ADOT Bicycle Safety Action Plan

ADOT MPD Task Assignment 18-10
PGTD 0440
Contract # T08-49-U0001

Working Paper 4 – Recommendations and Next Steps to Improve Bicycle Safety in Arizona

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August 31, 2011 rev1
091374036

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1 INTRODUCTION

1.1 Study Overview

According to the National Highway Traffic Safety Administration, in 2008, Arizona ranked ninth highest in the nation for bicyclist fatalities (2.92 fatalities per million residents); in that year, 19 bicyclists were killed on Arizona's roadways. While this represents a significant reduction from 2005 levels, when 36 bicyclists were killed, it is still above the U.S. average of 2.32 fatalities per million residents.

A review of Arizona crash data demonstrates that there were 1,089 bicycle-motor vehicle crashes reported on state highways between January 1, 2004 and December 31, 2008. The purpose of this Arizona Department of Transportation (ADOT) Bicycle Safety Action Plan (BSAP) is to identify improvements, programs, and strategies that, upon their implementation, will achieve the goal of reducing the frequency of bicyclist fatalities and injury crashes that occur on the State Highway System in Arizona. The BSAP includes effectiveness evaluation guidelines to allow progress to be measured over time on achievement of the BSAP goal. The improvements, programs, and strategies will support the goal and objectives identified in this working paper.

The BSAP will identify appropriate improvements, programs, and strategies that have a track record of effectiveness. Although it is typical that no single countermeasure or strategy will unilaterally reduce bicycle crashes, injuries, and/or fatalities, the combination of a comprehensive program of countermeasures can lead to a reduction in bicycle crashes. Potential improvements, programs, and strategies will consist of a combination of:

- Engineering solutions,
- Education of bicyclists and motorists,
- Improving enforcement of laws and regulations, and
- Evaluation guidelines to determine the effectiveness of the BSAP.

1.2 Study Area

The study area for the ADOT BSAP consists of all ADOT maintained highway rights-of-way. However, the study team fully recognizes that bicycle crashes, fatalities, and injuries in Arizona are not limited to state highway rights-of-way and occur on all Arizona roadways including those operated and maintained by county, tribal, and local jurisdictions. Education programs and engineering countermeasures recommended in the ADOT BSAP should extend beyond the State Highway System to non-State Highway System roadways including those in local cities, counties, and tribal lands.

County, tribal, and local agencies and jurisdictions are also encouraged to develop Bicycle Safety Action Plans for roadways within their jurisdiction.

1.3 Overview of Working Paper 4

Working Paper No. 1 presents a profile of bicycle safety on Arizona's state highways. The ADOT BSAP goal and emphasis areas were introduced in *Working Paper No. 2*. *Working Paper No. 3* identifies high priority crash locations on state highways, summarizes crash analyses at these locations, and identifies a menu of potential safety countermeasures that may be considered for implementation at each priority location to reduce bicycle crashes.

The purpose of *Working Paper No. 4* is to provide comprehensive recommendations to achieve the bicycle safety goal of the BSAP. Recommendations include policies, analysis tools, procedural and best-practices references, and programmatic consideration needed to improve bicycle safety on the State Highway System. Recommendations are intended for engineers/planners, bicyclist and motorist interest groups, law enforcement personnel, and others involved in improving bicycle safety.

Specifically, *Working Paper No. 4* includes the following:

- Chapter 1 – Introduction and Review of Goal, Emphasis Areas, and Priority Crash Locations
- Chapter 2 – Action Plan to Improve Bicyclist Safety on State Highways
- Chapter 3 – Funding for Bicycle Safety Improvements on the State Highway System
- Chapter 4 – Summary

1.4 ADOT Bicycle Safety Action Plan Goal

As proposed in Working Paper No. 2, the ADOT BSAP goal is:

Goal: Reduce the total number of bicycle crashes (fatalities and non-fatalities) on Arizona State Highways by 12 percent by the year 2018.

Between 2004 and 2008 there were 1,089 bicycle crashes on state highways, averaging 217 bicycle crashes on Arizona state highways each year. The reduction in bicycle crashes will be measured by a five-year average (2014 to 2018), with the years 2004 through 2008 acting as the base years. With a baseline of 217 crashes per year and a goal of 12-percent reduction, the target is a five-year average of 191, an average annual reduction of 26 crashes per year.

1.5 ADOT Bicycle Safety Action Plan Emphasis Areas

Emphasis areas to improve bicycle safety on the Arizona State Highway System were presented in *Working Paper No. 2* and are presented in **Table 1**. The majority of bicycle crashes in Arizona (approximately 90 percent) occur on local, city, and county roadways outside of ADOT jurisdiction. Although the goal and emphasis areas established for the BSAP focus on state highways, the countermeasures and mitigation strategies identified to achieve the BSAP goal should be considered by other jurisdictions to improve bicycle safety.

Table 1 – Emphasis Areas to Improve Bicyclist Safety on Arizona State Highways

	Emphasis Areas	Justification
1	Reduce the number of bicycle crashes in urbanized and developed areas (large urbanized, small urbanized, and small urban).	The vast majority of crashes occurred in urbanized areas. Crashes in rural areas represent a small percentage of crashes.
2	Reduce crashes in which a bicyclist or motorist failed to yield at signalized intersections.	36 percent of all crashes are attributable to bicyclists or motorists failing to yield at signalized intersections.
3	Reduce crashes in which a bicyclist or motorist failed to yield at unsignalized intersections.	14 percent of all crashes are attributable to bicyclists or motorists failing to yield at unsignalized (sign-controlled) intersections.
4	Reduce bicycle crashes involving vehicles making a right turn.	51 percent of bicycle crashes occurred while the motorist was making a right turn. The vast majority of these crashes occurred in urbanized commercial areas.
5	Reduce crashes in which the bicyclist was riding facing traffic (riding the wrong-way).	52 percent of crashes occurred when bicyclists were facing traffic. Of these, 37 percent of crashes occurred while the motorist was making a right turn.
6	Reduce crashes where the bicyclist was riding on the sidewalk.	32 percent of crashes involved a bicyclist riding on the sidewalk. Of these, 21 percent of the crashes involved the driver making a right turn.
7	Reduce bicycle crashes that occurred in dawn, dusk, or dark conditions.	22 percent of bicycle crashes occurred in dawn, dusk, or dark conditions.

1.6 State Highway "Concentration Area" Crashes

As documented in *Working Paper No. 1*, 1,089 motor vehicle-bicycle crashes occurred on Arizona state highways between 2004 and 2008. Utilizing GIS kernel analysis (a tool within ESRI ArcGIS that assists the user to spatially depict the density of a data set), state highway bicycle-motor vehicle crash "concentration areas" were identified. The tool was applied to develop density maps of bicycle crashes on state highways, as included in *Working Paper No. 1*.

A total of 746 crashes in the higher density areas ("concentration areas") were subsequently identified; Arizona Crash Reports were obtained for each of these 746 state highway concentration area crashes. The study team utilized the FHWA Pedestrian and Bicycle Crash Analysis Tool (PBCAT) to develop a database of the 746 "concentration areas" crashes. Hereafter, the term "concentration area crash" refers to the 746 crashes for which data was entered into the PBCAT database. This database serves as the basis for crash analysis. PBCAT was utilized to identify a "crash type" for each of the 746 crashes and to subsequently identify potential countermeasures utilizing the BIKESAFE Bicycle Countermeasure Selection System.

More than 70 specific bicyclist crash types are used in PBCAT. **Table 2** lists the top five crash types that comprise more than 50 percent of concentration area crashes. The crash types may be collapsed into 20 crash-typing groups. **Table 3** lists the three most frequent crash groups that comprise more than 50 percent of concentration area crashes.

Table 2 – State Highway Crash Types

Number of State Highway Crashes	Crash Type Number (PBCAT)	Crash Type Description
103	155	Bicyclist Ride Through - Signalized Intersection
83	141	Motorist Drive Out - Sign-Controlled Intersection
76	151	Motorist Drive Out - Right-Turn-on-Red
71	322	Motorist Drive Out - Commercial Driveway / Alley
61	152	Motorist Drive Out - Signalized Intersection

Table 3 – State Highway Crash Groups

Number of State Highway Crashes	Crash Group Number (PBCAT)	Crash Group Description
148	150	*Motorist Failed to Yield - Signalized Intersection*: The motorist enters an intersection and fails to stop at a traffic signal, striking a bicyclist who is traveling through the intersection on a perpendicular path. Typically, no turning movements are made by either party, except for a possible right turn on red. **Many of these crashes involve bicyclists who are riding the wrong-way against traffic**, either in the roadway or on the sidewalk approaching the intersection.
122	158	*Bicyclist Failed to Yield - Signalized Intersection:* The bicyclist enters an intersection on a red signal or is caught in the intersection by a signal change, colliding with a motorist who is traveling through the intersection. **This group of crashes could involve a lack of understanding of the signal or inexperience of a young bicyclist or flagrant disregard for the signal by an older bicyclist. In many of these crashes, the bicyclist is likely to be riding on the sidewalk or riding the wrong-way**, against traffic, and fail to notice the signal indication.
108	320	*Motorist Drove / Motorist Failed to Yield Midblock:* The motorist typically **pulls out of a driveway** or alleyway and fails to yield to a bicyclist riding along the roadway or a parallel path or sidewalk. **Two-thirds of these types** of crashes typically involve a bicyclist who **is riding the wrong-way against traffic**, either on the sidewalk or on the roadway.

1.7 Priority State Highway Bicycle-Motor Vehicle Crash Locations

Priority state highway crash locations for implementation of countermeasures to improve bicyclist safety were identified in *Working Paper No. 3*. High priority locations are classified as an "intersection/interchange" crash or as a "segment" crash.

1.7.1 Intersection/Interchange Crashes

Priority intersection/interchanges are those that meet the following criteria:

- Intersection experienced five or more crashes in the analysis period (2004-2008).

Table 4 lists priority intersection/interchange crash locations. Included in the table are the Location ID, intersection location, and the number of crashes. Fifteen intersections/interchange locations met the prioritization criteria. These 15 intersections experienced 85 bicycle-motor vehicle crashes during the analysis period.

These 15 intersections were analyzed in more detail and potential countermeasures for each location were identified. Mapping of each priority intersection/interchange is provided in Appendix B.

1.7.2 Segment Crashes

Priority segments are those that met the following criteria:

- Segment experienced more than five crashes in the analysis period (2004-2008), and
- Crashes per mile per year on the segment are greater than 1.

Nineteen segments met the prioritization criteria, comprising 441 crashes (of the 746 total "concentration area" crashes).

Table 5 lists the priority locations. Included in the table are the Location ID, segment limits, roadway characteristics (number of lanes, length), number of crashes, and the number of crashes per mile per year.

