September 17, 2014

TO: Members of the MAG Transportation Safety Committee

FROM: Renate Ehm, City of Mesa, Chair

SUBJECT: MEETING NOTIFICATION AND TRANSMITTAL OF TENTATIVE AGENDA

Tuesday, September 23, 2014 - 9:30 a.m.
MAG Office Building, 2nd Floor, Ironwood Room
302 North First Avenue, Phoenix

A meeting of the MAG Transportation Safety Committee will be held at the time and place noted above. Committee members or their proxies may attend **in person, via videoconference or by telephone conference call**. Those attending video conference must notify the MAG site three business days prior to the meeting. Those attending by telephone conference call please contact MAG offices for conference call instructions.

Please park in the garage under the MAG building, bring your ticket, parking will be validated. For those using transit, Valley Metro/RPTA will provide transit tickets for your trip. For those using bicycles, please lock your bicycle in the bike rack in the garage.

In 1996, the Regional Council approved a simple majority quorum for all MAG advisory committees. If the Transportation Safety Committee does not meet the quorum requirement, members who have arrived at the meeting will be instructed a legal meeting cannot occur and subsequently be dismissed. Your attendance at the meeting is strongly encouraged.

Pursuant to Title II of the Americans with Disabilities Act (ADA), MAG does not discriminate on the basis of disability in admissions to or participation in its public meetings. Persons with a disability may request a reasonable accommodation, such as a sign language interpreter, by contacting Jason Stephens at the MAG office. Requests should be made as early as possible to allow time to arrange the accommodation.

If you have any questions regarding the meeting, please contact Sarath Joshua at (602) 254-6300.

TENTATIVE AGENDA

	COMMITTEE ACTION REQUESTED
1. Call To Order For the September 23, 2014 meeting, the quorum requirement is 9 committee members.	
2. Approval of July 22, 2014 Meeting Minutes	2. Review and approve minutes of the Meeting held on July 22, 2014.
3. Call to Audience An opportunity will be provided to members of the public to address the Transportation Safety Committee on items not scheduled on the agenda that fall under the jurisdiction of MAG, or on items on the agenda for discussion but not for action. Members of the public will be requested not to exceed a three minute time period for their comments. A total of 15 minutes will be provided for the Call to the Audience agenda item, unless members request an exception to this limit. Please note that those wishing to comment on action agenda items will be given an opportunity at the time the item is heard.	3. For information.
4. Program Managers Report The following items will be addressed: • Status of RSA and PA projects • Corridor Safety Management Pilot Project	4. For information and discussion.
5. Network Screening Methodology for Intersections At the July 22nd meeting, the committee reviewed a recommendation, related to the MAG Network Screening Methodology, that is documented in the Technical Memorandum No. 4 of the Strategic Transportation Safety Plan (STSP). The STSP project team,	5. For information, discussion and possible action to modify the MAG Network Screening Methodology (for intersections) by removing Crash Rates as from the Intersection Safety Score formula and adjusting the weights as follows: Crash Frequency - 20 percent Crash Severity - 60 percent Crash Type - 20 percent

consisting of Lee Engineering LLC & Texas Transportation Institute staff, has recommended that crash rates should not be included in the methodology as it would create a biased outcome. The committee could not reach agreement on adopting this recommendation and requested MAG staff to compare the differences in intersection ranking that would result from removing crash rates. This analysis has been performed and is documented in Attachments One and Two. The recommendation to revise the current methodology, as included in Tech Memo 4, is provided in Attachment Three.

6. Recommended Practices for Improving Safety

The scope of work for Tasks 5 and 6 of the STSP includes identifying strategies for incorporating road safety considerations in the MAG Regional Transportation Plan (RTP), the MAG TIP process, and in future road infrastructure projects. A Working Group was formed, consisting of members from Transportation Safety, Transit, and Bike and Pedestrian Committees, to help identify regional practices for improving road safety for bicyclists and pedestrians and all transit users. The list of recommended practices produced by the Working Group is provided as Attachment Four. This list will be included in the STSP Implementation Plan. One of the recommended practices that calls for modifying the MAG TIP process to include safety considerations has been approved by the Streets Committee and Bike-Ped Committees. MAG Staff and a representative from the Working Group will present the list of Recommended Practices.

6. For information, discussion and possible action to approve the List of Recommended Practices to be included in the Implementation Plan of the STSP.

7. Reports by Committee Members on Transportation Safety Activities

Members will be requested to report agency

7. For information and discussion.

activities or current issues that are related to transportation safety.

8. Request for Future Agenda Items

   Members will be provided the opportunity to suggest future agenda topics.

8. For information and discussion.

9. Next Meeting

   The next regular scheduled Transportation Safety Committee meeting is scheduled to be held on Tuesday, November 25, 2014 at 9:30 a.m in the MAG Ironwood Room.

9. For information and discussion.

Adjournment

DRAFT MINUTES OF
MARICOPA ASSOCIATION OF GOVERNMENTS
TRANSPORTATION SAFETY COMMITTEE MEETING

July 22, 2014
Maricopa Association of Governments
Ironwood Room, Suite 200
302 N. 1st Ave,
Phoenix, AZ 85003

MEMBERS ATTENDING

Michael Duhame for Linda Gorman, AAA Arizona
*Tom Burch, AARP
Kohinoor Kar, ADOT
*Shane Kiesow, City of Apache Junction
Dana Chamberlin, City of Avondale
Chris Lemka, City of Buckeye
*Martin Johnson, City of Chandler
Bob Senita, City of El Mirage
*Kelly LaRosa, FHWA
Erik Guderian, Town of Gilbert
Kiran Guntupalli, City of Glendale
*Alberto Gutier, GOHS
#Luke Albert for Hugh Bigalk, City of Goodyear
*Nicolaas Swart, Maricopa County
Renate Ehm (Chair), City of Mesa
*Jeremy Knapp, Town of Paradise Valley
#Mannar Tamirisa for Jamal Rahimi, City of Peoria
Kerry Wilcoxon, City of Phoenix
#George Williams, City of Scottsdale
Mike Mecham, City of Surprise
Julian Dresang, City of Tempe
*Sam Diggins, RPTA

OTHERS PRESENT

Sarath Joshua, MAG
Margaret Boone, MAG
Eric Nava, MAG
Micah Henry, MAG
Teri Kennedy, MAG
Alex Oreschak, MAG
Monique de los Rios-Urban, MAG
BriAnne Turpin, Baker
Stephen Chang, City of Surprise
Janeen Gaskins, City of Surprise
Chelsea Erickson, MCDPH
Dawn Coomer, Valley Metro
Anissa Janovich, Valley Metro
Jothan Samuelson, Wilson
Mike Blankenship, AMEC
Jeff Bagdade, Atkins
Doug McCants, Atkins
Jim Lee, Lee Engineering
Anita Johari, ASJ Engineering
Shanthi Krishnan, Jacobs
Ray Yparraguirre, KHA
Skye Gentile, Parsons Brinkerhoff

* Not present or represented by proxy
# Participated by teleconference
+ Participated by videoconference

1. Call to Order

Chair Renate Ehm called the meeting to order at 9:31 a.m.

2. Approval of May 27, 2014 Meeting Minutes

Chair Renate Ehm called for a motion to approve the May 27, 2014 minutes noting a correction from Dana Chamberlin for the minutes to reflect her attendance at the May 27th meeting. Kerry Wilcoxon made a motion to approve the amended minutes, Erik Guderian seconded and the motion passed unanimously.

3. Call to Audience

Chair Renate Ehm made a call to the audience providing an opportunity to members of the public to address the Transportation Safety Committee. None requested.

4. Program Manager's Report

- Status of RSA and PA projects: Sarath Joshua provided information for each proposed RSA site including the schedule for six RSAs to be conducted in September, two in October and one in November and noted one RSA in the City of Glendale has been deferred to the next RSA cycle by the local agency. Mr. Joshua stated that one PA for the City of Tempe would have an August to November development schedule and two others for the City of Phoenix and Avondale would have a September to January development schedule. MAG anticipates a call for RSA projects in January 2015 to be carried out later in the fall of that year. Mr. Joshua also reported on the RSA Workshop hosted by MAG on June 4th that included two hands-on field observations and conducting a mini RSA resulting in some recommendations to the City of Phoenix. The Workshop was attended by 35 local agency and consultant staff.
- 2014 School Crossing Guard Workshops: Sarath Joshua reported the schedule for the upcoming workshops in partnership with various local agencies; July 29th in Phoenix at Washington High School, July 31st at the Mesa Convention Center and August 7th at the Rio Vista Community Center in Peoria noting the anticipated attendance for the workshops based on registrations to date is 388. Sarath asked Margaret Boone to report on the revised crossing guard video which has been requested by agencies all over the country. Ms. Boone reported that the process started back in February to revise the script to include white crosswalks, stutter flash crossings, HAWKS, and pedestrian signal crossings and thanked Don Cross from the City of Phoenix, Ray Parmigiani and Dale Brunk from the City of Mesa, and Brandon Forrey from the City of Peoria for participating in all the hard work done to produce the updated "Guardians of the Future" video that will be and shown at the upcoming workshops and available for viewing on the MAG website at http://srts.azmag.gov.
- 2015 HSIP Projects: Sarath Joshua reported HSIP funding has been programmed through 2017 for the funding allocated to Arizona MPOs and COGs. A request was forwarded from the MAG TIP programming manager, Teri Kennedy, to reach out to local agencies for projects that could advance FY2016 or FY2017 projects to FY2015 in the amount of approximately $143,000. There is an opportunity to facilitate this through a loan from another COG that is not able to program the funding. The funding would have to be forwarded to the other COG in FY2017. Mr. Joshua

requested that local agencies look at their FY2016 and FY2017 projects to see if it would be feasible to advance projects and obligate in the 2015 fiscal year.

