (Y/N)	SCORE	TOTAL SCORE	Proposed Fiscal Year	Comments
		Congestion						Safety									Cost						Bicycle/Pedestrian								
Pontatoc Rd: 2500' S of Skyline; Install guardrail, signing	**54**	A	5	N	0	1300	0	**182**	N	6		0	**1.00**	0	N	0	$40,000	$40,000	50		-	0	N	0	N	0	N	0	**62**	TBD	
Via Rancho Del Lago/Colossal Cave Road - Roundabout	**55**	C	15	Y	15	12452	5		N	0	1	3		0	N	0	$877,000	$877,000	30		626	0	N	0	N	0	Y	10	**60**	TBD	
Sandario Rd: Picture Rocks Rd to Mile Wide Rd. widening/drainage	**56**	A	5	Y	15	4356	2	**18**	N	37	2	5	**1.80**	0	Y	10	$9,500,000	$9,500,000	5		3958	0	N	0	N	0	N	0	**58**	TBD	
Acacia Bluffs/Camino del Sol; Median opening, turn lane	**57**	A	5	N	0	6813	3		N	0		0		0	N	0	$75,000	$75,000	50		-	0	N	0	N	0	N	0	**58**	2023	
Overton Rd/Rancho Feliz Dr; Widen, overlay, int. re-alignment	**58**	B	10	Y	15	6239	2		N	0	1	2		0	N	0	$700,000	$700,000	35		700	0	N	0	Y	10	N	0	**57**	2021	
Andrada Rd/Wentworth Rd; Drain Str, Sh Widening, Geo Imp	**59**	A	5	Y	15	4589	2		N	0		0		0	Y	10	$900,000	$900,000	30		-	0	N	0	Y	10	N	0	**57**	2023	
Picture Rocks Rd: Wade to SNP Boundary (East) widening/alignment	**60**	B	10	Y	15	6700	3	**14**	N	38	7	15	**1.45**	0	N	0	$5,500,000	$5,500,000	5		743	0	N	0	N	0	N	0	**55**	TBD	
Bopp Rd/San Joaquin Rd - Roundabout	**61**	A	5	Y	15	5230	2		N	0	2	4		0	N	0	$591,000	$591,000	35		281	0	N	0	N	0	Y	10	**52**	TBD	
Camino de Oeste N. of Speedway; Drain Str, Shldr Widening, Geo Imp	**62**	A	5	Y	15	1871	1		N	0	1	1		0	Y	10	$1,100,000	$1,100,000	25		2200	0	N	0	Y	10	N	0	**51**	2022	
Twin Lakes Dr/Mainsail Blvd; Lighting, Intersection Improv.	**63**	A	5	N	0	1281	0		N	0		0		0	N	0	$100,000	$100,000	45		-	0	N	0	N	0	N	0	**50**	2019	
Sabino Canyon Road/Sunrise Drive - Roundabout	**64**	B	10	Y	15	9183	3		N	0	1	1		0	N	0	$1,492,587	$1,492,587	25		2132	0	N	0	N	0	Y	10	**48**	TBD	
Gates Pass Rd/Kinney Rd - Roundabout	**65**	A	5	Y	15	4504	2		N	0	0	0		0	N	0	$840,000	$840,000	30		-	0	N	0	N	0	Y	10	**47**	TBD	
La Cholla/Moore Sight Distance Improvements	**66**	A	5	N	0	3877	1		N	0		0		0	N	0	$412,000	$412,000	40		-	0	N	0	N	0	N	0	**46**	2023	
Bilby Road/Palomino Rd; Shldr Widening, Retain Wall, Geo Imp	**67**	A	5	Y	15	2113	1	**214**	N	0		0		0	N	0	$800,000	$800,000	30		-	0	N	0	Y	10	N	0	**46**	2021	
Kinney Rd/McCain Loop S. Intersection Improvements	**68**	A	5	Y	15	1406	1		N	0	0	0		0	N	0	$500,000	$500,000	40		-	0	N	0	N	0	N	0	**46**	TBD	
Silverbell Rd/Aguirre Rd; Geo Improvement, Signage	**69**	A	5	N	0	724	0		N	0		0		0	N	0	$400,000	$400,000	40		-	0	N	0	N	0	N	0	**45**	2022	
Tuscon Mtn Park - Traffic Calming and Traffic Circles	**70**	A	5	N	0		0		N	0		0		0	N	0	$500,000	$500,000	40		-	0	N	0	N	0	N	0	**45**	TBD	
King Canyon - Trail head Improvements	**71**	A	5	N	0		0		N	0		0		0	N	0	$400,000	$400,000	40		-	0	N	0	N	0	N	0	**45**	TBD	
Kinney Rd: Sandario Rd to Gates Pass Rd (Park Boundary) - Widening	**72**	A	5	Y	15	2473	1	**38**	N	33	6	12	**1.55**	0	N	0	$6,500,000	$6,500,000	5		1083	0	N	0	N	0	N	0	**44**	TBD	
Sandario Rd: Mile Wide Rd to Ajo Hwy. - Widening/drainage	**73**	A	5	Y	15	1500	1	**120**	N	18	3	6	**5.80**	10	N	0	$10,440,000	$10,440,000	5		3263	0	N	0	N	0	N	0	**38**	TBD	