Table 4 – High Priority Intersection/Interchange Bicycle Crash Locations

Location ID	City/Town	On Street	Intersecting Street	Number of Crashes
39b	Tempe	Scottsdale Road	SR 202L Ramp	8
18c	Mesa	SR 87	SR 202L Ramp	6
26b	Phoenix	Indian School Road	SR 51 Ramp	6
28c	Phoenix	Northern Avenue	I-17 Frontage Road/Ramp	6
28e	Phoenix	Bethany Home Road	I-17 Frontage Road/Ramp	6
30a	Phoenix	Indian School Road	I-17 Frontage Road/Ramp	6
39a	Tempe	Priest Drive	SR 202L Ramp	6
39e	Tempe	Baseline Road	I-10 Ramp	6
6a	Chandler	Elliot Road	SR 101L Ramp/Frontage Road	5
6d	Chandler	SR 87	SR 202L Ramp	5
18e	Mesa	SR 87	McKellips Road	5
26f	Phoenix	7th Street	I-10 Ramp	5
26h	Phoenix	24th Street	SR 202L Ramp	5
27b	Phoenix	27th Avenue	SR-101L Frontage Road (Beardsley Road)	5
39f	Tempe	Priest Drive	US 60	5

Table 5 – High Priority Segment Bicycle Crash Locations

Location ID	City/Town	On Street	Limits	Number Through Lanes	Length (Miles)	Number of Crashes	Crashes/ Mile / Year
11c	Flagstaff	SR 40B	SR 89A to Elden Street	4	1	56	11.2
11a	Flagstaff	SR 89A (Milton Road)	I-17 to SR 40B	4	1.3	33	5.1
18a	Mesa	SR 101L Frontage Road/Ramp	University Drive to Broadway Road	2	1.01	15	3.0
11d	Flagstaff	Route 66	Switzer Canyon Drive to Lockett Road	4	3.1	45	2.9
22c	Oro Valley	SR 77	Mountain Vista Drive to Ina Road	6	1.33	19	2.9
40a	Tucson	SR 77 (Oracle Road)	River Road to Miracle Mile	6	2.5	32	2.6
8	Cottonwood	SR 89A	Cottonwood Street to Grosetta Road	4	0.63	8	2.5
44b	Yuma	SR 8B*	7th Street to Catalina Drive	4 or 6	3.05	35	2.3
24a	Payson	SR 87	Forest Drive to Ridge Lane	4	1.95	22	2.3
5	Casa Grande	SR 287/SR 387	Cottonwood Lane to Arizona Road	4	3.5	37	2.1
14b	Kingman	SR 66	I-40 to Armour Avenue	4	0.5	5	2.0
25e	Peoria and Glendale	US 60	Northern Avenue to Bethany Home Road	6	0.5	5	2.0
44a	Yuma	US 95*	Arizona Avenue to 24th Street	4	3.02	26	1.9

* Segments turned over to City of Yuma in 2010.

Table 5 – High Priority Segment Bicycle Crash Locations (continued)

Location ID	City/Town	On Street	Limits	Number Through Lanes	Length (Miles)	Number of Crashes	Crashes/ Mile / Year
40b	Tucson	SR 77 (Miracle Mile)	Fairview Avenue to Romero Road	4	0.67	6	1.8
35	Sedona	SR 89A	Dry Creek Road to Soldier Pass Road	4	1.88	15	1.6
11e	Flagstaff	US 180	SR 40B to Meade Lane	2	1.4	11	1.6
17b	Mesa	US 60X	Sossaman Road to Meridian Drive	6	5.02	34	1.4
37a	Sierra Vista	SR 92/SR 90	MLK Parkway/Tree Top Avenue to Calle Mercancia	4	2.49	15	1.2
19a	Mesa/ Gilbert	SR 87	Guadalupe Road to Baseline Road	6	1.02	6	1.2

2 ACTION PLAN TO IMPROVE BICYCLIST SAFETY ON STATE HIGHWAYS

Chapter 2 proposes an action plan to improve bicyclist safety on Arizona's highways. The action plan consists of action items to address needed revisions to policies and programs, or new tools to improve bicyclists' safety on the state highway system.

Each action item concludes with identification of the role of engineers, planners, law enforcement, and motorists/bicyclists. The action plan consists of the following action items, which are discussed in detail in the ensuing sections.

2.1 Conduct Roadway Safety Assessments for Priority Crash Locations

2.2 Modify ADOT Plans, Policies, and Guidelines

2.3 Install Pavement Markings to Discourage Wrong-way Bicycle Riding

2.4 Adopt an Arizona Complete Streets Policy

2.5 Consider Bicycles at Single Point Urban Interchanges (SPUIs)

2.6 Recommend Modifications to Arizona Crash Report Forms

2.7 Measure Bicyclist Ridership on State Highways

2.8 Recommend Enhancements to Arizona Driver License Manual and Customer Service Guide

2.9 Establish Connectivity / Alternative Routes to State Highways through Local Jurisdictions

2.10 Develop and Implement Bicyclist and Motorist Education Campaigns

2.11 Collaborate with Law Enforcement

2.12 Recommend Changes to Arizona Revised Statutes

2.13 Implement ADOT Access Management Plan

2.14 BSAP Evaluation Program

2.1 Conduct Roadway Safety Assessments for Priority Crash Locations

Working Paper No. 3 identified priority state highway bicycle-motor vehicle crash locations. The locations are reviewed in Section 1.7.

A menu of potential countermeasures that could be considered at each location was included in *Working Paper No. 3*. The countermeasures were identified from among 50 engineering, education, and enforcement countermeasures contained in the FHWA BIKESAFE Bicycle Countermeasure Selection System. More information about BIKESFE is available at (http://www.bicyclinginfo.org/bikesafe/).

The menu of countermeasures is presented at a planning level, based on countermeasures proven to effectively reduce the crash types most frequently exhibited at the priority

crash location. Potential countermeasures for consideration by engineers/planners and law enforcement personnel are presented. It is important to emphasize that a field review of each priority location was not conducted. Examples of potential countermeasures, as identified in *Working Paper No. 3*, to be considered at high crash locations include the following:

1. Curb radii reduction (to slow the speed of right-turning vehicles)
2. Sight distance improvement
3. Intersection signing and marking improvement
4. Bike lane or paved shoulder
5. Driveway improvement/access management
6. Intersection warning treatments (side path/ roadway intersection)

The next step in countermeasure development and implementation is to assemble a multidisciplinary team of traffic engineers, roadway designers, and bicycle professionals to collaboratively review each location, discuss, and select those countermeasures most appropriate considering engineering opportunities and constraints.

The ADOT Roadway Safety Assessment (RSA) program may provide an appropriate forum to review priority crash locations and develop appropriate recommendations. The RSA program conducts Road Safety Assessments on state, local, and tribal road facilities. The ADOT RSA team accepts application from interested agencies through an application process.

It is recommended that the ADOT Bicycle and Pedestrian Program collaborate with the ADOT RSA team to conduct RSAs for each priority location (19 segments and 15 intersections/interchanges). More information about the ADOT RSA program is available through the ADOT Traffic Safety Section (http://www.azdot.gov/highways/traffic/9620.asp). The RSA team may employ RSA materials that are specific to bicycle infrastructure that are currently being developed by FHWA.

Summary of Roles of Proposed Countermeasure: Implement Countermeasures at Priority Locations

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
-	-	• Conduct a Roadway Safety Assessment (RSA) for each priority crash location • Develop a program of improvements • Identify opportunities and funding for implementation	• Participate in RSA team

2.2 Modify ADOT Plans, Policies, and Guidelines

The FHWA and US Department of Transportation (USDOT) reaffirmed their support for bicycle and pedestrian accommodation on March 15, 2010 (*United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 15, 2010*, refer to http://www.dot.gov/affairs/2010/bicycle-ped.html, emphasis added):

> "Transportation agencies should plan, fund, and implement improvements to their walking and bicycling networks, including linkages to transit. In addition, DOT encourages transportation agencies **to go beyond the minimum requirements**, and proactively provide convenient, safe, and context-sensitive facilities that **foster increased use by bicyclists** and pedestrians of all ages and abilities, and utilize universal design characteristics when appropriate. Transportation programs and facilities should accommodate people of all ages and abilities, including people too young to drive, people who cannot drive, and people who choose not to drive.

The USDOT/FHWA Policy Statement directs agencies to develop policy statements that affirm their commitment to improving conditions for bicycling and walking, and to go beyond minimum design standards in doing so.

> "The DOT encourages States, local governments, professional associations, community organizations, public transportation agencies, and other government agencies, **to adopt similar policy statements** on bicycle and pedestrian accommodation as an indication of their commitment to accommodating bicyclists and pedestrians as an integral element of the transportation system. In support of this commitment, transportation agencies and local **communities should go beyond minimum design standards** and requirements to create safe, attractive, sustainable, accessible, and convenient bicycling and walking networks. Such actions include:
>
> 1. Considering walking and bicycling **as equals with other transportation modes**: The primary goal of a transportation system is to safely and efficiently move people and goods. Walking and bicycling are efficient transportation modes for most short trips and, where convenient intermodal systems exist, these nonmotorized trips can easily be linked with transit to significantly increase trip distance. **Because of the benefits they provide, transportation agencies should give the same priority to walking and bicycling as is given to other transportation modes**. Walking and bicycling should not be an afterthought in roadway design.

Arizona State Transportation Board Policies (revised January 4, 2011) also emphasize ADOT's commitment to accommodation of bicycles on the State Highway System. (http://www.azdot.gov/Board/PDF/Board_Policies_010411.pdf):

4: Multimodal Facilities Policy

2. It is the policy of the Board to facilitate and encourage the development and use of alternate transportation modes by (emphasis added):

   a) Reflecting the **integration** of all modes of transportation (e.g. motor vehicles, rail, air, **bicycle, pedestrian,** and other modes) in all phases of project planning and development.

   c) Directing ADOT to accommodate other modes where possible whenever constructing, revising, and/or improving a highway **by evaluating how pedestrian, bicycle**, transit improvements and inter-modal transfer facilities **can be incorporated in the design**.

7: Bicycle and Pedestrian Facilities Policy

1. It is the policy of the Board to **encourage bicycling and walking** as viable transportation modes, and actively work toward improving the transportation network so that these modes are accommodated, by:

   a) **Promoting increased use of bicycling and walking**, and accommodating bicycle and pedestrian needs in the planning, design and construction of transportation facilities alongside state highways.

   b) Developing design guidelines and measures that give the roadway designer flexibility in **accommodating the needs of all users** of the transportation facility.

   c) Developing design guideline implementation policies that **balance** the needs of **motorists, bicyclists and pedestrians**.

2.2.1 ADOT Bicycle Policy

The ADOT Bicycle Policy, MGT 02-01 (http://www.azbikeped.org/images/MGT01-2%20Bike%20Policy.pdf) establishes uniform guidelines for accommodating bicycle travel on the State Highway System. The policy was updated in 2007 and specified a review date of 2010. The ADOT Bicycle Policy has provided significant benefits to bicyclists on the state highway system. However, crash analysis conducted for the BSAP demonstrates that improvements to bicycling safety are needed on the State Highway System. A strengthening of the ADOT Bicycle Policy can contribute to improved bicyclist safety on state highways.

It is suggested that an internal ADOT Work Group be established to review the ADOT Bicycle Policy, and to propose changes that reflect both ADOT Transportation Board Policies and recent FHWA policy statements as described above.

Potential revisions to the ADOT Bicycle Policy, for consideration by the internal ADOT work group, are identified below. Potential additions to the Policy are in *italics;* deletions are in strike through ~~(strikethrough).~~

POLICY

1. It is ADOT's goal to develop a transportation infrastructure that provides safe and convenient bicycle access *that fosters increased usage by bicyclists*. ADOT further advocates that bicyclists have the right to operate in a legal manner on all roadways open to public travel, with the exception of fully controlled-access highways. Bicyclists may use fully controlled-access highways in Arizona except where specifically excluded by regulation and where posted signs give notice of a prohibition. In support of, and in accord with the foregoing, it is ADOT's policy to:

   a. *Go beyond minimum requirements to* include provisions for bicycle travel in all new major construction and major reconstruction projects on the state highway system. New bridge and roadway widening projects are normally considered as being within the scope of major construction or major reconstruction. *Bicycle accommodation will be considered in* pavement preservation, minor and spot improvement projects ~~are not included~~ *if the cost of accommodations is reasonable and feasible; at a minimum,* existing widths for bicycles will be maintained. The scoping documents for new construction and reconstruction will define the parameters for inclusion of bicycle travel.

   b. Utilize the AASHTO Guide for the Development of Bicycle Facilities as the design guide for roadway features to accommodate bicycles.

   c. Utilize the Manual on Uniform Traffic Control Devices. Part 9 as adopted in accordance with ARS 28-641 for design of traffic controls for bicycle facilities.

   d. Provide shared roadway cross-section templates as a minimum condition with new major construction and major reconstruction projects, regardless of the presence of a shared use path.

   e. ~~Consider,~~ *Provide* as a part of major new construction and major reconstruction in urban areas, wide curb lanes up to 15' in width (exclusive of gutter pan) and placement of a stripe at the vehicle lane edge where appropriate. ~~This decision will be made on a project basis weighing such factors as location, vehicular traffic, grades, anticipated bicycle usage, and right of way availability.~~

   f. ~~Consider,~~ *Provide* bicycle lanes for inclusion with major new construction or major reconstruction when~~:1) incremental costs for construction and maintenance are funded by a local agency AND 2)~~ the bicycle lane is included as a part of a bicycle facilities plan adopted by a local agency.

   g. As a part of major new construction and major reconstruction, ADOT will fund and construct at-grade or grade separated (including bridges) street or roadway crossings of state highway system roadways to meet cross section templates accommodating bicyclists that have been adopted as standard by the local agency. The limits of construction are determined on a project-by-project basis, are normally within the ADOT right of way, and may include appropriate transitions to existing roadways outside of ADOT right of way.

h. Accommodate shared use paths within the ADOT right of way when the facilities are: 1) designed and located in accordance with accepted criteria for a proper and safe facility AND 2) funded and properly maintained by the local agency.

i. Utilize the ADOT Traffic Engineering PGP # 1030 to designate route sections where bicycle traffic is prohibited on fully access-controlled State Highways.

j. Utilize the ADOT Traffic Engineering PGP # 480 for placement of longitudinal rumble strips on State Highways.

k. Use pavement surfacing materials that provide reasonably smooth surfaces on travel lanes and shoulders in conjunction with paving projects.