- Vice Chair Nominations: Sarath Joshua reported that the Vice Chair position has become vacant due to the current Vice Chair Chris Lemka leaving employment at the City of Glendale. MAG sent a memo out with a deadline of July 31st for nominations for Vice Chair.

5. MAG Transportation Alternatives Program: Non-Infrastructure - Second Call for Projects
Sarath Joshua stated that MAG was allocated $400,000 to be programmed in FY2015-2017. Three projects were submitted in the 1st call for projects; two from the Maricopa County Health Department for $45,000 in each program year for a total request of $135,000 and one project in the City of Surprise for $24,500 noting a project limit of $45,000 for the first call for projects. This resulted in recommendation and approval of $114,500 to be programmed in FY2015 and $90,000 each in FY2016 and FY2017. A second call for projects was issued based on criteria discussed at previous meetings. The committee discussed allowing approved projects to advance to FY2015, increase the maximum project amount to $135,000. Margaret Boone referred the committee to the attachment and provided an explanation that the $285,500 that was issued with the second call included the City of Surprise $24,500 already approved and that with the additional $180,000 resulting from the advancement of the Maricopa County projects to FY2015 reduced the available amount to $105,500. Ms. Boone noted that the committee is considering the amended scope for the City of Surprise Schools in the amount of $48,000, the Glendale Cityscape project in the amount of $128,000 and the Valley Metro Be Bright project in the amount of $124,315. The total for the second call for projects is over $300,315 for the available amount to be programmed of $105,500 and opened the item up for discussion by the committee. Sarath noted that due to the complexity of programing these funds with the first and second project calls and advancements that MAG would be happy to further explain the process based on any questions by the committee. Kerry Wilcoxon asked if there are any projects that could be funded partially. Kiran Guntupalli explained that if the amount awarded to the City of Glendale project was less than $80,000 it would be difficult to justify the amount of staff resources required to complete the project that would involve a survey of all elementary schools within the City of Glendale and ensure that existing SRTS maps are updated, and assess the condition of and adequacy of existing striping. Janeen Gaskins stated that the City of Surprise amended their original project to increase for the one school and added studies for two additional schools and noted that it could be feasible to defer the study for one of the schools if a reduced amount of funding was awarded. Dawn Coomer stated that the Valley Metro project includes staff and materials highlighted in the application and that it would be difficult to decide which schools they could not be able to work with if a reduced amount of funding were to be awarded. Chris Lemka asked Valley Metro if there had been any coordination with the Glendale school in their application which seems to be in overlap with the Glendale project submitted for funding. Ms. Coomer stated that Valley Metro would be happy to work with the City of Glendale in any way that is deemed appropriate and that her understanding of the Glendale project is that it is a mapping project where the Valley Metro project is an education and encouragement project. Kerry Wilcoxon asked what amount would be rolled over into future fiscal years and if some of the funding from any of the three were delayed into the future fiscal years would it would adversely affect the proposed projects. Kiran Guntupalli clarified that Glendale would not wish to change the

project scope and would rather cover the additional funds with the local match. If Glendale would not be awarded at least the $80,000 they would consider submitting their application for the January 2015 call for projects. Janeen Gaskins stated that the City of Surprise would be grateful for any funding awarded at this time and would apply again in January and asked that they would be able to at least complete the study for at least one school. Dawn Coomer stated that Valley Metro would reapply next year but that staff funding is included in the application and that Valley Metro does not receive any funding from any external agencies that there would be challenges to keep staff with cycle to cycle funding. Margaret Boone suggested that any additional evaluation scores be submitted at that time in order to be able to display the evaluation scores for further committee discussion. Julian Dresang asked for clarification on the available funding amount and if the Valley Metro project could definitely not move forward with a reduced amount of funding. Dawn Coomer stated that the majority of the requested funds would be for staff to administer the project. Julian Dresang suggested that if the Valley Metro project could not be funded with the available $105,500 and the City of Surprise project could reduce their request by amending project scope, the committee might want to consider the Surprise project. Chris Lemka asked Valley Metro to explain about the personnel included in the application and if this person would be 100 percent dedicated to the project as written in the application. Dawn Coomer stated that staff costs included oversight, administration and the safety education coordinator, and which includes fringe and overhead. She said that this person is already employed at Valley Metro but the position is currently funded under the ADOT administered Transportation Enhancement funding source that was replaced with the Transportation Alternatives funding source. If Valley Metro does not receive the requested funding, the current funding will run out although there is enough to fund the position if their request is not met for FY2015. Kerry Wilcoxon asked if the committee were to recommend to funding the minimum amount of $80,000 for the Glendale project leaving $25,500. Would the City of Surprise be able to utilize those funds. Janeen Gaskins stated that they would be able to utilize the reduced amount of funding. Margaret Boone requested any additional evaluation scores to be submitted at that time. Julian Dresang stated that he did not see value in reviewing evaluation scores if the Valley Metro project could not be funded in full. George Williams stated that he would like to see the final evaluation scores in order to get a feel for where the committee stands on each project. Renate Ehm added that the City of Surprise project came out ahead of the other projects in her evaluation and that she would be reluctant to cut short the funding they have requested and that her second choice was the Valley Metro project which could be funded with the remaining amount as it sounded as if they could utilize the reduced amount to fund at least two projects. Bob Senita asked if the Maricopa County Health Department (MCHD) had been asked if they would be willing to rescind their request to advance their funding so that other projects could be funded in FY2015. Sarath Joshua noted that the MAG call for projects included allowing projects to be advanced to FY2015. The MCHD by their request to MAG made known their intentions of advancing all of the funding. Otherwise the funds would have remained in FY2016 and FY2017. Julian Dresang requested if Valley Metro could verify if they could do their project with the lower funding amount with a ‘yes’ or ‘no’ answer. Dawn Coomer said that she would look at funding the staff first and then the materials but could not offer information on what that amount would be at this time. Sarath Joshua reminded the committee of the previous recommendation by the committee to allow the advancement of the FY2016 and FY2017 projects as well as the committee’s desire to

focus first on the development of the Safe Route to School maps for schools across the region through this and future calls for projects. Margaret Boone reported after tallying the final evaluation scores that there were 10 evaluations and that the Surprise, Valley Metro, and Glendale projects ranked as the first, second and third respectively. Renate Ehm suggested that the amounts be placed in the scoring matrix with a reduced amount for the Surprise project to show what would be left. George Williams and Chris Lemka both stated that they were in favor of fully funding the Surprise project and offering Valley Metro the remaining as ranked second in the evaluation. George Williams stated that he was not comfortable offering a project $57,000 if it was not certain that the funding would benefit the project and asked what other options there were for the remaining funds outside of another call for projects. Margaret Boone stated that the remaining amount could be loaned to a future year based on information received from Teri Kennedy. **George Williams made a motion to 1) accept the advancement of the Maricopa County Health Department funding request to FY2015, 2) fully fund the City of Surprise project and 3) to forward the remaining funds to the January call for projects for programming in a future year. Kerry Wilcoxon seconded and the motion passed unanimously.** Kiran Guntupalli commented the application process required a fairly significant effort and that MAG should consider simplifying the application process to match available funds.

6. <u>2014 Corridor Safety Management Plan – Pilot Project</u>

Chair Renate Ehm stated that in the interest of time that agenda item number six would be moved to the end of the agenda. Sarath Joshua outlined the new project in the MAG work program in the amount of $200,000 to carry out the pilot project and that a working group will still need to be formed to refine a scope for the project. Mr. Joshua went on to state that before the scope is refined there needs to be an agreement based on input from the committee on the corridor and length to be included in the study. Background information was sent out to the committee with the agenda including a report on synthesis study on the effectiveness of safety corridor programs. Kerry Wilcoxon suggested that the City of Phoenix has the best opportunity for a contiguous corridor offering the corridor of west Indian School Road between 43rd and 75th Avenue to capture two of the top twenty ranking in the MAG Top 100 high crash locations. Sarath stated that the working group would come back to the committee at the November meeting with a draft scope, there would be a call for proposals within the on-call consultant list, and that a February of 2015 kick-off is anticipated. Sarath stated that this would be an extended RSA for a corridor but may also look at a possible law enforcement initiative or education campaign for the corridor. Erik Guderian stated that the scoping should be cautious of the extensive data required if there are a lot of access points between the intersections. Kohinoor Kar suggested that the word "plan" should be removed from the title if the pilot project will not produce a full blown plan for the entire Indian School Road corridor. Sarath Joshua stated that there will be no evaluation component or implementation plan and suggested that the name cannot change in the work program but that the working title could be changed. **Julian Dresang made a motion to include the Indian School Road corridor from 51st Avenue to 75th Avenue for the pilot project as it fits within the work program budget, seconded by Chris Lemka and the motion passed unanimously.**

7. Bicycle and Pedestrian Pathway/Railroad Crossing Recommendations

Sarath Joshua introduced MAG Bike and Ped coordinator Alex Oreschak to present this item. Mr. Oreshak provided some background stating the expansion of the regional pathway system as well as more usage of canal pathways focused on private canal and UPRR crossings in the East Valley agencies of Chandler, Gilbert and Tempe which may be transferrable to other situations. The project team included SRP, ADOT, ACC, and Operation Lifesaver and was initiated to address gaps where pathways meet railroad tracks, pathway users illegally crossing and safety/liability concerns. Mr. Oreschak reviewed the recommendations to implement grade-separated crossings where feasible, work with railroad to create action plan for implementing safe at-grade crossings and address crossings on a case-by-case basis and went over a few possible design considerations included in the final report. Erik Guderian asked about SRPs reaction to closing one side of the canal since they require one side of the canal to be reserved for maintenance. Alex noted that SRP put forward a recommendation to put a prefabricated bridge across in order to maintain access to one or the other side of the canal.