6. Traffic Crash Statistics

Introduction

TED publishes the Pima County Traffic Crash Statistics each year in the SMS Report. Crash statistics for routinely monitored intersections and roadway segments within unincorporated Pima County that are the responsibility of TED are provided in the included tables. TED obtains a majority of the crash information from traffic crash reports submitted to TED by PCSD.

Regarding record availability and inclusion in this report, some intersections are the joint responsibility of Pima County and other local jurisdictions, including the City of Tucson, Town of Marana, Town of Oro Valley, and Town of Sahuarita. For those roadways bordering these jurisdictions or for those roadways that border or lie within the Tohono O'odham Nation, the Pascua Yaqui Nation, the Coronado National Forest, or the Saguaro National Parks (East and West), the crashes may have been investigated by that jurisdiction's law enforcement agency and not reported to PCSD.

Though TED has made a concerted effort to compile a complete database, some crash data may have been inaccessible due to these jurisdictional boundaries, roadway naming conventions, or differences in crash reporting methods. For the purposes of this report, statistical crash data is not included for any signalized intersection that is maintained by another jurisdiction.

General Information

PCDOT compiles basic information for all intersection and roadway segment locations for both the past one-year period (Calendar Year 2015) and three-year periods (Calendar Years 2013 through 2015). This information includes:

1. **Volume** — the average daily entering volume (ADEV) for intersections or the two-way average daily traffic volume (ADT) for roadway segments.

2. **Crashes** — the number of crashes that occurred at the intersection or within the boundaries of the roadway segment during the analysis period. For roadway segments, the number of crashes includes crashes that occurred at the intermediate intersections that involved any vehicle/pedestrian traveling on the defined segment. In addition, the crash frequency included in the roadway segment tabulations is the number of crashes per mile.

3. **Roadway segment length** — the length of the roadway segment in miles.

4. **Severity of Crashes** — the severity of each crash is based on the severity of the most seriously injured person involved in the crash. Additional information on this topic is provided in the discussion of Severity Index.

The statistics cited in this report were calculated using the above information. Statistics were compiled separately for intersections and for roadway segments. From this point forward, the term "location" will be used when referring to either an intersection or a roadway segment. The

calculated statistics are based on accepted, independent traffic engineering variables and are described as follows:

1. **Crash Frequency**—the number of crashes occurring at the intersection during the given time period or the number of crashes per mile occurring within the roadway segment during the given time period.