1. ~~Evaluate and consider the impacts of~~ *Accommodate* bicyclists when restriping roadways in conjunction with new construction, reconstruction, pavement preservation and minor spot improvement projects.

m. Utilize Intergovernmental Agreements to define funding and maintenance responsibilities with local governments for bicycle facilities within State highway right-of-way.

2. It is ADOT's Policy not to:

a. Reduce existing travel lane widths *on higher speed, free flowing, principal arterials* to accommodate bicycle traffic unless the *need is justified to allow provision for bicyclists, and* supported by a traffic study. *Travel lane widths may be considered for reduction to accommodate bicycles under interrupted-flow operating conditions at lower posted speeds (45 mph or less). Narrower lane widths on lower speed (45 mph or less) facilities are normally adequate and have some advantages.* Concurrence by the State Traffic Engineer and the Assistant Engineer, Roadway Engineering Group are required.

b. Sign or designate bikeways on any roadways on the State Highway System or roads on State owned right of way without concurrence of the District Engineer and State Bicycle Coordinator.

c. Sign or designate sidewalks as bicycle routes or bikeways.

d. Use transportation enhancement funds for maintenance of bicycle facilities.

e. Mark or sign sidewalks or shared-use paths on State right of way parallel and adjacent to roadways for the preferential or exclusive use of bicyclists per ADOT Traffic Engineering PGP # 1031.

3. It is ADOT's policy to require written approval from the State Traffic Engineer and the Assistant State Engineer, Roadway Engineering Group in consultation with the State Bicycle Coordinator for any variations or exceptions to this policy.

2.2.2 ADOT Roadway Design Guidelines

Modifications to ADOT, Roadway Engineering Group, Roadway Design Guidelines

(http://www.azdot.gov/highways/Roadway_Engineering/Roadway_Design/Guidelines/Manuals/PDF/RoadwayDesignGuidelines.pdf) should be considered to improve the routine accommodation of bicycles on the State Highway System. Potential modifications are listed below. Additions are indicated in *italics*; deletions are shown in strikethrough (~~strikethrough~~).

209.1 – Climbing Lanes, paragraph 7

Also see the design memorandum entitled "A Policy on the Design of Passing Lanes and Climbing Lanes" on the Roadway Design website~~. If bicyclists are utilizing the facility, a~~ *A* minimum shoulder width of 4 ft *or more* should be provided *to accommodate bicyclists*.

209.2 – Passing Lanes, paragraph 8

For adding passing lanes to existing roadways, see the design memorandum entitled "A Policy on the Design of Passing Lanes and Climbing Lanes" on the Roadway Design website. ~~If bicyclists are utilizing the facility, a~~ *A* minimum shoulder width of 4 ft *or more* should be provided *to accommodate bicyclists.*

306.4 – Urban Cross Sections, paragraph 3:

A) Urban Section UA*:* This section should be used on highways for the initial construction to four lanes. This section is normally used as the urban extension of a divided rural or fringe-urban highway. Use of this section should be based, in part, on a consideration of the access requirements of adjacent properties. The section may not be appropriate for areas of heavy strip development. ~~On a project by project basis,~~ *Provide* a 15 ft outside lane, exclusive of curb and gutter, ~~may be considered to accommodate bicycle usage.~~ *and place a stripe at the vehicle edge line* to accommodate bicycle usage. ~~Factors to be considered include location, vehicular traffic, grades, anticipated bicycle usage, and right of way availability.~~

408.11 - Right Turn Channelization**,** paragraph 13

D) Bicycle Buffer: ~~Where bicycles are expected to be prevalent, a~~ *A* buffer area between the through lane and the right-turn lane should be provided. Figure 408.11A shows the bicycle buffer with a wide curb lane. The buffer area is formed by the extension of the through lane and the face of curb line. Figure 408.11B shows the bicycle buffer for non-curb and gutter sections. ~~The buffer may be omitted where bicycle traffic or right-turn traffic is expected to be infrequent.~~

2.2.3 ADOT Safety Action Plan, Arizona Strategic Highway Safety Plan, and FHWA Oversight Agreement

ADOT Safety Action Plan

The ADOT Safety Action Plan (2009) provide suggestions to enhance ADOT's focus on its road safety goals and to empower the agency to take a leadership role in addressing safety issues throughout the state of Arizona. The ASAP was developed based on more than 30 interviews with ADOT staff in the Intermodal Transportation Division, Multimodal Planning Division, Motor Vehicle Division, and other divisions, as well as safety staff from related agencies.

The ASAP identified bicycles as an important safety consideration in the following recommendation (ASAP, page 2-9):

> Progress would be maximized by encouraging staff to go "above and beyond" traditional engineering practices. Crashes have many factors, which must be considered in developing safety countermeasures, including:
>
> - Demographic factors: e.g., young, old, ethnic groups
> - Behaviors: e.g., impairment, fatigue, use of occupant protection
> - Crash types: e.g., roadway departure, intersection, multi-vehicle, single vehicle, vehicle type
> - Modes: e.g., passenger car, pedestrian, bicycle, heavy truck, motorcycle

It is recommended that as the future updates to the ADOT Safety Action Plan should be coordinated with findings of the ADOT Bicycle Safety Action Plan. Bicyclist safety can be incorporated throughout the ASAP. Potential considerations could include:

- Incorporate bicycle fatalities and injuries into the "Safety Dash Board".
- Include bicycle representation in the proposed ADOT Safety Management Team.
- Include bicycle safety considerations in the project scoping of all projects.

Arizona Strategic Highway Safety Plan (SHSP)

(http://www.azdot.gov/Highways/Traffic/TSS/SHSP/AZ_Strategic_Highway_Safety_Plan.pdf)

The Arizona Strategic Highway Safety Plan was completed in 2007. While bicycles are not specifically identified as an emphasis area of the Plan, the SHSP addresses bicycling through the following:

- The Governor's Traffic Safety Advisory Council (GTSAC) includes a School-Based Initiatives Subcommittee that develops and implements strategies to improve the safety of children walking and bicycling to / from school (page 3).
- Bicycle safety is addressed through multiple emphasis areas, including:
  - Selection of lane departure fatalities and intersection fatalities would also address 46 percent of Arizona's bicycle fatalities and serious injuries (page 19).

- An Intersection Strategy and Countermeasure is to improve the operation of pedestrian and bicycle facilities and promote the implementation of the Statewide Pedestrian Safety Action Plan (page 93-94). The SHSP recommends that bicycle and pedestrian facilities be improved at intersections with high number of pedestrian and bicycle fatalities.

Findings of the Bicycle Safety Action Plan may be considered during the next update of the Arizona Strategic Highway Safety Plan.

FHWA and ADOT Stewardship Oversight Agreement for Arizona (http://www.fhwa.dot.gov/azdiv/stewtoc.htm)

The FHWA and ADOT Stewardship and Oversight Agreement for Arizona (March 2010) includes performance measures associated with the performance of the Federal Aid Highway Program in Arizona. These performance measures are developed, reassessed, and/or revised as necessary on an annual basis. The Agreement currently includes performance measures for pedestrian safety, including the number of pedestrian fatalities (current year + 4 year history), and the number of state highway system pedestrian fatalities (current year + 4 year history).

It is proposed that bicycle safety performance measures be considered for inclusion in the Oversight Agreement:

- Number of statewide bicyclist fatalities (current year + 4 year history).
- Number of state highway system bicyclist fatalities (current year + 4 year history).

Inclusion of bicycle safety data in the Oversight Agreement will demonstrate bicycle safety trends both statewide and on the state highway system.

Summary of Roles of Proposed Countermeasure: ADOT Bicycle Policy and Road Design Guidelines

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
-	-	• Review ADOT Bicycle Policy and Roadway Design Guidelines • Incorporate language into ADOT Bicycle Policy and Roadway Design Guidelines to strengthen the accommodation of bicycling on state highways, consistent with USDOT Policy Statement • Consider bicycles in updates to the ASAP, Strategic Highway Safety Plan, and FHWA and ADOT Stewardship and Oversight Agreement	-

2.3 Install Pavement Markings or Signage to Discourage Wrong-Way Bicycle Riding

Wrong-way bicycle riding was identified as a common contributing factor to bicycle-motor vehicle crashes.

Potential countermeasures to reduce wrong-way bicycle riding, during which the bicyclist is riding while facing traffic, include pavement markings and signage.

Currently, ADOT Bicycle Policy is not to mark shoulders as bicycle lanes unless funded by the local agency and with concurrence of the District Engineer. It is suggested that ADOT allow pavement markings and/or signage in or adjacent to shoulders that meet minimum widths for bike lanes (based on AASHTO's *Guide for the Development of Bicycle Facilities*), particularly those located at BSAP priority locations. These pavement markings and/or signage would help indicate the appropriate direction of travel for the bicyclist.

Potential signing and marking alternatives include:

- Install a bicycle lane symbol with a directional arrow. Ideally, a directional arrow would be placed at the beginning and end of each block. Currently, ADOT policy does not allow for the signing and marking of shoulders as bicycle lanes unless funded and maintained by local agencies. This option would require modification of ADOT Bicycle Policy, ADOT design guidelines, and ADOT Traffic Engineering Policies, Guidelines and Procedures (PGP), to allow pavement markings to be placed in wide shoulders.
- Install "Bicycle Wrong Way" (Section 9B.07) and 'Ride with Traffic" (R5-1b, R9-3cP) signs, consistent with MUTCD.

Summary of Roles of Proposed Countermeasure: Pavement Markings

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
• Follow laws and safe practices by riding with traffic	-	• Review ADOT Bicycle Policy and Traffic Engineering PGP • Install "Bicycle Wrong Way, Ride With Traffic" signs on state highway segments that exhibit a high degree of wrong-way bicycle riding crash types • Develop a plan to obtain ADOT approval to install bicycle lane pavement markings on wide shoulders	• Enforce wrong-way bicycling riding on the roadway

2.4 Adopt Arizona Complete Streets Policy

State highways often serve as a "Main Street" in many of Arizona's urbanized rural communities. These state highways serve multiple users, including vehicles, pedestrians, and bicyclists; however, many state highways through rural urbanized areas are designed primarily for motor vehicles. Improving state highways to accommodate all users is essential to improving bicyclist safety. Roadways that serve all users are often referred to as "Complete Streets." An ongoing movement across the country is to "complete the streets," by planning and constructing road networks that are safer and more welcoming for all users.

It is recommended that ADOT develop and implement a Complete Streets Policy that addresses accommodation of all roadway users on state highways, particularly through urbanized rural communities and the crossing of relatively wide state highways including interchanges and large intersections.