8. Update on Strategic Transportation Safety Plan (STSP) & Adoption of Network Screening Recommendation

Margaret Boone reported that STSP Tech Memo#3 has been completed and available at the MAG website http://stsp.azmag.gov. Ms. Boone also reported that Task 5 and 6 is currently underway and involves exploring incorporation of safety in the Regional Transportation Plan and all projects programmed in the TIP. As a subset activity of this task, a Working Group was convened in partnership with the Safety, Transit & Bike/Ped Committees with a goal of recommending regional practice(s) for addressing ped/bike safety issues accessing transit stops/stations and gave an example of one of the practices developed by the Working Group: Develop evaluation criteria that would facilitate the incorporation of safety features in all TIP project application categories. Draft Tech Memo #5 is available for review with a deadline for comments by EOB July 24, 2014. Sarath Joshua reported on the recommendation in Tech Memo #4 for modifications to the current Network Screening reviewed as part of Task 4 in the development of the STSP. Mr. Joshua stated the basis of the recommendation, which is included in the Draft Final Tech Memo #4, included that the intent of a good methodology is to outline an approach that minimizes known biases towards intersections with low and high volumes. In addition, use of the crash rate factor infers that the relationship between number of crashes and volume are linear when in fact recent safety research indicates more of a curve. The recommendation is to remove crash rates in the ISS equation. Since the methodology was adopted by the Safety Committee this agenda item is for discussion and possible action by the committee to adopt a revised methodology consistent with the recommendations as well as MAP-21 requirements. Members of the committee discussed the recommendation and how that would affect the MAG Top 100 list of high crash risk locations noting that the City of Scottsdale and City of Phoenix have reservations about excluding the crash rate unless it could be demonstrated that it is simply a re-shuffling of the location rankings and that it did not have a larger effect in drastically propelling or demoting intersections in the ranking. Chris Lemka recommended that this item be brought back at the September meeting once committee members could be provided information on the STSP consultants recommendation as well as the data set provided with the three and four factor rankings for review. Sarath noted that MAG would provide the data set and Margaret Boone noted

that the Tech Memo #4 which includes the requested information is available for review on the STSP webpage. Chair Renate Ehm noted the deference of this item and encouraged the committee to review the Tech Memo #5.

9. Reports by Committee Members on Transportation Safety Activities
Chair Renate Ehm requested to defer this item to the next meeting. No objections heard.

10. Request for Future Agenda Items
Chair Renate Ehm requested to defer this item to the next meeting. No objections heard.

11. Next Meeting
Chair Renate Ehm stated that the next meeting is scheduled for Tuesday, September 23rd, 2014 at 9:30 a.m. in the Ironwood Room.

12. Adjournment
Chair Renate Ehm adjourned the meeting at 11:39 a.m.

3-Factor Rank Top 50 High Crash Risk Locations

Attachment One

Agency	Intersection	All Crashes	3 Factor Score	3 Factor Rank	Final Rank	Diff 3Factor- 4 Factor
Tempe	SOUTHERN AVE & RURAL RD	118	0.75624	1	2	-1
Chandler	RAY RD & ALMA SCHOOL RD	76	0.744556	2	5	-3
Phoenix	INDIAN SCHOOL RD & 51ST AVE	110	0.7101	3	4	-1
Surprise	EL MIRAGE RD & BELL RD	51	0.666697	4	39	-35
Phoenix	THOMAS RD & 43RD AVE	96	0.635545	5	8	-3
Phoenix	MCDOWELL RD & 44TH ST	104	0.633133	6	6	0
Chandler	WARNER RD & ARIZONA AVE	91	0.630937	7	13	-6
Glendale	OLIVE AVE & 59TH AVE	171	0.627562	8	1	7
Phoenix	INDIAN SCHOOL RD & 59TH AVE	104	0.597167	9	7	2
Phoenix	INDIAN SCHOOL RD & 19TH AVE	82	0.57402	10	23	-13
Glendale	BELL RD & 83RD AVE	121	0.571067	11	12	-1
Phoenix	GREENWAY RD & 32ND ST	81	0.564338	12	17	-5
Phoenix	NORTHERN AVE & 43RD AVE	68	0.559884	13	33	-20
Gilbert	WARNER RD & VAL VISTA DR	71	0.553741	14	21	-7
Phoenix	GREENWAY RD & 19TH AVE	69	0.546987	15	26	-11
Phoenix	MCDOWELL RD & 16TH ST	66	0.539475	16	29	-13
Phoenix	MCDOWELL RD & 43RD AVE	84	0.537637	17	20	-3
Phoenix	GRAND AVE & 39TH AVE	6	0.536214	18	98	-80
Glendale	PEORIA AVE & 51ST AVE	76	0.535953	19	25	-6
Phoenix	INDIAN SCHOOL RD & 67TH AVE	115	0.530235	20	9	11
Phoenix	INDIAN SCHOOL RD & 16TH ST	73	0.528418	21	42	-21
Phoenix	PEORIA AVE & I 17	91	0.527431	22	32	-10
Phoenix	BASELINE RD & 19TH AVE	64	0.526225	23	22	1
Peoria	UNION HILLS DR & 83RD AVE	75	0.518225	24	30	-6
Gilbert	VAL VISTA DR & ELLIOT RD	68	0.514824	25	37	-12
Phoenix	BASELINE RD & 48TH ST	65	0.511505	26	62	-36
Phoenix	BUCKEYE RD & 35TH AVE	57	0.508772	27	48	-21
Phoenix	THOMAS RD & 36TH ST	64	0.506535	28	28	0
Avondale	MCDOWELL RD & DYSART RD	122	0.501675	29	31	-2
Phoenix	NORTHERN AVE & 7TH ST	69	0.500998	30	45	-15
Phoenix	INDIAN SCHOOL RD & 32ND ST	58	0.499415	31	44	-13
Chandler	RAY RD & MCCLINTOCK DR	70	0.496735	32	41	-9
Phoenix	BELL RD & 43RD AVE	55	0.494409	33	59	-26
Phoenix	INDIAN SCHOOL RD & 7TH ST	73	0.491611	34	46	-12
Phoenix	GLENDALE AVE & 43RD AVE	62	0.487642	35	58	-23
Phoenix	MCDOWELL RD & 40TH ST	62	0.479104	36	40	-4
Buckeye	YUMA RD & WATSON RD	47	0.471414	37	18	19
Glendale	THUNDERBIRD RD & 59TH AVE	127	0.467541	38	11	27
Pinal County	OCOTILLO RD & GANTZEL RD	41	0.461321	39	60	-21
Gilbert	WARNER RD & LINDSAY RD	55	0.459219	40	56	-16
Phoenix	GREENWAY RD & 40TH ST	49	0.449321	41	65	-24
Phoenix	MCDOWELL RD & 27TH AVE	45	0.446762	42	70	-28
Phoenix	HAPPY VALLEY RD & 67TH AVE	54	0.443877	43	67	-24
Mesa	HOLMES AVE & ALMA SCHOOL RD	42	0.442328	44	72	-28
Phoenix	INDIAN SCHOOL RD & S 1010	50	0.441422	45	38	7
Phoenix	BETHANY HOME RD & 7TH AVE	49	0.441293	46	66	-20
Phoenix	CAMELBACK RD & 7TH AVE	58	0.437936	47	61	-14
Phoenix	THOMAS RD & 75TH AVE	101	0.437599	48	36	12
Mesa	GUADALUPE RD & ALMA SCHOOL RD	48	0.437332	49	73	-24
Phoenix	INDIAN SCHOOL RD & 44TH ST	53	0.436046	50	80	-30