2. **Crash Rate**—expressed as crashes per million entering vehicles (c/mev) for intersections and as crashes per million vehicle miles (c/mvm) for roadway segments, the crash rate is calculated utilizing the traffic crash and volume information for both the one-year and three-year periods. The use of three-year data tends to de-emphasize unusually high or low annual crash rates caused by unique circumstances such as abnormally severe weather or modified travel patterns due to roadway/intersection related construction projects.

3. **Injury Scale** – Class 5 – Fatality
   Class 4 - Incapacitating injury
   Class 3 – Non-incapacitating injury
   Class 2 – Complaint of pain, possible injury but no visible signs
   Class 1 – No injury, property damage only

4. **Severity Index (SI)** —developed by the National Safety Council, The severity index (SI) of a crash is equal to the total equivalent property damage only (EPDO) divided by the number of crashes. The severity index is calculated using the following formula:

$$SI = \frac{5.8\,(Nk + Na) + 2\,(Nb + Nc) + Npd}{T}$$

where
SI = Severity index.
Nk = Number of fatal crashes.
Na = Number of crashes where the most severe injury was a Class 4 (incapacitating) injury.
Nb = Number of crashes where the most severe injury was a Class 3 (non-incapacitating) injury.
Nc = Number of crashes where the most severe injury was a Class 2 (possible injury/no visible sign of injury, but complaint of pain or momentary unconsciousness) injury.
Npd = Number of property damage only crashes.
T = Total number of crashes.

5. **Priority Index (PI)** — the priority index for each location is calculated by adding the rank of the three statistic groups (crash frequency, crash rate, and severity index) for each location. The three crash statistics are treated equally in importance, no one statistic is given extra weight prior to the summation.

6. **Priority Index Rank (PI Rank)** —Numerical ranking of the PI for each location, with “1” being the highest priority index rank. The lower the priority index, the higher the priority index rank and the more critical the need for corrective action.

For the separate statistic groups, each location is assigned a rank that represents the relative position of the location based upon decreasing values for the respective statistic group. More than

one location may have the same rank within each statistic group. Traffic volume was eliminated as a separately ranked variable since it is incorporated into the calculation of the crash rate.

Crash Statistics Tables

Section 1: Unsignalized Intersections with Four or More Crashes in 3 Years

This is an alphabetically arranged list of the 76 unsignalized intersections with four or more traffic crashes. Both one-year and three-year information is provided for each intersection regarding the intersection ADEV, crash frequency, crash rate, severity index, priority index, and the priority index rank.

Section 2: Signalized Intersections

This alphabetically arranged list provides traffic crash information for 103 Pima County maintained signalized intersections, operational as of December 31, 2015. As noted in the introduction, records may be incomplete for those intersections bordering another jurisdiction. The listing gives statistical information for both the past one-year and three-year periods. If the intersection has been signalized for less than five years, crash statistics may include crash data collected both before and after signalization.

Section 3: Roadway Segments with less than or equal to 10,000 vpd

This alphabetically arranged list provides traffic crash information for the roadway segments routinely monitored by TED that have traffic volumes of 10,000 vpd or less. Currently, there are about 261 roadway segments within this lower volume classification. TED provides information for each location regarding the roadway segment length, ADT, crash frequency per mile, crash rate per mile, severity index, priority index, and priority index rank.

Section 4: Roadway Segments with greater than 10,000 vpd

This alphabetically arranged list provides traffic crash information for the roadway segments routinely monitored by TED with traffic volumes greater than 10,000 vpd. Currently, about 123 roadway segments fall within this higher volume classification. TED provides information for each location regarding the roadway segment length, ADT, crash frequency per mile, crash rate per mile, severity index, priority index, and priority index rank.

Summary

PCDOT uses the crash statistics compiled herein to help identify and prioritize crash mitigation projects within unincorporated Pima County, to evaluate the safety impact of recent improvements, and to assess the current effectiveness of the SMS program. The same statistics are also now being used to provide information on the continued problem of transportation crashes and the toll they are taking not only on our community, but also our state and our nation.

PIMA COUNTY
TRANSPORTATION