Developing and implementing a Complete Streets Policy would ensure that ADOT consistently designs and operate the entire roadway with all users in mind ─ including bicyclists, public transportation vehicles and riders, and pedestrians of all ages and abilities (www.completestreets.org, accessed on March 4, 2011).

An ADOT Complete Streets Policy may include language similar to the following:

> The State Department of Transportation shall provide for the needs of drivers, public transportation vehicles and patrons, bicyclists, and pedestrians of all ages and abilities in all planning, programming, design, construction, reconstruction, retrofit, operations, and maintenance activities and products. The Department shall view all transportation improvements as opportunities to improve safety, access, and mobility for all travelers in Arizona and recognizes bicycle, pedestrian, and transit modes as integral elements of the transportation system (www.completestreets.org, accessed on June 25, 2011).

An ADOT Complete Streets Policy should address the following: (http://www.completestreets.org/changing-policy/model-policy/model-state-legislation-options, accessed on June 25, 2011):

- Direct roadways to be designed and operated to be safe and accessible for all users, including: bicyclists, pedestrians, transit users, and motorists of all ages and abilities, including children, youth, families, older adults, and individuals with disabilities.
- Apply to all state highways, recognizing that roadway design should be appropriate to the function and context of the facility, and should be sensitive to the surrounding land use and community character (e.g., rural, suburban, or urban context). The policy should recognize that complete streets elements will differ in rural and urban areas.
- Recognize the local context and that that the needs vary in urban, suburban, and rural settings. The policy could specifically define applicability limits (e.g., within one mile of an urban area).

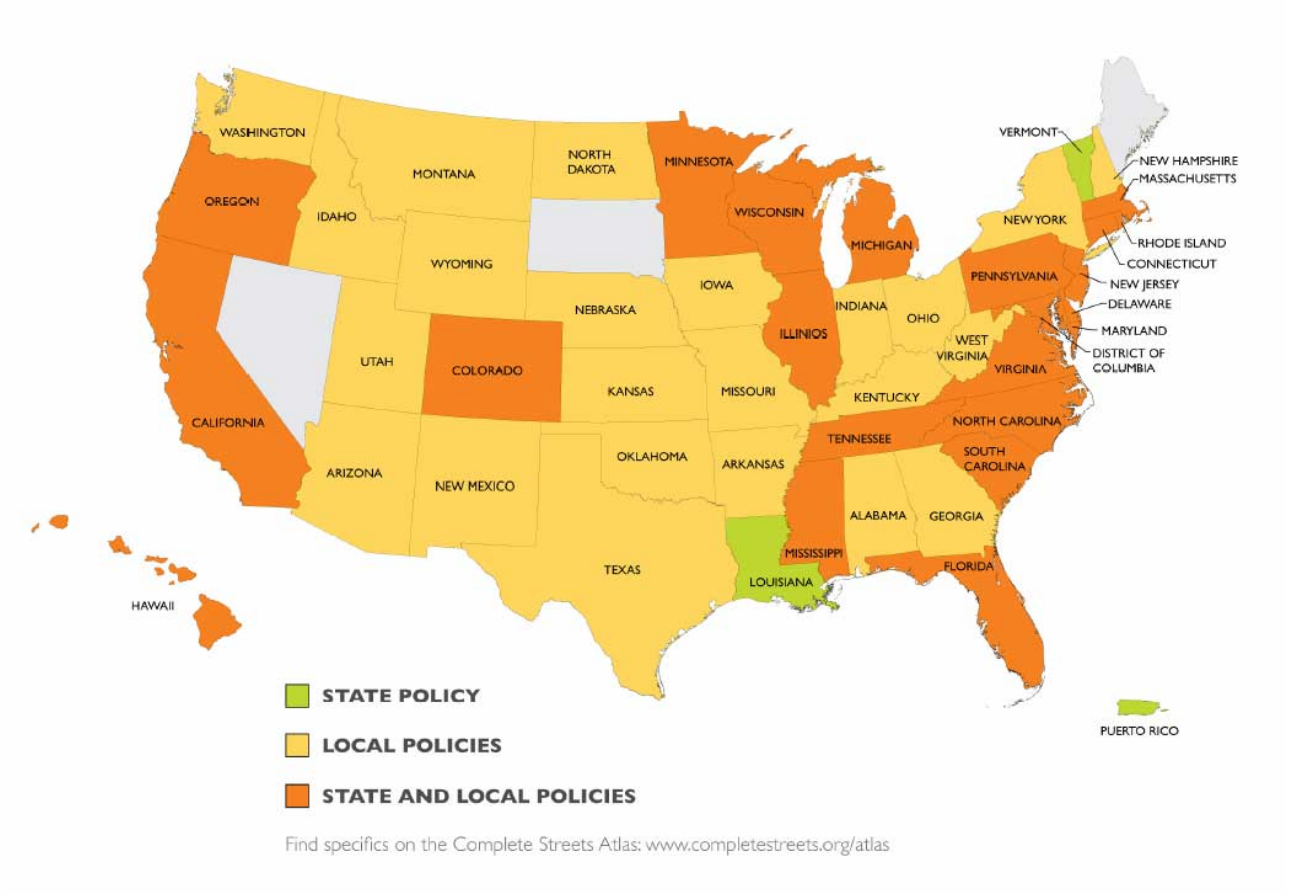
- Be applicable in almost all transportation projects and phases, including any construction, reconstruction, retrofit, maintenance, alteration, or repair of streets, bridges, or other portions of the transportation network.
- Recognize that there is no requirement to immediately retrofit (this serves to alleviate concerns that a policy would mandate immediate retrofits on all existing roads).
- Include minimal number of exceptions. Example exceptions are where non-motorized users are prohibited, or there is an irrefutable absence of present and future need, or the project places "excessive" or "disproportionate" costs compared to need or probable use. Exceptions should be rare, documented and publicly available, and approved at a high level.

According to the National Complete Streets Coalition, as of May 2011, 29 states have adopted some form of state-level Complete Streets policy (legislation, design guidelines, executive order, and/or internal policy) aimed at converting street networks into complete streets. Key findings of "*Complete Streets Policy Analysis 2010: A Story of Growing Strength*," were:

- "Over one-third of all Complete Streets policies adopted are expressed through relatively simple resolutions, and approximately one-quarter are laws or ordinances. Internal policies, expressed through top-level departmental objectives, made up about 12 percent of all policies, and 14 percent are contained inside planning documents such as comprehensive plans."
- State governments must lead. "Localities look to the state to provide examples of policy language, but also how to effectively create Complete Streets. Outreach from the New Jersey and Wisconsin DOTs [has] helped not only their district departments, but also locals, understand the more technical and process details to Complete Streets."
- The strongest policies are those that are clear in intent, stating facilities that meet the needs of all types of travelers using the roadway "shall" or "must" be included in transportation projects.

The status of Complete Streets adoption throughout the United States is shown in **Figure 1**. Sixteen states have adopted a state-wide Complete Streets policy in the form of legislation, resolution, executive orders, or design guidance. Examples are available at. http://www.completestreets.org/changing-policy/model-policy/model-state-legislation-options/. The State of California developed an internal DOT policy through California Department of Transportation (Caltrans) Deputy Directive Number DD-64-R1, entitled "Complete Streets - Integrating the Transportation System." The internal policy provides a policy statement, definitions/background, responsibilities regarding implementing complete streets, and an applicability statement. The Deputy Directive is provided at: http://www.dot.ca.gov/hq/tpp/offices/ocp/complete_streets_files/dd_64_r1_signed.pdf; and further information on this policy is provided at: http://www.dot.ca.gov/hq/tpp/offices/ocp/complete_streets.html. Caltrans followed up by developing a guide for *Complete Intersections* (refer to http://www.dot.ca.gov/hq/traffops/survey/pedestrian/.)

Within Arizona, the Maricopa Association of Governments recently developed the MAG Complete Streets Design Guide. The City of Scottsdale is the only Arizona jurisdiction with a Complete Streets policy.



Source: http://www.completestreets.org/webdocs/resources/cs-policyanalysis.pdf

Figure 1 – Nationwide Status of Complete Streets Policy Development

Summary of Roles of Proposed Countermeasure: Complete Streets Policy

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
-	-	• Develop an internal DOT policy that would be approved/signed by ADOT State Engineer	-

2.5 Consider Bicycles at Single Point Urban Interchanges (SPUIs)

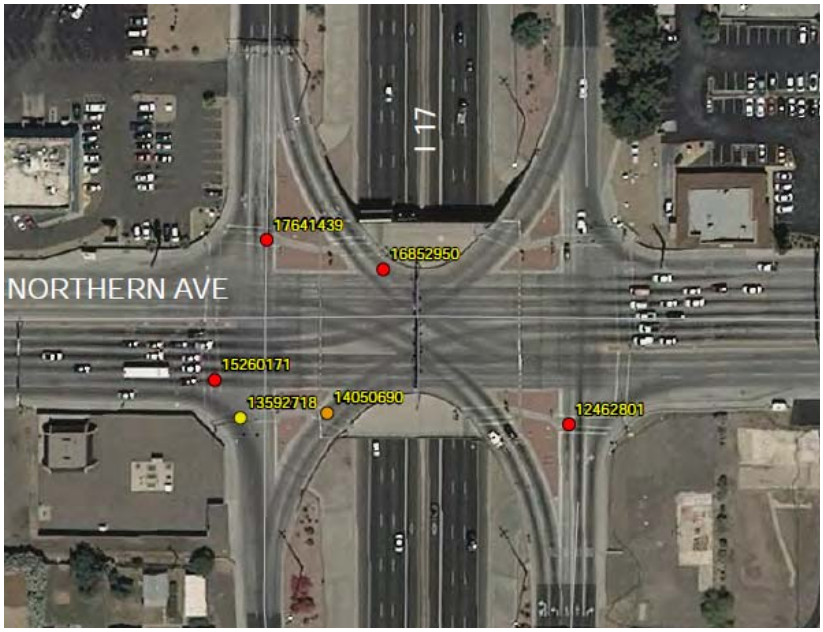
The BSAP has identified that a significant number of bicycle-motor vehicle crashes occur at interchanges.

Interchanges can present many challenges for bicyclists. Ramp angles and design speeds encourage drivers to primarily focus on vehicular traffic and provide insufficient attention to bicyclists and pedestrians. Turning roadways for on-ramps and off-ramps require roadway markings and signage for bicyclists and pedestrians are frequently discontinuous through interchange areas. As stated in the AASHTO Guide for the Development of Bicycle Facilities (1999):

> "Turning roadways provided for interchange ramp ingress and egress often require bicyclists on the cross street to perform merging, weaving, or crossing maneuvers with ramp vehicles. These conflict points are made challenging when a wide disparity exists between traffic on the ramp and cross street bicycle traffic crossing the ramp…. If a bike lane or route must traverse an interchange area, these intersections or conflict points should be designed to limit the conflict areas or to eliminate unnecessary uncontrolled ramp connections to urban roadways"

Interchanges can better accommodate bicycles by constructing ramp angles at 90 degree/right angles, designing exit ramps for low-speed ramp-cross street intersections, limiting free flow right-turn lanes to one lane, and continuing cross-street shoulder widths through the interchange area.

Several of the priority intersection/interchange locations, which experienced a significant number of bicycle-motor vehicles crashes, are single point urban interchanges (SPUI). An example of a SPUI is shown below. SPUIs are similar to diamond interchanges except that in a SPUI, the two intersections of a diamond interchange are combined into a single intersection, allowing opposing left turn movements. SPUIs can provide improved operations and reduced right-of-way requirements compared to other interchange forms; however, their design can be challenging for bicyclists due to a number of considerations, including:



- Due to the large intersection area,

bicyclists may need more green and all-red clearance time before opposing traffic proceeds;

- The presence of bicycles, due to their slower speeds, may reduce the capacity of the SPUI, thereby negating the benefits of the SPUI over other design alternatives.