4-Factor Top 50 High Crash Risk Locations

Attachment Two

Agency	Intersection	All Crashes	Avg. Crash Rate	Final Rank	Diff 3Factor- 4 Factor
Glendale	OLIVE AVE & 59TH AVE	171	2.63	1	7
Tempe	SOUTHERN AVE & RURAL RD	118	1.70	2	-1
Tempe	BASELINE RD & Loop 101	151	2.76	3	58
Phoenix	INDIAN SCHOOL RD & 51ST AVE	110	1.36	4	-1
Chandler	RAY RD & ALMA SCHOOL RD	76	1.28	5	-3
Phoenix	MCDOWELL RD & 44TH ST	104	1.45	6	0
Phoenix	INDIAN SCHOOL RD & 59TH AVE	104	1.64	7	2
Phoenix	THOMAS RD & 43RD AVE	96	1.31	8	-3
Phoenix	INDIAN SCHOOL RD & 67TH AVE	115	1.56	9	11
Glendale	GLENDALE AVE & 67TH AVE	92	1.89	10	43
Glendale	THUNDERBIRD RD & 59TH AVE	127	1.72	11	27
Glendale	BELL RD & 83RD AVE	121	1.45	12	-1
Chandler	WARNER RD & ARIZONA AVE	91	1.26	13	-6
Tempe	UNIVERSITY DR & RURAL RD	138	1.86	14	55
Mesa	SOUTHERN AVE & DOBSON RD	129	1.81	15	39
Glendale	BELL RD & 67TH AVE	127	1.70	16	51
Phoenix	GREENWAY RD & 32ND ST	81	1.27	17	-5
Buckeye	YUMA RD & WATSON RD	47	1.72	18	19
Phoenix	DUNLAP AVE & 35TH AVE	114	1.55	19	33
Phoenix	MCDOWELL RD & 43RD AVE	84	1.23	20	-3
Gilbert	WARNER RD & VAL VISTA DR	71	1.23	21	-7
Phoenix	BASELINE RD & 19TH AVE	64	1.35	22	1
Phoenix	INDIAN SCHOOL RD & 19TH AVE	82	1.09	23	-13
Phoenix	BASELINE RD & 51ST AVE	83	1.75	24	65
Glendale	PEORIA AVE & 51ST AVE	76	1.25	25	-6
Phoenix	GREENWAY RD & 19TH AVE	69	1.18	26	-11
Phoenix	THUNDERBIRD RD & I 017	113	1.51	27	41
Phoenix	THOMAS RD & 36TH ST	64	1.33	28	0
Phoenix	MCDOWELL RD & 16TH ST	66	1.20	29	-13
Peoria	UNION HILLS DR & 83RD AVE	75	1.27	30	-6
Avondale	MCDOWELL RD & DYSART RD	122	1.88	31	-2
Phoenix	PEORIA AVE & I 17	91	1.15	32	-10
Phoenix	NORTHERN AVE & 43RD AVE	68	1.07	33	-20
Phoenix	MCDOWELL RD & 67TH AVE	98	1.62	34	59
Phoenix	THOMAS RD & 67TH AVE	101	1.43	35	23
Phoenix	THOMAS RD & 75TH AVE	101	1.32	36	12
Gilbert	VAL VISTA DR & ELLIOT RD	68	1.20	37	-12
Phoenix	INDIAN SCHOOL RD & S 1010	50	1.50	38	7
Surprise	EL MIRAGE RD & BELL RD	51	0.72	39	-35
Phoenix	MCDOWELL RD & 40TH ST	62	1.27	40	-4
Chandler	RAY RD & MCCLINTOCK DR	70	1.22	41	-9
Phoenix	INDIAN SCHOOL RD & 16TH ST	73	1.05	42	-21
Mesa	SOUTHERN AVE & COUNTRY CLUB DR	107	1.48	43	57
Phoenix	INDIAN SCHOOL RD & 32ND ST	58	1.03	44	-13
Phoenix	NORTHERN AVE & 7TH ST	69	1.03	45	-15
Phoenix	INDIAN SCHOOL RD & 7TH ST	73	1.01	46	-12
Mesa	ELLSWORTH RD & BASELINE RD	49	1.34	47	10
Phoenix	BUCKEYE RD & 35TH AVE	57	0.97	48	-21
Peoria	THUNDERBIRD RD & 75TH AVE	79	1.38	49	46
Pinal County	GANTZEL RD & COMBS RD	45	1.35	50	20

MARICOPA ASSOCIATION of GOVERNMENTS

Strategic Transportation Safety Plan

MAG Contract No. 529 Project No. SP13-01

Technical Memorandum No. 4 – Network Screening Methodologies for Prioritization of Road Safety Needs

4.1 INTRODUCTION

The Maricopa Association of Governments is developing a comprehensive update of the 2005 Strategic Transportation Safety Plan (STSP) with oversight from the MAG Transportation Safety Committee and the Transportation Safety Stakeholders Group (TSSG). The new STSP will establish regional vision, goals, objectives, strategies, countermeasures, and performance measures for transportation safety. It is a data-driven, multi-year comprehensive plan that establishes goals, objectives, and key emphasis areas and integrates the four E's of highway safety – engineering, education, enforcement and emergency medical services (EMS). The STSP allows MAG safety programs and member agencies to work together in an effort to align goals, leverage resources, and collectively address the region's safety challenges. The STSP will also identify strategies for addressing new areas of transportation safety. The development of the STSP will be closely coordinated with the ongoing development of the state's Strategic Highway Safety Plan (SHSP) by the Arizona DOT. The recommendations included in the STSP will be incorporated in the next generation MAG Regional Transportation Plan.

The information included in this Technical Memorandum No. 4 addresses network screening methodologies for prioritization of MAG road safety needs.

4.2 RELEVANCE TO RESOURCE ALLOCATION AND PRIORITIZATION

Network screening enables an agency to systemically assess locations where there are opportunities for safety improvements. In most cases, agencies do not have available resources to fund all desirable safety enhancement projects, so network screening provides the added benefit of helping to rank candidate locations by their specific safety needs and priorities. The strategic and effective use of national or regional safety improvement funds can help MAG partners leverage the use of these key funding sources for identification and selection of the most appropriate safety enhancement projects for their region.

4.3 NETWORK SCREENING BACKGROUND

As presented in the AASHTO *Highway Safety Manual (HSM)*, network screening is part of the roadway safety management process and is useful in the identification and ranking of sites based on the estimated reduction in crashes associated with the implementation of appropriate countermeasures. Through the application of network screening, systematic safety evaluations can be performed that will provide consistent and repeatable results which are useful in identifying and prioritizing candidate safety

enhancement locations. A wide variety of analysis methods may be considered for site identification based on specific needs such as intersection improvement programs, safety policy evaluations, and similar[1].

The HSM identifies a five step process for network screening that consists of the following:

1. Establish Focus
2. Identify Network and Establish Reference Populations
3. Select Performance Measures
4. Select Screening Method
5. Screen and Evaluate Results

The focus step is used to define the problem and determine the reason for applying a network screening effort. An example could be evaluating the merits of adding left-turn lanes at intersection locations. On a larger scale, a focus could simply be to evaluate all urban road segments with traffic volumes greater than some established minimum value so that locations that require additional safety treatments can be identified.

Reference populations are then selected to help better define ways to evaluate the problem. For example, for the left-turn lane focus example the reference population would then be signalized intersections. This population could be further narrowed based on a variety of road characteristics, traffic conditions, and facility users. The selection of performance measures and a network screening technique suitable for evaluating the performance measures is then initiated. One common assessment approach is to identify road segments or intersections of interest and then divide these roadway components into groups with similar characteristics for a more detailed analysis. The results can then be collectively evaluated for corridor safety evaluations.

Currently MAG has developed a network screening procedure for evaluating intersections. At this time, a similar network screening approach is needed for roadway segments. This technical memorandum provides a review of the existing intersection network screening procedure and recommendations to consider for enhancing this approach. Also included in this memorandum is a recommendation for potential network screening techniques for roadway segments. In addition, non-motorized user issues are not always identified using traditional network screening methods. In many cases, the immediate response to an injured pedestrian or bicyclist is to seek emergency medical care as quickly as possible. As a result, it is likely that many crashes involving pedestrians and bicycles are not accurately reported or included in available crash statistics. This technical memorandum includes some additional recommendations to address how to identify locations where facilities intended to protect these vulnerable road users may benefit from additional safety assessment strategies.

4.4 MAG Network Screening Methodology for Intersections

The review of the MAG intersection screening techniques includes a brief overview of the current approach, recommendations for enhancing the procedure, and future supplementary network screening recommendations that merit consideration.

4.4.1. Current Approach

At this time, the MAG Network Screening Methodology for Intersections (NSM-I) includes several safety assessment techniques that are then weighted and combined into an Intersection Safety Score (ISS). The intent of this composite ISS approach is to minimize known biases in the analysis procedure. For example,

[1] *Highway Safety Manual, 1st Edition.* AASHTO, 2010. Page 4-1

using crash frequencies as a sole method for determining safety needs would introduce a bias towards locations with higher volumes. It is advisable, therefore, to select network screening methods that do not have a known bias or to develop techniques to minimize known biases. The MAG NSM-I approach currently uses the following four crash-related attributes for this purpose:

- Crash Frequency (CF),
- Crash Severity (CS),
- Crash Type (CT), and
- Crash Rate (CR).

The ISS is then developed by assigning weights to these four attributes with the CS value assigned a 40 percent weight and the CF, CT, and CR each assigned a 20 percent weight.

4.4.2. Recommendations to Consider for Enhancement of the Existing NSM-I Approach

The current NSM-I technique provides a well-constructed procedure for overcoming many of the known limitations associated with intersection network screening methods. The creation of a composite ISS is a very useful approach for an overall network screening evaluation. There are two modifications that MAG should consider for this approach: (1) removing or minimizing use of the CR in the ISS, and (2) aggregating the intersections by type or exposure so that comparable conditions are assessed. These two recommendations are discussed in the following sections.

Removing or Minimizing Use of the CR in the ISS

The known bias associated with crash frequency (biased towards locations with high volumes) is one reason why CRs have historically been consistently used in the network screening process. A CR, in simple terms, is a ratio of the number of crashes to the traffic volume at a location. It is noteworthy that the CF value is actually included in the CR calculation. Using a CR is intuitive and, if traffic volume is known, can be easy to apply. Unfortunately, a CR value also has a bias towards low volume locations. The ratio format of the CR also implies that the relationship between the number of crashes and the crash volume is linear (i.e. the CR calculation equates to the slope of a line). In recent years, safety research efforts have determined that the sometimes complex relationship between the number of crashes and the traffic volume is usually not linear but rather has a shape better represented by an equation for a curve that generally flattens as traffic volume increases. For these reasons, the use of CR values should be reserved for locations with similar traffic volumes if safety comparisons are based on CR values.