A number of states have adopted SPUI guidelines that consider bicyclists. For example, Caltrans has developed guidelines to better accommodate bicyclists, as described in a Memorandum dated June 15, 2001, entitled, "Single Point Interchange Planning, Design, and Operations Guidelines." Caltrans refers to SPUIs as Single Point Interchanges (SPI). Excerpts regarding SPI designs to accommodate bicyclists are (emphasis added):

> "**(refer to Figure 2 below)** shows a Compact SPI designed to accommodate bicyclists, and minimize the intersection size thus improve overall operations. . . . The Compact SPI design utilizes a **single lane free right turn lane** so bicyclists need to cross only one lane of uncontrolled traffic. . . . To accommodate bicyclists through SPI intersections, all SPI alternatives shall be Compact SPI . . . If an SPI alternative other than a Compact SPI is chosen, a separate bicycle facility shall be constructed in conjunction with the SPI. The separate bicycle facility would typically be a bicycle overcrossing or undercrossing and should be located in the immediate vicinity of the SPI to minimize out of direction travel by bicyclists. . . . **If it is anticipated that in the future the right turn move at a Compact SPI will be signalized, a separate bicycle facility should be incorporated into the current project**. **Bicycle push buttons to extend the next through-move green phase for bicyclists have been installed in California**. The push button is located at the limit line and near the curb facing the street for easy bicyclist access. This allows the bicyclist to cross the SPI with minimum conflict. . . . This concept may be applicable at other existing SPIs. Where bicycle push buttons are installed at SPIs, a sign advising bicyclists that pushing the button will provide an extended green light on the next cycle shall be installed. The sign should be white on green, have a bicycle symbol and say: 'Push button for more time on next green."

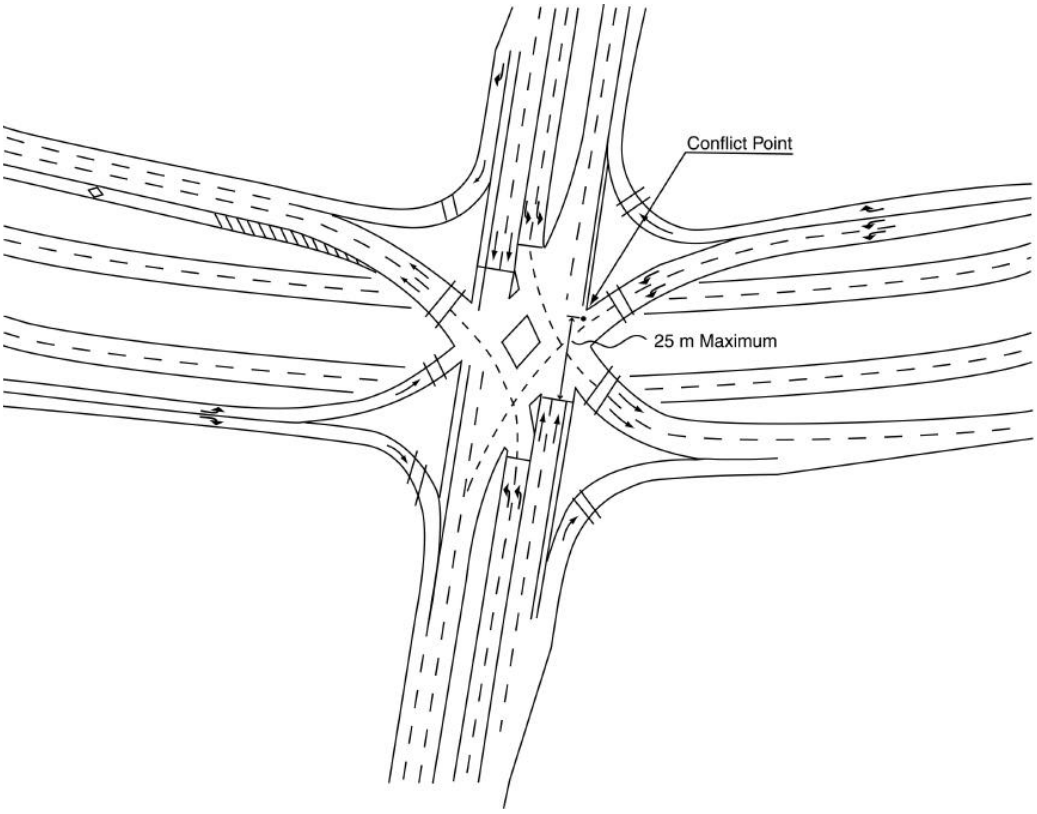


Figure 2 – Compact SPI to Accommodate Bicyclists

Source: Caltrans, http://www.dot.ca.gov/hq/oppd/spiguides6_15_01.pdf

Another example of a bicycle-friendly SPUI design is shown in **Figure 3**, and is from the Oregon Department of Transportation, Statewide Bicycle and Pedestrian Plan Update. ODOT provides the following guidance regarding SPUI designs to make them more accessible for bicyclists and pedestrians (source: http://www.oregon.gov/ODOT/HWY/BIKEPED/docs/OBP_Plan/Chapter_6_intersections.pdf?ga=t, accessed on May 27, 2011):

> "The Single Point Urban Interchange is gaining favor for urban locations because of the reduced need for right-of-way. It can be made accessible to pedestrians and bicyclists by following these principles:
>
> - Each vehicular movement should be clearly defined and controlled;
> - Exit and entry ramps should be designed at close to right angles;
> - Pedestrian crossings should be visible and easily identifiable;
> - Pedestrians should not be required to cross more than one or two lanes at a time;
> - Bicyclists should be able to proceed through the intersection in a straight line;
> - Motor vehicles merging to and from freeway on/off ramps should be required to yield to through cyclists.

The SPUI works reasonably well for pedestrians and bicyclists if the intersection is that of a local thoroughfare and a freeway; pedestrian and bicyclists need to be accommodated only on the cross-street, not the freeway. If a SPUI is used for the grade-separated intersection of two surface streets, which accommodate pedestrians and cyclists, then the SPUI design is not effective, as pedestrians and cyclists on one of the streets will be in a freeway-like environment, with free-flowing exiting and merging ramps."

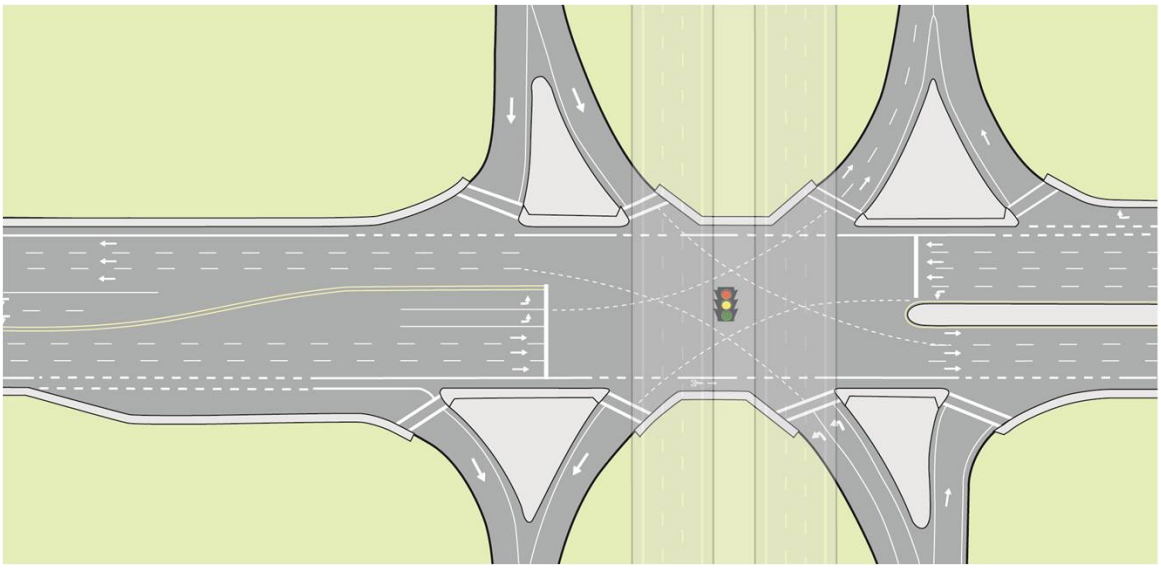


Figure 3 – State of Oregon SPUI Design

Source: Oregon Department of Transportation

Summary of Roles of Proposed Countermeasure: Bicycle Accommodation at Interchanges

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
• Be particularly alert when crossing through interchanges	• Be alert for bicycles at interchanges and intersections	• Design interchanges to accommodate bicycles	-

2.6 Recommend Modifications to Arizona Crash Report Form

The analysis of bicycle crashes, as documented in *Working Paper No. 1*, employed the Pedestrian Bicycle Crash Analysis Tool (PBCAT). The use of PBCAT enabled the study team to associate crash data that led to the identification of a crash type for each analyzed bicycle-motor vehicle crash. To complete the PBCAT analysis, the study team compiled data beyond that available in the Arizona Crash Report. In many cases, the data was readily available through roadway inventory databases. In other cases, the data was not

readily available and ideally would have been provided by the police officer at the time of the crash.

The Arizona Crash Report form was updated in 2009; however, the new format was not in use during the BSAP analysis period, which analyzed crashes that occurred between 2004 and 2008. While the 2009 Arizona Crash Report form represents a significant improvement over its predecessor, additional enhancements to the form with respect to bicycle crashes will allow improved analysis of bicycle crashes. It is suggested that a thorough review of the Arizona Crash Report form be undertaken and modifications and enhancements to improve data collection regarding bicycles be identified. Our review of the Arizona Crash Report form identifies that the data items described in **Table 6** could be included or enhanced in the Arizona Crash Report form.

Perhaps as important as new data items is emphasis of the importance of comprehensively completing the existing data fields in the Arizona Crash Report form. The BSAP crash analysis demonstrated that many of the data fields were left incomplete, particularly as they related to the bicyclist.

Table 6 – Comparison of Arizona Crash Report Form, ADOT Crash Record Database, and BSAP PBCAT Database fields

Arizona Crash Report Data Item	Data Description	Discussion	Recommendation for Arizona Crash Report
4dd	Safety Devices	The current definition in the Crash Report form states that "helmet used…is not used for non-motorists such as bicycle and other pedal cycle riders and vehicle occupants other than motorized cycles." The Model Minimum Uniform Crash Criteria, Third Edition (2008) (MMUCC) recommends including a non-motorist Safety Equipment (e.g. helmets, lighting, etc.) data field to evaluate the effectiveness of non-motorist safety equipment, and to calculate usage statistics to inform development and evaluation of educational countermeasures.	• Include a new data item representing non-motorized safety equipment (helmet. lighting, reflective clothing, etc.) • Alternatively, a pedalcycle / bicycle supplement could be developed similar to supplements for fatal crash, truck/bus, and occupants (10 or more)
23	Traffic Unit Maneuver/Action • 17: Crossing Road	Data item title does not emphasize to the reporting police officer that this data item also applies to bicyclists	Change data item title to "Non-Motorist Crossing Road"
	Traffic Unit Maneuver/Action • 18: Walking With Traffic	Data item title does not emphasize to the reporting police officer that this data item also applies to bicyclists	Change data item title to "Non-Motorist Walking/Riding With Traffic"
	Traffic Unit Maneuver/Action • 19: Walking Against Traffic	Data item title does not emphasize to the reporting police officer that this data item also applies to bicyclists	Change data item title to "Non-Motorist Walking/Riding Against Traffic"
-	Presence/Type of Bicycle Facility	This data is currently not collected in the Arizona Crash Report Form. This data item is recommended in the MMUCC, which states that this data is needed to: • Determine usage and safety of bicycle facilities.	Add data field for presence/type of bicycle facility. MMUCC defines this data item as: Any road, path, or way which is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

Table 6 – Comparison of Arizona Crash Report Form, ADOT Crash Record Database, and BSAP PBCAT Database fields (continued)

Arizona Crash Report Data Item	Data Description	Discussion	Recommendation for Arizona Crash Report
-	Presence/Type of Bicycle Facility (continued)	• Determine the location of bicycle crashes in relation to a bicycle facility. This data is important for ascertaining the relative safety performance of various types/classes of bike paths to guide future design/operation decisions (MMUCC)	Subfields include: 1) Facility: None, Wide Curb Lane, Marked Bicycle Lane, Unmarked Paved Shoulder, Separate Bicycle Path/Trail, Unknown 2) Signed Bicycle Route: Yes, No, Unknown, Not Applicable
-	Widths of Lane(s) and Shoulder(s)	This data is currently not collected in the Arizona Crash Report Form. This data item is recommended in the MMUCC, which states that it is important to monitor the association of lane/shoulder widths and the frequency of crashes.	Add data field for widths of the lane(s) and shoulder(s). MMUCC defines this data item as: Widths (in feet) of the lane(s) and of the shoulder(s) where crash occurred. Data attributes would include the width of the lane(s) and of the shoulder(s) at the location of the crash. Suggested data fields are: • Lane Width • Right Shoulder Width • Left Shoulder Width
-	Adjacent development type	Functional class of the roadway is recommended in the MMUCC, to be added through linking of the crash data with the roadway inventory data. The MMUCC states that "knowledge of land use is needed in analyzing crashes as part of a network analysis."	Add data field to describe adjacent land uses. Suggested data fields are: Residential, commercial, industrial, retail, recreational, mixed use, other, unknown.
-	Mainline number of lanes at intersection	This data item is recommended in the MMUCC in order to accurately describe the intersection, and to identify associations of crashes with roadway/intersection width.	The MMUCC defines this data field as: Number of through lanes on the mainline approaches of an intersection, including all lanes with through movement (through and left-turn, or through and right-turn) but not exclusive turn lanes.

2.7 Implement a Bicycle Counting Program

The US DOT Policy on Bicycle and Pedestrian Accommodation (*Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 15, 2010,* accessed on June 25, 2011 at http://www.dot.gov/affairs/2010/bicycle-ped.html*)* includes the following:

"Recommended Actions…should include (emphasis added):

- **Collecting data on walking and biking trips**: The best way to improve transportation networks for any mode is to collect and analyze trip data to optimize investments. Walking and bicycling trip data for many communities are lacking. This data gap can be overcome by establishing routine collection of nonmotorized trip information. Communities that routinely collect walking and bicycling data are able to track trends and prioritize investments to ensure the success of new facilities. These data are also valuable in linking walking and bicycling with transit.
- **Setting mode share targets for walking and bicycling and tracking them over time**: A byproduct of improved data collection is that communities can establish targets for increasing the percentage of trips made by walking and bicycling"

Similar to most states, agencies, and jurisdictions, ADOT lacks a program to routinely collect bicycle and pedestrian count data.

Development of a bicycle count program can provide meaningful data to ADOT to be used to track trends and to prioritize investments on state highways. A bicycle counting program may utilize automatic bicycle counters. Automatic bicycle counters can provide counts of bicyclists in high crash segment locations and can provide support for expenditures on new bicycle facilities and bicycle policies. Bicycle counters at high crash locations will provide information to compute an exposure rate. Currently, an automatic bicycle counter is being tested on SR 179 near Sedona, Arizona. Consideration should be given to expanding the bicycle counters to BSAP high priority segments to assist in determining exposure rates for bicyclists. A bicycle count program should include a data collection schedule, prioritization of locations, evaluation of information, and how the information can be used.

Summary of Roles of Proposed Countermeasure: Bicycle Counting Program

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
-	-	• Develop a bicycle counting program to measure ridership on state highways, and in particular on BSAP high priority segments.	-

2.8 Recommend Enhancements to Arizona Driver License Manual and Customer Service Guide

In the web-based survey conducted earlier in this project, multiple survey respondents cited a need for increased public knowledge regarding bicycle laws in Arizona and bicyclists rights on state highways. This is confirmed through the crash analysis, which demonstrated that both motorists and bicyclists frequently exhibit unsafe behaviors that are correctable through education.

Two actions are recommended:

1. Collaborate with Motor Vehicle Division (MVD) to include additional mandatory questions on the Arizona Drivers License test regarding bicyclist laws and bicyclist rights. The driver's license test should include a question on the minimum safe distance when passing a bicycle in the same direction. A limitation in using the driver's license test as an education mechanism is that Arizona driver's licenses expire on the 65th birthday; as such, drivers rarely are required to take a test. Other mechanisms, such as defensive driver training or traffic safety diversion programs should be utilized.
2. Collaborate with MVD to revise the *Arizona Driver License Manual and Customer Service Guide* to emphasize bicycle safety.

Based on a review of the current *Arizona Driver License Manual and Customer Service Guide* published by the ADOT MVD, **Table 7** shows suggested revisions or enhancements.

Table 7 – Suggested Revisions to Arizona Driver License Manual and Customer Service Guide

MVD Guide Reference	Current Text	Suggested Revision or Enhancement
Page 26 – Positioning Vehicle-Cushion of Space Around Your Vehicle	When sharing a lane with a bicycle, allow at least 3 feet for clearance between you and the bicycle. Moderate your speed. At high speeds, your vehicle may cause a gust of wind that could knock the bicyclist to the ground. Be alert for the bicycle swerving.	Add illustration of three foot clearance to emphasize.
Page 28 – Passing	When you want to pass a vehicle traveling in the same direction, pass on the left. Signal that you are about to change lanes. Make sure you have time and room to get all the way in front of the vehicle you are passing without creating danger for vehicles coming toward you. Move into the left lane and pass the vehicle. When you can see the entire front or both headlights of the vehicle you passed in your rearview mirror, look over your shoulder to	No change

Table 7 – Suggested Revisions to Arizona Driver License Manual and Customer Service Guide (continued)

MVD Guide Reference	Current Text	Suggested Revision or Enhancement
Page 28 – Passing (continued)	be sure the lane is clear, signal that you are changing lanes, then return to the lane on the right. This procedure also applies to passing slow moving bicycles and mopeds	
Page 29 – Roundabouts	Always yield to pedestrians and bicyclists that are crossing the road. Bicyclists – Be aware of traffic rules or walk your bike and use the crosswalks.	Add depictions of cars yielding for bicyclists and pedestrians in the roundabout.
Page 38 – Signal Lights	These traffic lights apply to pedestrians, bicycle and moped riders, as well as to motorists.	No change
Page 44 – Turning	Rules for turning apply at all locations, even driveways and alleys, not just at intersections. Signal, reduce your speed and turn smoothly. As you turn, make sure to check for pedestrians, mopeds and bicycles.	No change – see suggested revision to Page 45
Page 45 – Right Turns-Right turns on red	Always yield the right-of-way to pedestrians, bicyclists and of course, oncoming traffic. Unless signs direct you otherwise, turn into the right lane of the road you enter.	Provide an illustration showing potential conflicts regarding bicyclists.
Page 48 – Sharing the Road with a Bike	Bicyclists must obey the same traffic laws as drivers of vehicles, and they have the right-of-way under the same conditions as motorists. Motorists should be alert for bicyclists along the roadway because cyclists are often difficult to see. Extra caution is necessary. Motorists are required to allow a minimum safe distance of 3 feet when passing a bicycle traveling in the same direction. At night, you should dim your headlights for bicyclists. Drivers should be prepared for a bicyclist swerving. Although bicyclists must ride with the flow of traffic and stay near the right side of the road, they can legally move left for several reasons, such as: ▪ Turning left. ▪ Avoiding hazards.	Add a graphic depicting the 3-feet rule to emphasize it. Highlight the 3-foot rule in text, and place it in a separate paragraph.

Table 7 – Suggested Revisions to Arizona Driver License Manual and Customer Service Guide (continued)

MVD Guide Reference	Current Text	Suggested Revision or Enhancement
Page 48 – Sharing the Road with a Bike (continued)	▪ Passing pedestrians or vehicles ▪ If the lane in which the person is operating a bicycle is too narrow for a bicycle and motor vehicle to travel safely side-by-side.	Add text to fourth bullet to read: • If the lane in which the person is operating a bicycle is too narrow for a bicycle and motor vehicle to travel safely side-by-side. In this case, the bicyclist may use as much of the lane as needed to discourage unsafe passing.
Page 48 – Sharing the Road with a Bike (continued)	Important rules for bicyclists: ▪ Do not carry more persons than the design of the bicycle permits. ▪ Do not ride more than two side-by side. ▪ Ride as near to the right side of the road as possible. ▪ Use proper hand signals. ▪ Do not bicycle under the influence of drugs or alcohol — it is illegal. When riding at night, have a white head lamp visible from 500 feet, and a rear reflector.	• ~~Ride as near to the right side of the road as possible~~ Ride on the right side of the roadway in the same direction as other traffic. (Note: This is a much more important safety message and directly addresses the #1 safety risk - wrong-way bicycling. This also avoids having to list the exceptions noted above, which would be needed if the text refers to "as far to the right as practical" {NEVER "as far as possible"!}) For more information and tips on bicycling on Arizona roads and streets, see "Arizona Bicycling Street Smarts", at http://www.azbikeped.org/azbss.htm
Page 66 –Test Questions	11. What are the rights of a person riding a bicycle in the street?	Add questions – Question: When passing a bicycle traveling in the same direction, what is the minimum legal passing distance between the motorist and the bicyclist? Answer: not less than 3 feet Question: Although bicyclists must ride with the flow of traffic and as close as practicable to the right-hand curb or edge of the roadway, in which situations can they legally move left? Answers: a. When turning left b. To avoid a hazard c. If the lane in which the person is operating a bicycle is too narrow for a bicycle and a vehicle to travel safety side by side within the lane. d. All of the above.

Summary of Roles of Proposed Countermeasure: Driver License Manual and Exam Revisions

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
-	-	• Collaborate with MVD to modify the Driver License Manual and Exam, to particularly reflect Arizona's 3-foot law.	• Collaborate with MVD to modify the Driver License Manual and Exam, to particularly reflect Arizona's 3-foot law.

2.9 Establish Connectivity and Alternative Routes to State Highways through Local Jurisdictions

Bicyclists do not stop riding at jurisdictional boundaries, nor when ownership of a road changes from a city to ADOT. However, in many cases on Arizona's highways, discontinuities exist in the bicycling network as a result of roadway ownership boundaries, including discontinuation of bicycle lanes or narrowing of wide shoulders upon entering ADOT right-of-way. Furthermore, many Arizona state highways, as they are designed for high-speed motor vehicle traffic, are uncomfortable facilities for bicyclists, even when the state highway passes through the center of town and serves more of a "main street" role than a state highway role.

While ADOT should continue to improve accommodation of bicyclists on state highways, it is suggested that local cities and towns also develop bicycle alternatives to the state highway. For example:

- A local street that runs parallel to a state highway could be marked and improved as a bicycle route. Signs directing the bicyclists to the local parallel bicycle route would lessen the dependency of bicyclists on the state highway system. Alternative routes may have fewer driveways and lower traffic volumes that are more conducive to bicycling.
- Additional mid-mile crossings of interstates and freeways would separate bicyclists from the traffic interchange area. In the Phoenix area, mid-mile collector and arterial streets could be constructed to cross I-17 to provide an alternative to the traffic interchanges located at the mile arterials. Currently, particularly north of I-10, bicyclists who desire to cross I-17 are limited to opportunities at the traffic interchanges and a pedestrian overpass at Maryland Ave.

  Noteworthy is that three of fifteen high priority intersection/interchange locations, as documented in Working Paper 3, are along I-17. Twelve other locations on I-17 were also identified as experiencing a high number of bicycle-motor vehicle crashes.

Summary of Roles of Proposed Countermeasure: Alternative Parallel Bicycling Routes

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
• Coordinate with local agencies to identify alternative parallel routes to the state highway system that are more comfortable and conducive to bicycling.	-	• Identify alternative parallel routes to the state highway system that are more comfortable and conducive to bicycling; do not neglect bicycle accommodation on the state highway system. • Identify opportunities to construct additional crossings of freeways and interstates to provide bicyclists an alternative to the traffic interchange.	