The current calculation for the ISS applies a 20 percent weight to the CF and CR. Because the CF is included in the CR calculation, the ISS may be skewed by the use of both values in the equation. In addition, the current NSM-I approach for the CR is time consuming because traffic volume values may not always be available for all intersections. As a result, MAG should consider removing one of these values from the ISS and redistributing the weights to the other components. One possible modified ISS equation is shown below:

$$ISS = \left(\frac{1}{4} \times \frac{CF}{Max(CF)}\right) + \left(\frac{1}{2} \times \frac{CS}{Max(CS)}\right) + \left(\frac{1}{4} \times \frac{CT}{Max(CT)}\right)$$

Aggregating the Intersections by Type or Exposure

The comparison of similar intersection types can help eliminate some of the biases attributed to traffic volumes at intersections. For example, a high volume signalized intersection (where rear-end collisions

may be prominent) merits unique evaluation, and a direct comparison between this intersection and a low-volume intersection (where angle crashes may be prominent) would probably mask critical safety enhancement needs. If, on the other hand, intersection types can be evaluated separately based on functional purpose and user distributions, the result will be a more robust screening assessment that better targets key populations. For initial intersection categories, the following intersection types could be independently screened and ISS values developed for each:

- Low-volume STOP-controlled intersections,
- Moderate-volume STOP-controlled or signalized intersections,
- High-volume signalized intersections, and
- Interchange terminal intersections.

Interchanges in urban environments can include a single intersection (such as a single-point interchange), two intersections (common for an urban diamond), or multiple intersections. For this reason, it would be advisable to consider intersections located within the influence area of the interchange. Due to the prevailing urban nature of a large portion of the MAG region, the need to evaluate urban interchanges and better understand their relationships to signalized intersections located in close proximity is important for comprehensive safety assessments. Currently research is underway at the national level (National Cooperative Highway Research Program (NCHRP) Project 7-23) to better identify operational and safety issues associated with access management in the vicinity of interchanges. As part of this effort, the research team is proposing to help define this interchange influence area based on the type of terminal intersection configuration. Until the NCHRP work is complete, MAG could use some basic assumptions regarding surface street influence area such as a one-fourth mile upstream and downstream buffer at the interchange.

4.4.3. Future Enhancements to the NSM-I

Recent enhancements to safety assessment techniques have resulted in evidence based and data driven statistical procedures known as safety performance functions (SPFs). The AASHTO HSM includes nationally derived SPFs for a variety of segment and intersection locations. These SPFs, in concert with companion crash modification factors (CMFs), act as tools for predicting crash performance for various highway types and associated characteristics. Because road and driver characteristics can vary between regions and since regional environmental and enforcement issues may also contribute to local safety conditions, the SPFs should be calibrated for the MAG region prior to establishing or adopting the use of regional SPFs. It would be optimal for the MAG partners to develop a strategy to systematically calibrate existing SPFs and develop MAG-specific SPFs for facilities with calibration factors that result in extreme values (optimal calibration factors should have a value of approximately 0.7 to 1.3).

The future integration of SPFs into the intersection network screening procedures would help reduce the known biases of using crash frequencies and rates. The SPF could be used to determine the number of crashes that can typically be expected for a particular type of intersection. Network screening would then identify locations where the historic (or observed) crashes exceeded the number of predicted crashes for that type of facility. SPF values can be based on total crashes or fatal and injury crashes, so specific crash severity thresholds could also be determined using this procedure. SPFs can also be used to apply Empirical Bayes (EB) procedures that further improve crash estimation quality. Until MAG is able to calibrate or develop region-specific SPFs, the HSM SPFs could be used for comparative purposes only.

A key input variable for all intersection SPFs is the traffic volume for the major and minor approaches. As noted in the existing NSM-I documentation, traffic volume is not always available for the crash rate

calculation. Consequently, a future recommendation would also be to enhance the available traffic volume information for candidate network locations. It may be feasible to use a subset of traffic volume data to develop an estimation method for approximating missing traffic volume values.

Finally, the HSM SPFs are used in conjunction with CMFs as previously noted. A CMF is a multiplicative factor that represents the anticipated influence that an individual feature or a set of road characteristics may have on the predicted number of crashes. For example, a CMF equal to 0.97 would represent a three percent reduction in crashes (i.e. 1.00 – 0.97 = 0.03). Similarly, a CMF value greater than 1.0 represents an anticipated increase in the number of crashes. In many cases, a CMF can be very influential while other CMFs represent only minor changes in crash totals. In the event MAG elected to use the current HSM SPFs along with their companion CMFs for the purposes of network screening at intersections, the information shown in Table 1 identifies these CMFs and indicates those that will have the greatest impact on the predicted safety performance. The priority indications shown in the table are based on (1) CMFs that are dramatically influenced by their associated road characteristics, and (2) CMFs with values that are not close to a value of 1.0 (i.e. CMFs that do not substantially change the predicted number of crashes should not have high data collection priorities).

Table 1. Priority Data Needs for HSM Intersection CMFs

	Priority Level for Data Needs at Intersection Types											
	3-Leg STOP Controlled			**3-Leg Signalized**			**4-Leg STOP Controlled**			**4-Leg Signalized**		
CMF Description	High	Medium	Negligible or Not Applicable	High	Medium	Negligible or Not Applicable	High	Medium	Negligible or Not Applicable	High	Medium	Negligible or Not Applicable
Urban and Suburban Arterial Intersections												
Left-turn lanes	✓					✓	✓					✓
Left-turn signal phasing			✓		✓				✓		✓	
Right-turn lanes			✓		✓				✓		✓	
Right-turn on red			✓			✓			✓			✓
Street lights		✓			✓			✓			✓	
Red light cameras			✓			✓			✓			✓
Rural Multilane Highway Intersections												
Skew angle	✓			HSM SPF Not Available			✓					✓
Left-turn lanes	✓						✓					✓
Right-turn lanes		✓					✓					✓
Street lights			✓						✓			✓
Rural Two-lane Highway Intersections												
Skew angle		✓		HSM SPF Not Available			✓					✓
Left-turn lanes	✓						✓			✓		
Right-turn lanes	✓						✓				✓	
Street lights		✓						✓			✓	

As shown in Table 1, identifying left-turn lane information at STOP controlled intersections should be given priority for urban and suburban arterial intersections. Similarly, left-turn lanes, skew angles, and right-turn lanes have high to medium priority for rural multilane and two-lane STOP controlled intersection locations.

The rural two-lane 4-leg signalized intersection is the only signalized facility type where the left-turn lane information should receive priority data collection attention.

4.5 Recommendations for MAG Network Screening Methodology for Segments

Currently MAG does not have a comprehensive method for performing network screening for segment locations. Similar to concerns identified for the MAG NSM-I procedure, the application of segment screening methods based solely on crash frequency trends can be biased to high volume locations. A secondary issue common to segment analysis is the accurate reporting of crash locations. Evaluating very short segments may result in incorrect assumptions about the number of crashes along a segment location. Consequently, effective segment screening techniques should incorporate procedures that provide some flexibility for potentially imprecise location information.

Another item that must be considered is how to identify the segment related crashes that should be included in the segment network screening analysis. The NSM-I only uses crashes identified by the Arizona Department of Transportation's Accident Location Identification Surveillance System (ALISS) as "intersection related", so the network screening for segments should include all crashes **that are not designated** as "intersection related" in the Arizona crash database. As noted in the NSM-I description, the ALISS data are assumed to be 100 percent accurate for the purposes of this network screening procedure.

4.5.1. Safety Network Screening Methodology for Segments (NSM-S)

Network screening for segment locations can be accomplished by selecting target performance measures accompanied by an effective screening method. The following summary addresses recommended target performance measures that can be reasonably evaluated with the existing MAG data. Section 4.4.2 provides a recommended future network screening approach as MAG data and region-specific SPFs become available.

Target Performance Measures

A wide variety of candidate performance measures are available for safety network screening; however, data requirements must be considered when defining practical and effective methods. Page 4-8 of the HSM provides a table (Table 4-1 of the HSM) that summarizes data needs for a wide variety of performance measures. Of course selection of candidate performance measures should also consider quality of data and stability of the analysis procedure. For this reason, an optimal performance measure that evaluates system-wide performance is one that compares proportions of crash type or severity that are typically observed at similar sites and ranks sites based on levels of excess proportions.

In addition, recent MAP-21 legislation stipulates performance measures that focus on total number of fatal crashes, total number of serious injury crashes, and rates attributed to these fatal and serious injury crashes. Consequently, the segment screening method should also evaluate these specific frequency values. [Note: The required rate values will be generalized rates where the frequency is divided by million vehicle miles traveled. This exposure information will be acquired from the FHWA Highway Performance Monitoring System (HPMS) and not evaluated on an individual site basis, so the rates are not included in this proposed analysis.] Therefore, the proposed NSM-S procedure recommends the following performance measures:

- Excess proportions of specific crash types (primary performance measure),
- Frequency of total crashes (secondary performance measure),
- Frequency of fatal crashes (secondary performance measure), and
- Frequency of serious injury crashes (secondary performance measure).

The "Excess Proportions of Specific Crash Types" method, as introduced in the HSM, is based on comparing the observed number of crashes at a study location to proportional distributions of crashes for similar locations. For example, a 0.5 mile long urban roadway segment with four lanes could be expected to have a variety of crashes including run-off-road, sideswipe, head-on, etc. These same crash types may occur for high, moderate, and low volume conditions, but their proportions are likely to change. Lower volume conditions would be less likely to have sideswipe or head-on crashes but more likely to have run-off-road crashes. Using the excess proportions approach, the various roadway segment types would be aggregated into corridor types and further subdivided by traffic exposure thresholds. A proportion of crash types would then be developed for each of the candidate corridors based on crash history for these facility types in the region. The network screening procedure would then compare the observed crash proportions to those commonly observed for similar locations and identify excess proportions that merit additional analysis. This procedure is not influenced dramatically by time sensitive fluctuations (making it a good screening candidate as it is not directly affected by regression to the mean biases). Some potential limitations to the procedure include the fact that traffic volume is not explicitly considered in the analysis (thus the aggregation by facility type and by volume thresholds). Of course, this means the procedure can be applied at all locations, even when traffic volume information is not available. The addition of secondary performance measures (frequency of total, fatal, and serious injury crashes) will help confirm locations that merit additional safety evaluations. An example application of this method can be observed on page 4-40 of the HSM.

Screening Method

The AASHTO HSM[2] identifies the peak searching method and the sliding window method as the two recommended techniques for performing network screening along roadway corridor segments. Though in its early application stages, an additional and promising screening method known as the continuous risk profile has recently been introduced in California.[3] Segment screening methods can vary dramatically depending on the stability of the crash data, but as a general rule the use of both the peak searching method and the sliding window will insure the most reliable results.[4]

Peak Searching Method

To use the peak searching method, divide the roadway segment of interest into equivalent length windows that do not overlap and calculate a performance measure of interest. A small window length of 0.1 miles should first be evaluated, but this length is gradually adjusted to longer values. The coefficient of variation (CV) is evaluated for each segment. The CV helps determine the level of precision for window performance measures. An example application of this method can be observed on page 4-17 of the HSM.

Sliding Window Method

The sliding window approach helps to compensate for errors in crash location reporting by providing assessments of overlapping windows. For this reason, if only one screening method is selected, the sliding window provides this additional benefit that would make it a good choice. For this screening method, the user selects a window length (say 0.5 miles long), evaluates performance measures for the window, and then conceptually "slides" the window some small offset (say 0.1 miles) and repeats the analysis. By evaluating an individual location multiple times (for example the segment between the 0.4 and 0.5 mile

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[2] AASHTO. *Highway Safety Manual*, Washington, D.C. 2010.

[3] Chung, K., and D. R. Ragland. "A Method for Generating a Continuous Risk Profile for Highway Collisions," Paper UCB-TSC-TR-2007-6, Institute of Transportation Studies, UC Berkeley Traffic Safety Center, University of California, Berkeley.

[4] Hauer, E., J. Kononov, B. Allery, and M.S. Griffith. "Screening the Road Network for Sites with Promise", *Transportation Research Record 1784, pp. 27-32, 2002.*

location would be evaluated five times), inaccurate crash reporting locations are minimized. An example application of this method can be observed on page 4-16 of the HSM. This technique can be automated using GIS tools or spreadsheet tools.

4.5.2. Future Enhancements to NSM-S

As noted in Section 4.4.3, SPFs are powerful tools that can be used to predict the number of crashes for a particular type of facility. As a result, determining the expected number of crashes or crash types at a site can help agencies better define targeted safety expenditures. A key component for the use of SPFs is the study segment traffic volume. This critical data element may not always be available and so the recommendations for the near term safety network screening for segments do not include SPFs. A future enhancement to the recommended procedure, therefore, would be the following items:

- Develop a traffic volume database for corridor roadway segments,
- Calibrate the HSM SPFs with their companion CMFs for MAG-specific regions or develop new region-specific SPFs (as needed), and
- Systematically acquire information about supporting data elements for use with the various companion CMFs.

As noted in Section 4.4.3, a first step towards developing data for the HSM segment CMFs is to prioritize the influence of the various CMF elements in the overall crash prediction process. Table 2 identifies these CMFs and further determines those that are most influential in the overall safety assessment process (i.e. merit a higher priority in data collection plans) because they are either affiliated with road characteristics that substantially modify the CMF values or result in CMF values that are not close to a value of 1.0.

Table 2. Priority Data Needs for HSM Segment CMFs

CMF Description	Priority Level for Data Needs at Segment Types														
	2-Lane Undivided Arterial			3-Lane Arterial with a TWLTL			4-Lane Undivided Arterial			4-Lane Divided Arterial			5-Lane Arterial with a TWLTL		
	High	Medium	Negligible or Not Applicable	High	Medium	Negligible or Not Applicable	High	Medium	Negligible or Not Applicable	High	Medium	Negligible or Not Applicable	High	Medium	Negligible or Not Applicable
Urban and Suburban Arterial Segments															
On-Street Parking	✓			✓			✓			✓			✓		
Roadside Fixed Objects		✓			✓			✓			✓			✓	
Median Width			✓			✓			✓			✓			✓
Street Lights			✓			✓			✓			✓			✓
Automated Speed Enforcement			✓			✓			✓			✓			✓
Rural Multilane Highway Segments															
Lane Width	HSM SPF Not Available			HSM SPF Not Available				✓			✓		HSM SPF Not Available		
Right Shoulder Width								✓			✓				
Roadside Side Slope								✓				✓			
Median Width									✓			✓			
Street Lights									✓			✓			
Automated Speed Enforcement									✓			✓			
Rural Two-lane Highway Segments															
Lane Width	✓			HSM SPF Not Available											
Shoulder Width and Type	✓														
Horizontal Curves			✓												
Superelevation		✓													
Grades		✓													
Driveway Density	✓														
Centerline Rumble Strips			✓												
Passing Lanes	✓														
Two-Way Left-Turn Lane			✓												
Roadside Design	✓														
Street Lights		✓													
Automated Speed Enforcement		✓													

4.6 Potential MAG Screening for Non-Motorized Users

While the HSM and other literature provides a method and means of performing network screening on intersections and road segments, there is considerably less published information related to network screening of pedestrian and bicycle crashes. Many of the techniques described in the HSM to identify higher risk intersections or segments where measurable safety improvements are most likely to be achieved may be applicable to pedestrian and bicycle crashes.

Pedestrian and cyclist crashes are a point of emphasis with the MAG region. Figure 1 summarizes the pedestrian crash data for the region. The planning region has averaged approximately 1028 pedestrian crashes per year for the five years of data examined (2008 – 2012).

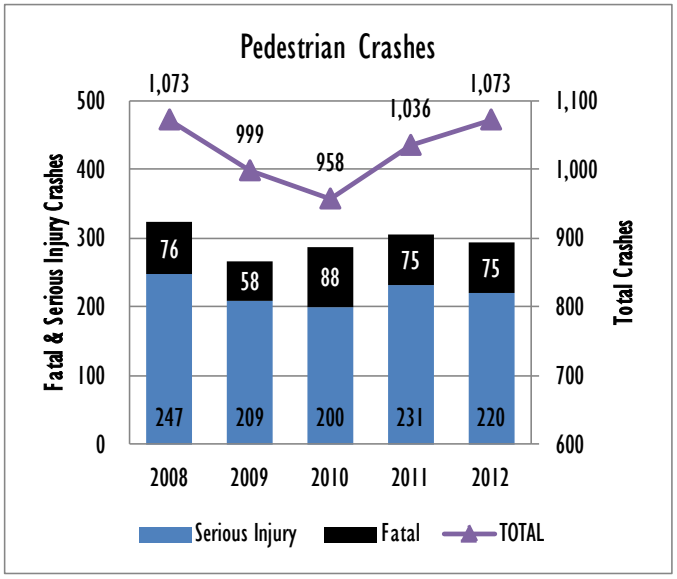

Figure 1. Pedestrian Crashes in the MAG Planning Area

Bicyclist crashes have a similar level of occurrence in the MAG planning region with an average of approximately 1435 cyclist crashes occurring per year as shown in Figure 2. Bicyclist crash data indicates that a lower percentage of crashes involve serious and fatal injuries compared to pedestrian crashes.

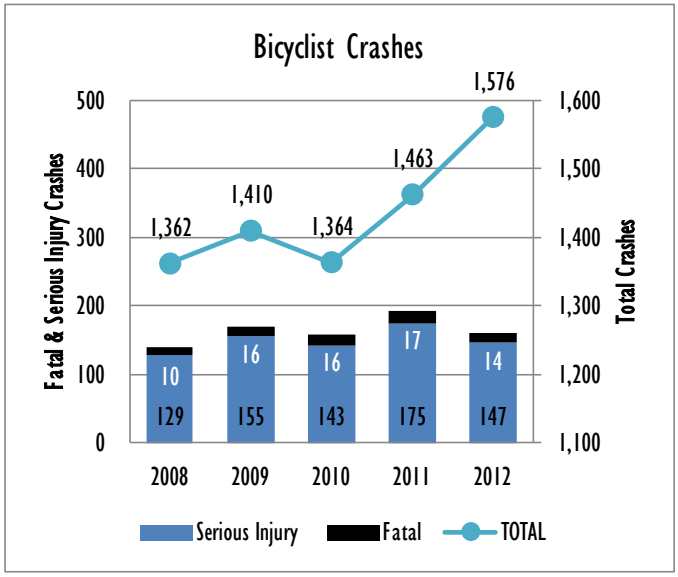

Figure 2. Bicyclist Crashes in the MAG Planning Area

Pedestrian and bicycle crashes are infrequent and less repeatable making it more difficult to identify high crash locations for these vulnerable road users. This section of the memorandum first reviews background information related to bicycle and pedestrian crashs and then demonstrates how some of these concepts may apply to the MAG region.

4.6.1. Background

The Florida Department of Transportation developed a statistical model to identify a threshold number of pedestrian crashes per mile of roadway to allow a segment-based screening of the roadway network on

a systemic basis[5]. This type of methodology would be a segment-based approach similar to the sliding window or peak searching methods described in the HSM except the statistical process allows the identification of a critical crash frequency.