2.10 Develop and Implement Bicyclist and Motorist Education Campaigns

Education of motorists and bicyclists is an essential element to reducing bicycle-motor vehicle crashes on state highways. Recommendations to educate bicyclists and motorist are listed below.

Integrate BSAP into ADOT Bicycle and Pedestrian Safety Education Materials

The BSAP emphasis areas can be incorporated into educational programs for motorists and bicyclists, such as the ADOT "Be a Roll Model" campaign (http://www.azbikeped.org/education.html#campaigneducation).

Three BSAP emphasis areas, in which education can play a significant role, are listed in **Table 8.** Potential safety campaign messages that can be incorporated into educational campaigns are provided in **Table 8**.

Table 8 –BSAP Emphasis Areas and Safety Campaign Messages

Emphasis Areas	Strategy
Reduce crashes in which the bicyclist was riding facing traffic.	Campaign can explain the danger of wrong-way bicycling riding.
Reduce crashes where the bicyclist was riding on the sidewalk.	Campaign can show potential issues and hazards of bicyclists riding on the sidewalk.
Reduce bicycle crashes that occurred in dawn, dusk, or dark conditions.	Campaign can emphasize use of lights while riding at night and low light conditions.

While motorists' education is important, improving bicyclist skill level may be the most critical element of an education program. As evidenced in the BSAP, a large number of crashes occur while bicyclists are riding improperly. Some of the most important bicycling behaviors that should be addressed in a bicycle safety education campaign include the following:

Bicyclist Wrong-Way Riding – Campaign and educational programs can emphasize the dangers of wrong-way riding, such as (http://bicyclesafe.com/):

- Cars which pull out of driveways, parking lots, and cross streets (ahead of you and to the left), which are making a right onto your street, aren't expecting traffic to be coming at them from the wrong-way.
- It is difficult to make a right turn when you are riding in the wrong direction.
- Cars will approach you at a much higher relative speed.
- Riding the wrong-way is illegal and you can get ticketed for it.

Bicyclist Riding on Sidewalks – Key considerations are (adapted from http://www.commutebybike.com/2008/07/09/top-5-rules-for-riding-on-the-sidewalk/):

- The law in most areas of the country requires bicycles to follow the same rules of the road as other motor vehicles.
- Riding the sidewalk has its own dangers such as cars pulling out of driveways, turning conflicts, and potential for pedestrian/ bicyclist crashes.
- The sidewalk is designed for pedestrians, so bicyclists should not be going faster than them. Pedaling fast down the sidewalk raises the potential for a serious bicyclist/pedestrian crash.

Bicyclists' Education Emphasizing that Bicyclists have the Same Responsibilities as Motorists – Examples of emphasis areas could include:

- Bicyclists must obey all traffic control signs and signals, just like motorists.
- Motorists and bicyclists must yield the right-of-way to each other.
- Bicyclists must signal their turns and should ride in a predictable manner.
- Bicyclists must use a headlight and rear reflectors when it is dark. To increase visibility, add a rear flashing light.

Bicyclist Riding in Dark Conditions – Key considerations are:

- When riding at night, bicyclists are required by law to use a white front lamp and a red rear reflector and should use a red rear lamp.

Nighttime bicycle crashes represent a significant percentage of motor vehicle-bicycle crashes. While no single crash type is overly dominant in nighttime crashes, over 50% of crashes were typed as "motorist drive-out" or "motorist-turning." Increasing the visibility of bicyclists riding at night is critical to reducing bicycle-motor vehicle crashes.

A.R.S. 28-817 requires bicyclists to utilize a white front lamp and a red rear reflector when riding at night. However, reflectors require several conditions to be met in order to be effective. Potential situations where reflectors may not be effective, or work at all, include (http://www.sheldonbrown.com/reflectors.html):

- Bicyclist (and the reflector) is outside the beam of a driver's headlights.
- The reflector is tilted at an angle ("entrance angle") that severely degrades its optical performance.

- The driver's eye may be outside the narrow cone of light that the reflector sends back to the light source.
- Fog can completely block the reflector when other lights remain visible.
- The driver may have a burned-out headlight
- The headlights may be mis-aimed or covered with dirt.
- The reflector surface can be abraded, covered with moisture or dust, or otherwise altered in a way that wrecks its optical performance.

It is unclear from the available ADOT crash data what percentage of crashes involved a bicyclist utilizing a front lamp and a rear reflector. However, it is intuitive that increased visibility of bicyclists is essential to reducing nighttime crashes. This requires increased compliance to existing Arizona law through enforcement and education.

Safety education campaigns should emphasize the importance of utilizing front and rear lamps, in addition to reflectors, to increase visibility in dark conditions. Bicyclist should be taught that the use of rear red-lamp provides an additional layer of security to improve the safety of the bicyclist.

Motorist Education Emphasizing that Bicyclists Have the Same Rights as Motorists – Examples of emphasis areas could include (http://www.sfbike.org/download/resources/Motorists-STR.pdf):

- Reduce your speed when passing bicyclists, especially if the roadway is narrow.
- When a road is too narrow for cars and bikes to travel safely side by side, bicycles should "take the lane," which means riding in or near the center of the travel lane.
- Recognize situations and obstacles which may be hazardous to cyclists, such as potholes, debris, and drain grates. Give bicyclists adequate space to maneuver.
- Do NOT pass bicyclists if oncoming traffic is near. Wait as you would with any slow-moving vehicle.
- When turning left at an intersection, yield to oncoming bicyclists just as you would yield to oncoming motorists.
- Give at least three feet of passing space between the right side of your vehicle and a bicyclist just as you would with a slow-moving vehicle (The “Be a Roll Model” Campaign recommends 5 feet).
- Do not pass bicyclists if you will be making a right turn immediately afterward. Always assume bicyclists are traveling through unless they signal otherwise.

Educational campaigns should recognize, and reach out to, demographic groups with restricted transportation choices that may more often be riding bicycles, especially in urban areas, and need reaffirmation of “rules-of-the-road”.

Inform Local Bicycling Safety Campaigns and Events

The BSAP can inform other bicycle safety campaigns and bicycling events that are held throughout the state. The findings of this study can be used to provide input to safety campaigns, seminars, and events, such as the statewide bicycle safety campaign being developed by Valley Metro. More information about the Valley Metro bicycle program is at http://www.valleymetro.org/bikewalk/.

Continue Distribution of Educational Materials

The ADOT Bicycle and Pedestrian Program distributes educational materials to regional, local, advocacy organizations, and individuals throughout the state. Multimedia materials developed by ADOT to inform and educate bicyclists, pedestrians, and motorists about the rules of the road, laws, and safety can be found at http://www.azbikeped.org/education.html. *Arizona Bicycling Street Smarts* (http://www.azbikeped.org/azbss.htm) is an example of an ADOT-sponsored publication that seeks to educate and increase the skill level of bicyclists as they operate on streets with motor vehicles. It is recommended that ADOT continue to distribute this resource, and make this resource available to other agencies and advocacy groups.

Draw Upon National Educational Resources

ADOT can continue to educate bicyclists utilizing resources developed nationally. The League of American Bicyclists (LAB) developed a comprehensive bicyclist education program to improve bicyclist behavior (http://www.bikeleague.org/programs/education).

The LAB's "Smart Cycling" program is a set of curricula for adults and children taught by certified instructors. It is recommended that ADOT encourage and partner with local agencies and bicycle advocacy organizations to offer the LAB courses to as many bicyclists as possible, including children in elementary and middle schools. In fact, the MAG Strategic Transportation Safety Plan includes a goal to reduce the number of crashes that involve bicyclists or pedestrians through utilizing LAB materials. Stated goals of the Plan include the following: (http://www.azmag.gov/Documents/pdf/cms.resource/strategic_safety_plan226438.pdf)

- Promote bicyclist training programs for youth and adults. Utilize programs such as that provided by the League of American Bicyclists and Pedestrian & Bicycle Information Center.
- Cosponsor safety and training programs with Coalition of Arizona Bicyclists and/or other agencies.

Summary of Roles of Proposed Countermeasure: Bicyclist and Motorist Education Campaigns

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
Practice safe bicycling behavior, including the following: • Travel with flow of traffic • Drive on the roadway • Proper lane positioning • Adherence to signs and signals • Proper yielding when entering a roadway	Practice safe motorist behavior, including the following: • Safe and legal passing • Yield when entering the roadway from driveways • Yield when required at intersections	• Develop and implement bicyclist and motorist education campaigns and programs, with particular emphasis on key contributing factors identified in the BSAP	• Enforce motorists laws (and as applicable to bicyclists); utilize enforcement activities to educate bicyclists and motorists of proper and safe bicycling practices

Summary of Roles of Proposed Countermeasure: Bicyclist and Motorist Education Campaigns (continued)

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
• Effective left turn strategy • Cyclist conspicuity • Emergency maneuvers • Bicycle maintenance • Sobriety • Utilize front and rear lights in low-light conditions	Sobriety	•	•

2.11 Collaborate with Law Enforcement

Bicycle education of public safety and law enforcement was identified as a need in an earlier phase of this study. Officer training leading to better enforcement of traffic laws also can have a trickle-down effect of educating the general public. Examples of training resources are provided at the website Bicyclinginfo.org at http://www.bicyclinginfo.org/enforcement/training.cfm:

- Bicycle Traffic Enforcement Video - This is an internal training video for the Portland Police Bureau available through the PBIC Video Library (http://www.walkinginfo.org/videos/).
- Traffic Enforcement for Bicyclist Safety - A training video for Chicago Police Officers created in partnership between the Chicago Police Department and The Chicago Department of Transportation available through the PBIC Video Library (http://www.walkinginfo.org/videos/).
- Law Enforcement's Roll Call Video: "Enforcing Law for Bicyclists" - This short video was developed by National Highway Traffic Safety Administration (NHTSA)
- Enhancing Bicycle Safety: Law Enforcement's Role - This two-hour self-paced training for law enforcement officers was developed by the U.S. Department of Transportation, NHTSA
- NHTSA Community Oriented Bicycle Safety for Law Enforcement (2002)
- Wisconsin Pedestrian and Bicycle Law Enforcement Training Course (2007)
- Law Officers Guide to Bicycle Safety (2002)
- NHTSA Resource Guide on Laws Related to Pedestrian and Bicycle Safety
- Florida Bicycle Law Enforcement Guide (2003)
- North Carolina Department of Transportation Bicycle Law Enforcement Manual (1981)

Summary of Roles of Proposed Countermeasure: Law Enforcement

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
• Obey all traffic laws	• Obey all traffic laws	Facilitate education programs targeted toward public safety and law enforcement; enhance working relationships with public safety and law enforcement to establish a 'team' approach to reducing bicycle crashes	Enforcing bicyclist behaviors: • Enforcing correct direction of travel on roadways • Enforcing adherence to signs and signals • Enforcing yielding when entering roadway • Enforcing use of required lighting • Enforcing proper behavior of group rides Enforcing motorist behaviors • Enforcing vehicle speed • Enforcing red-light running • Enforcing required safe-passing distance (at least 3 feet) • Enforcing yielding when entering the roadway from driveways • Enforcing yielding when required at intersections • Enforcing yielding when turning right or left • Enforcing sobriety

2.12 Recommend Changes to Arizona Revised Statutes

Arizona recently received a "B" grade in legislation as applicable to bicyclists by the League of American Bicyclists, indicating that while Arizona law, as it relates to bicycles, is above average, opportunities for improvement exist.

Central to Arizona Revised Statues (A.R.S) as they apply to bicycles is ARS 28-812, which states that an individual riding a bicycle on a roadway or shoulder is granted all of the rights of a driver of a vehicle, and is also subject to the responsibilities and duties also applicable to a vehicle driver. However, there are opportunities to improve A.R.S. as they relate to bicycle riding on sidewalks.