Some researchers have had success using GIS-based clustering analysis to determine common factors in pedestrian crashes. Information contained on the PEDSAFE website (www.pedbikesafe.org) indicates that the mapping of crash locations is an important first step in improving pedestrian safety. Density maps of reported crashes can be a useful tool but care must be taken to recognize that exposure data related to total pedestrian numbers and traffic volumes can affect the reported crash densities. Additionally, the website points out that crash experience may not necessarily match the locations with highest risk. Much of this information is also relevant to the identification of high crash locations for bicycle crashes.

In a study of pedestrian crashes in New York and Toronto, researchers used GIS-based clustering to determine the commonality between fatal and injury crashes. This methodology allowed the researchers to identify policy recommendations in an effort to improve pedestrian safety[6].

In a study from the Las Vegas metropolitan area, Pulugurtha and Nambisan used GIS to assist in the identification of high crash locations[7]. The methodology used to screen the metro area's pedestrian crashes was based on a seven-step methodology that included breaking the study area down into zones. In this case, zip codes were used as analysis zones and the pedestrian crashes from the heavily urbanized areas were address matched and then overlaid onto the analysis zones. Through the use of zip code or census block data, demographic data can be easily included in the analysis to allow a more focused pedestrian study that looks at a subset of the pedestrian crash data (e.g. senior citizens). The pedestrian crashes were then ranked using two crash indices, one based on the number of pedestrian crashes at the location, the population of the analysis zone, and percentage relationships for both. The research also used a second ranking index based strictly on the percentage of crashes within the study area that the specific study location comprised. Ultimately in this instance, the selection of treatment locations were based strictly on their percentage of the total pedestrian data set.

In Ottawa, Canada, the city developed a Pedestrian Safety Evaluation Program for use in improving pedestrian safety by prioritizing pedestrian safety improvements throughout the city[8]. The program included a prioritization / network screening element that used a modified version of the Pedestrian Intersection Safety Indices (Ped ISI) originally developed by FHWA[9]. The Ped ISI tool allows the ranking of intersections based on their traffic control, number of lanes, 85th percentile speeds, average daily traffic, and the predominant land use in the area. The Ped ISI tool is not based on the number of crashes at a location, but is instead focused on the characteristics that contribute to a lower level of pedestrian safety. In performing the network screening for the Pedestrian Safety Evaluation Program in Ottawa, city staff combined the results of the Ped ISI rankings with crash histories and public input to develop their ranked locations for safety improvements. In the Ottawa study, crash data was utilized in a deemphasized fashion due to the relative rarity of pedestrian crashes as compared to vehicle crashes as a whole.

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[5] *Identifying Pedestrian High-Crash Locations as Part of Florida's Highway Safety Improvement Program.* Transportation Research Record 1828. Transportation Research Board, Washington, DC, 2003.

[6] A clustering regression approach: A comprehensive injury severity analysis of pedestrian–vehicle crashes in New York, US and Montreal, Canada. Safety Science, Volume 54, April 2013.

[7] Pulugurtha, S. S., and S. S. Nambisan. *A methodology to identify high pedestrian crash locations: An illustration using the Las Vegas Metro Area. TRB 2003 Annual Meeting CD Rom.*

[8] Tanaka, Krista. *Ottawa Pedestrian Safety Evaluation Tool*. Paper presented at 2012 Conference of the Transportation Association of Canada.

[9] *Pedestrian and Bicyclist Intersection Safety Indices: User Guide.* FHWA Report No. FHWA-HRT-06-130. April 2007

One thing that is evident with respect to pedestrian and bicycle crash screening is the desirability to use a more lengthy number of years of crash data. The FHWA Document "How to Develop a Pedestrian Safety Action Plan" states "*to identify high crash corridors or areas, three year of crash data is ideal, but as little as one year of crash data may be sufficient*."[10] The training materials designed for the FHWA Designing for Pedestrian Safety courses recommend five years of pedestrian crashes to identify high-crash spot locations. The FHWA "How-To" document also indicates that "b*ecause some pedestrian crashes are rarely repeatable, other types of data should be used to identify where pedestrians safety improvements are needed, specifically pedestrian count and behavior studies.*"

The Massachusetts DOT produces a pedestrian and bicycle crash cluster map in their annual crash report. The crash cluster analysis uses data from the most recent nine-year (9) period instead of three years as used in vehicular intersection crash analysis. Additionally, the cluster analysis is composed of a greater clustering distance using a 100 meter search distance instead of a 25 meter search distance as used for vehicular intersection crashes[11].

Metroplan, the central Arkansas MPO published the CARTS Pedestrian/Bicycle Crash Analysis. Due to the relatively low number of crashes, they evaluated crashes for years 2001 through 2010. Crash clusters were independently assessed for pedestrian and bicycle crashes and utilized a 1000 foot search radius around each crash[12]. Sample output from the Metroplan analysis is shown in Figure 3.

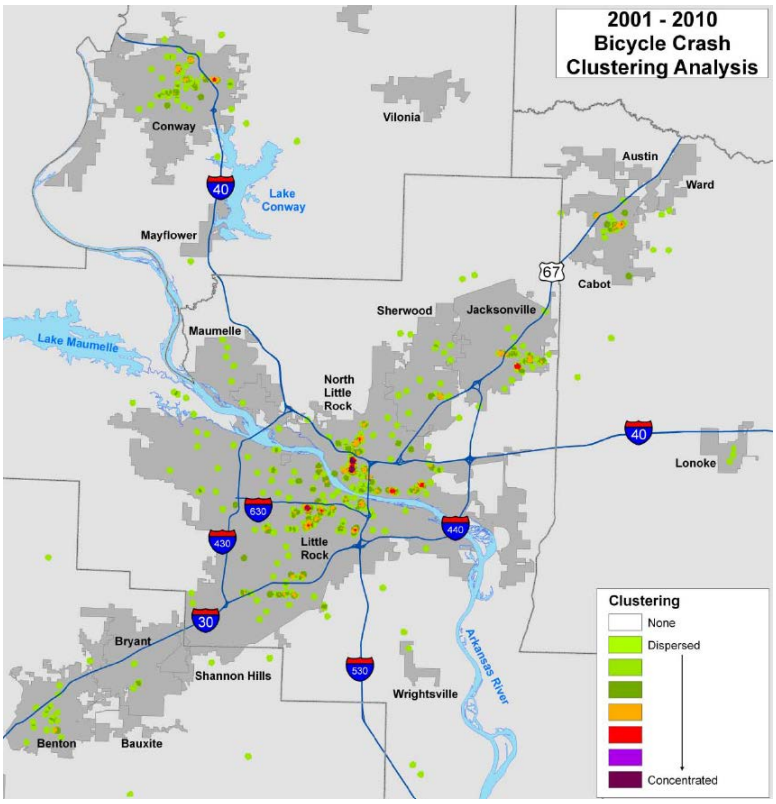

Figure 3. Bicyclist Crash Clustering

Various clustering analysis techniques appear to hold some promise in identifying high crash areas for additional review. The larger cluster radius used in the Arkansas study appears to hold promise at a regional level. This type of clustering analysis would potentially allow for quick identification of sub-areas for more focused study using more rigorous techniques.

As a whole, pedestrian and bicycle crash network screening appears to be a developing element in highway safety. One point that stands out is the need to use longer timeframes for the data sets for identifying high pedestrian or bicyclist crash sites. Because the MAG region has been rapidly growing and changing, nine years of crash data may be excessive. Five years of crash data seems more appropriate for this activity.

[10] How to Develop a Pedestrian Safety Action Plan, FHWA, Office of Highway Safety, Washington, DC, reprinted May 2008
[11] *2010 Top Crash Locations Report*. Massachusetts Department of Transportation. September 2012.
[12] CARTS Pedestrian/Bicycle

4.6.2. Recommendations for MAG Bicycle and Pedestrian Screening

The consideration of land use and socioeconomic information may be incorporated into the network screening process for evaluating bicycle and pedestrian crash distributions. As noted in the background section (see Section 4.6.1), spatial analysis is becoming one of the most common techniques for assessing candidate locations where bicycle or pedestrian crashes may be occurring. The occurrence of a pedestrian and bicycle crash is a rare event when contrasting frequency values to motor vehicle crashes. One option may be to consider the average number of pedestrian and bicycle crashes based on vehicle miles traveled. Figure 4 demonstrates how pedestrian and bicycle crashes that occurred from 2008 to 2010 generally increased by vehicles miles traveled on urban arterial roads in the MAG region. The figure also includes a standard error indication for each exposure threshold. As exposure increases it becomes clear that crash dispersion also increases. Ideally the preferred option would be to develop a SPF from the data shown, but due to the small number of these crash types it is not practical to statistically develop a rigorous SPF for this purpose.