Bicycle Riding on Sidewalks

Bicyclists riding on the sidewalk and riding while facing traffic were identified as contributing factors to bicycle crashes. A typical crash scenario is when a bicyclist enters a roadway immediately after riding on the sidewalk while facing traffic. In such a scenario, the motorist may not see a bicyclist approaching from the right-hand side of the roadway.

When riding in the roadway or shoulder, Arizona law requires bicycles to ride with traffic. A.R.S. 28-721 states that vehicles (and bicyclists) operating on the roadway should drive on the right half of the roadway. ARS 28-812 states that a person riding a bicycle on a roadway or on a shoulder adjoining a roadway is granted all of the rights and is subject to all of the duties applicable to the driver of a vehicle.

While A.R.S. 28-904 prohibits driving a vehicle on a sidewalk, Arizona law does not prohibit bicyclists from operating on the sidewalk, nor does it govern the operation of bicycles on a sidewalk. As ARS 28-627 grants the power to local authorities to regulate the operation of bicycles, cities and towns have legal authority to develop local regulations on the use of sidewalks by bicyclists.

When riding on a sidewalk, it is important for bicyclists to function as pedestrians – at a slow rate of speed; yielding to other pedestrians; carefully scanning cross streets before proceeding across the intersection, cross street, or driveway; and being willing to walk the bicycle when conditions dictate.

It is recommended that A.R.S. be revised to govern the activities of bicycles on sidewalks. The Uniform Vehicle Code (UVC), though never adopted in Arizona, exemplifies potential enhancements to A.R.S.

> UVC § 11-1209(c), Bicycles and human powered vehicles on sidewalks
>
> A person propelling a vehicle by human power upon and along a sidewalk, or across a roadway upon and along a crosswalk, shall have all the rights and duties applicable to a pedestrian under the same circumstances.

An expansion of the ordinances proposed in the UVC is proposed in "Model Traffic Bicycle Laws", by Fred Oswald et. al., available at http://bikelaws.org/laws/UVC-model-bike.pdf (Accessed on August 27, 2011).

§ 11-1209 Bicycles and human powered vehicles on sidewalks

(a) A person propelling a bicycle upon and along a sidewalk, or across a roadway upon and along a crosswalk, shall yield the right of way to any pedestrian and shall give audible signal before overtaking and passing such pedestrian. This audible signal may be given by the voice or by a bell or other warning device capable of giving an audible signal and shall be given at such a distance and in such a manner as not to startle person or persons being overtaken and passed.

(b) A person shall not ride a bicycle upon and along a sidewalk, or across a roadway upon and along a crosswalk, where such use of bicycles is prohibited by official traffic-control devices.

(c) A person shall not operate a bicycle from a sidewalk so as to suddenly leave a curb or other place of safety and move into the path of a vehicle that is so close as to constitute an immediate hazard

(d) No person shall operate a bicycle on a sidewalk at a speed greater than an ordinary walk when approaching or entering a crosswalk, approaching or crossing a driveway or crossing a curb cut or pedestrian ramp if a vehicle is approaching the crosswalk, driveway, curb cut or pedestrian ramp. This paragraph does not require reduced speeds for bicycles when other vehicles are not present.

(e) A person propelling a vehicle by human power upon and along a sidewalk, or across a roadway upon and along a crosswalk, shall have all the rights and duties applicable to a pedestrian under the same circumstances.

(f) No person shall be required to operate a bicycle on a sidewalk.

Summary of Roles of Proposed Countermeasure: Modifications to Arizona Revised Statutes

Bicyclists	Motorists	Engineers and Planners	Law Enforcement
		• Review A.R.S; provide recommendations to A.R.S. to department legislative liaisons for consideration; partner with advocacy organizations to revise A.R.S.	

2.13 Implement ADOT Access Management Plan

Every driveway and street connection represents a potential conflict point for bicyclists and motorists. Several crash statistics, as identified in Working Paper No. 1, are symptomatic of a plethora of driveway openings, and a lack of adequate access management on many state highways through urban areas. Examples include:

- Most crashes (99 percent) occurred in urbanized and developed areas
- 46 percent of crashes occurred near commercial or industrial development while a vehicle was making a right turn
- The majority of crashes (51 percent) occurred while a vehicle was making a right

Managing access, including the number, locations, and spacing of driveways, can have a significant benefit to both the bicyclist and the motorist. As stated in BIKESAFE (http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=8, accessed on 8/27/2011), access management strategies such as providing raised/non-traversable medians and limiting driveway access may be useful in promoting safe bicycle travel, particularly on arterial or major collector streets, since they help reduce the number of potential conflict points.

Access management strategies that would improve bicyclist safety include:

- Limiting the number of or establishing minimum spacing between driveways
- Providing for right-in, right-out only movements
- Restricting turns to certain intersections

- Curb radii reduction to slow vehicle traffic making a right turn.
- Using non-traversable medians to manage left- and U-turn movements.

ADOT is currently developing a Statewide Access Management Plan. The Plan will result in an access management classification system for the state highways and a comprehensive access management manual to guide the uniform application of access management throughout the state. The ADOT Bicycle and Pedestrian Program supports implementation of the ADOT Access Management Plan. Implementation of the Plan will improve conditions for bicyclists on state highways.

2.14 BSAP Evaluation Program

Crash reduction goals are reviewed in Chapter 1. The BSAP Goal is to:

Goal: Reduce the total number of bicycle crashes (fatalities and non-fatalities) on Arizona State Highways by 12 percent by the year 2018.

Between 2004 and 2008 there were 1,089 bicycle crashes on state highways, averaging 217 bicycle crashes on Arizona state highways each year. The reduction in bicycle crashes will be measured by a five-year average (2014 to 2018), with the years 2004 through 2008 acting as the base years. With a baseline of 217 crashes per year and a goal of 12-percent reduction, the target is a five-year average of 191, an average annual reduction of 26 crashes per year.

To chart progress toward the BSAP goal, crash data should be reviewed a minimum of once every three years. The crash analysis documented in Working Paper No. 1 analyzes data for 2004 to 2008. An update analysis should be conducted for 2009, 2010, and 2011 crash data. 2011 data will be available in 2012. In addition, an annual review of strategies and recommendations should be completed to ensure that progress is being made towards their implementation.

3 FUNDING ALTERNATIVES

FHWA Guidance on Bicycle and Pedestrian Provisions of Federal Transportation Legislation (updated October 22, 2008) provides an overview of funding options for bicycle (and pedestrian) improvements. The Guidance states that Federal surface transportation law provides tremendous flexibility to States and MPOs to fund bicycle and pedestrian improvements from a wide variety of programs, and that virtually all the major transportation funding programs can be used for bicycle- and pedestrian-related projects. When considering ways to improve conditions for bicycling and walking, States and MPOs are specifically encouraged to:

- Include bicycle and pedestrian improvements as an integral part of larger projects, as described above, and;
- To review and use the most appropriate funding source for a particular project and not rely primarily on the Transportation Enhancement activities. Many bicycle and pedestrian projects are more suitable for funding under the Congestion Mitigation and Air Quality Improvement Program (funding currently only in the Phoenix area), Surface Transportation Program, or one of the other programs listed in **Table 9**.

Table 9 provides an overview of the availability of Federal transportation funds for a wide variety of bicycle and pedestrian projects and offers guidance as to the most appropriate potential funding category for a range of typical projects and programs.

Table 9 – Potential Funding Sources

	FUNDING PROGRAMS (Refer to Key at end of table)															
	NHS	STP	HSIP	SRTS	TEA	CMAQ	RTP	FTA	TE	BRI	402	PLA	TCSP	JOBS	FLH	BYW
Bicycle and pedestrian plan		*				*						*	*			
Bicycle lanes on roadway	*	*	*	*	*	*		*	*	*					*	*
Paved Shoulders	*	*	*	*	*	*				*					*	*
Signed bike route	*	*		*	*	*									*	*
Shared use path/trail	*	*		*	*	*	*			*					*	*
Single track bike trail							*									
Spot improvement program		*	*	*	*	*										
Maps		*		*		*					*					
Bike racks on buses		*			*	*		*	*							
Bicycle parking facilities		*		*	*	*		*	*							*
Trail/highway intersection	*	*	*	*	*	*	*								*	*
Bicycle storage/service center		*		*	*	*		*	*				*	*		
Sidewalks, new or retrofit	*	*	*	*	*	*		*	*	*					*	*
Crosswalks, new or retrofit	*	*	*	*	*	*		*	*						*	*

Table 9 – Potential Funding Sources (continued)

	FUNDING PROGRAMS (Refer to Key at end of table)															
	NHS	STP	HSIP	SRTS	TEA	CMAQ	RTP	FTA	TE	BRI	402	PLA	TCSP	JOBS	FLH	BYW
Signal improvements	*	*	*	*	*	*										
Curb cuts and ramps	*	*	*	*	*	*										
Traffic calming		*	*	*									*			
Coordinator position		*		*		*							*			
Safety/education position		*		*		*					*					
Police patrol		*		*							*					
Helmet promotion		*		*	*						*					
Safety brochure/book		*		*	*	*	*				*					
Training		*		*	*	*	*				*					

KEY

NHS	National Highway System	BRI	Bridge
STP	Surface Transportation Program	402	State and Community Traffic Safety Program
HSIP	Highway Safety Improvement Program	PLA	State/Metropolitan Planning Funds
SRTS	Safe Routes to School Program	TCSP	Transportation and Community and System Preservation Pilot Program
TEA	Transportation Enhancement Activities	JOBS	Access to Jobs/Reverse Commute Program
CMAQ	Congestion Mitigation/Air Quality Program	RTP	Recreational Trails Program
FLH	Federal Lands Highway Program	FTA	Federal Transit Capital, Urban & Rural Funds

Source: Bicycle and Pedestrian Guidance, FHWA, http://www.fhwa.dot.gov/environment/bikeped/bp-guid.htm#bp4

4 SUMMARY

The action plan elements developed in this Working Paper are focused to achieve the bicycle safety goal of reducing the total number of bicycle crashes (fatalities and non-fatalities) on Arizona state highways by 12 percent by the year 2018.

The action plan elements particularly address the seven key emphasis areas described in Chapter 1. **Table 10** provides an overview of which action plan elements relate to specific emphasis areas.

Table 10 – Effect of Action Plan Elements on Emphasis Areas

Action Plan Elements	Emphasis Areas – Reduce Bicycle Crashes:						
	In urbanized and developed areas	Where a bicyclist or motor vehicle failed to yield at signalized intersections	Where a bicyclist or motor vehicle failed to yield at unsignalized intersections	That involves vehicles making a right turn	Where the bicyclist was riding facing traffic	Where the bicyclist was riding on the sidewalk	That occurred in dawn, dusk, or dark conditions
Conduct RSAs to Review and Select Appropriate Countermeasures at Priority Crash Locations	√	√	√	√	√	√	√
Review and Modify Polices, Plans, and Guidelines	√				√	√	
Pavement Marking to Address Wrong-way Bicycle Riding	√				√		
Adopt Arizona Complete Streets Policy	√				√	√	
Design Considerations at SPUIs		√				√	
Crash Report Data Enhancements							
State Highway Bicycle Counters	√						

Table 10 – Effect of Action Plan Elements on Emphasis Areas (continued)

Action Plan Elements	Emphasis Areas – Reduce Bicycle Crashes:						
	In urbanized and developed areas	Where a bicyclist or motor vehicle failed to yield at signalized intersections	Where a bicyclist or motor vehicle failed to yield at unsignalized intersections	That involves vehicles making a right turn	Where the bicyclist was riding facing traffic	Where the bicyclist was riding on the sidewalk	That occurred in dawn, dusk, or dark conditions
Drivers License Review and Enhancements to Driver License Manual and Customer Service Guide	√	√	√	√	√	√	√
Establishing Connectivity /Alternate Routes to State Highways Through Local Jurisdictions	√	√	√	√	√	√	√
Educational Plan for Motorists and Bicyclists		√	√	√	√	√	√
Bicycle Safety Enforcement Training		√	√	√	√		
Revisions to Arizona Revised Statutes					√	√	√
Access Management	√		√	√			