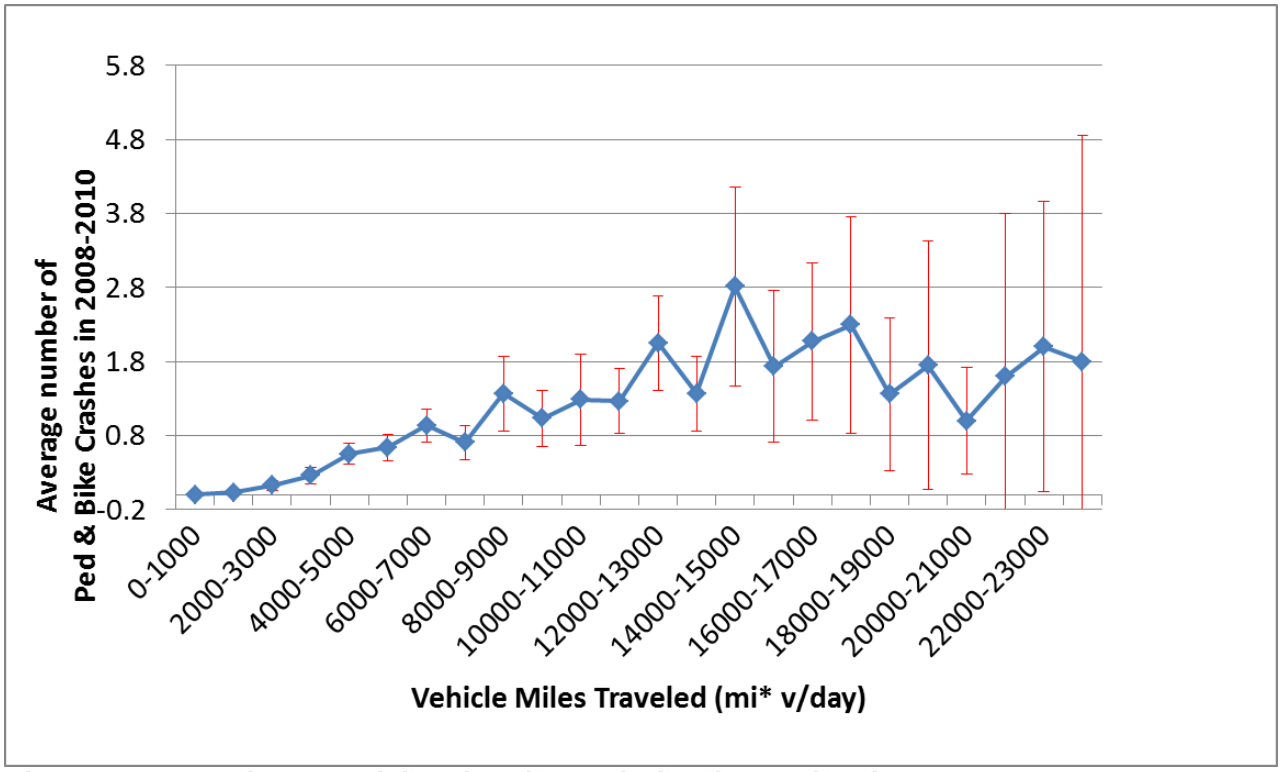

Figure 4. MAG Urban Arterial Pedestrian and Bicycle Crashes by Exposure

It is possible to identify extreme examples of locations that merit a more detailed engineering study for pedestrian and bicycle crashes. For example, Figure 5 shows how a spatial evaluation of MAG data could be used to locate unusually high crash frequency locations; however, this approach does not explicitly consider land use and is likely to have a bias towards high motor vehicle volume locations.

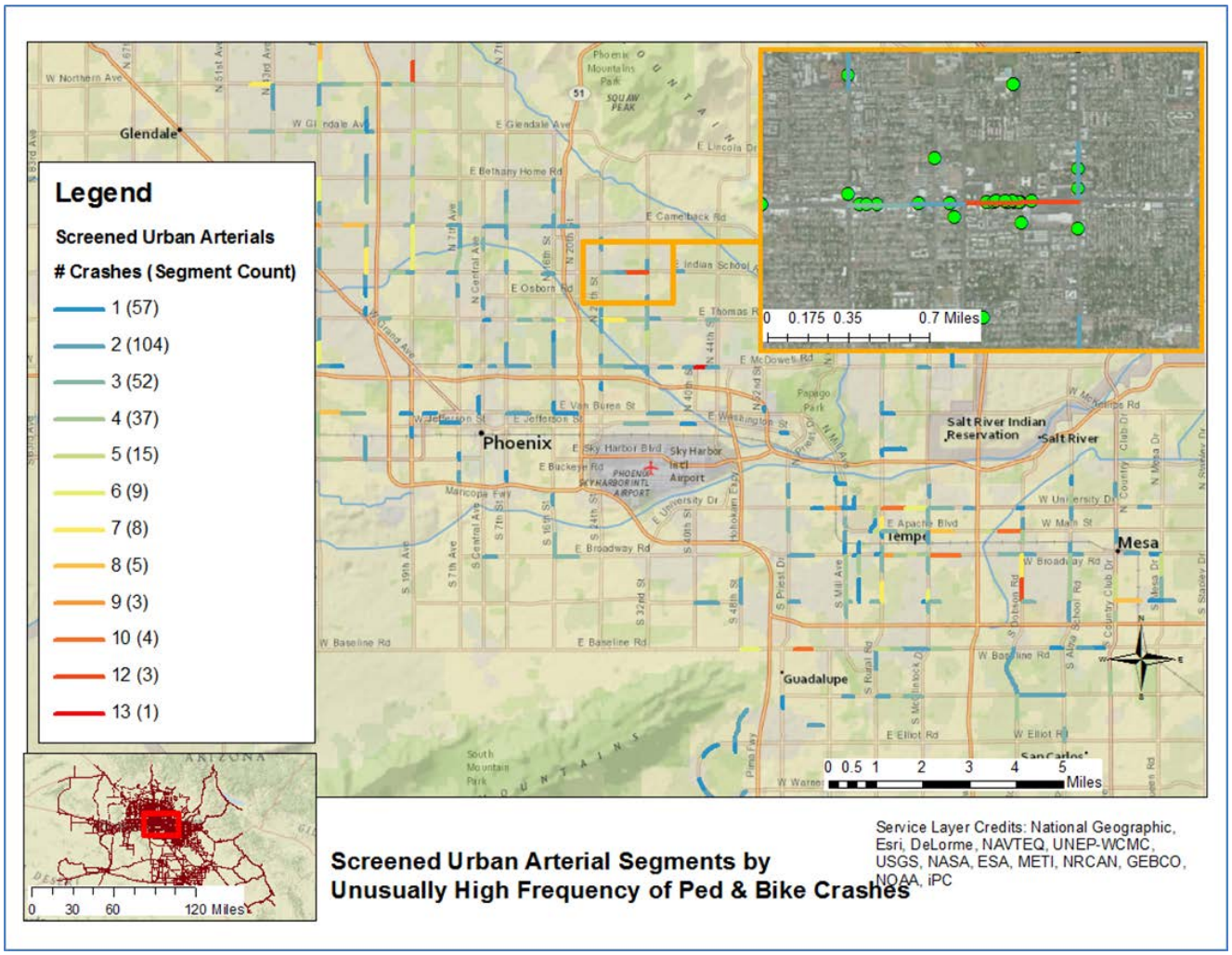

Figure 5. Unusually High Pedestrian and Bicycle Crash Locations

An interesting GIS feature that could be used to further analyze crash conditions for pedestrians and bicycles is the "Optimized Hot Spot Analysis" approach. This method creates a grid and assigns a "score" for each cell based on the number of crashes within the cell in combination with the number of crashes in neighboring cells. The resulting map is a crash density map where the red regions are those with the "higher than average" crashes and blue areas represent "lower than average" crash conditions (see Figure 6).

Alternative spatial screening can evaluate the number of pedestrian and bicycle crashes by population density (see Figure 7) and by age (see Figure 8). Screening by land use, however, simply reflected increased pedestrian and bicycle crashes in regions of high traffic volume and so is not recommended for diagnostic purposes, but could be useful for public outreach efforts.

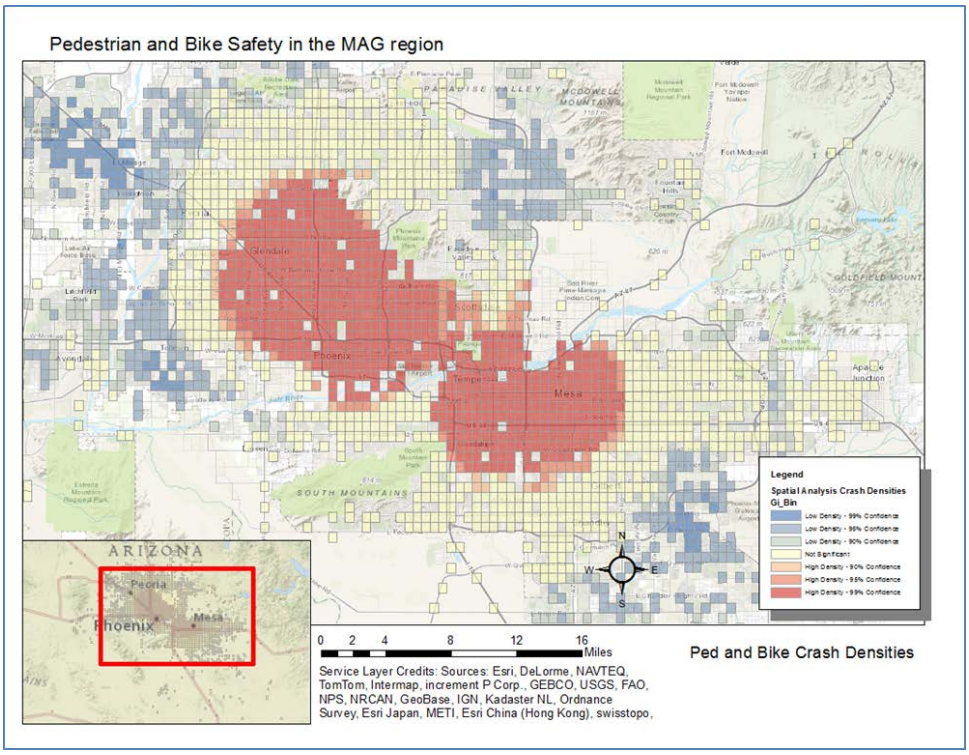

Figure 6. Pedestrian and Bicycle Crash Densities

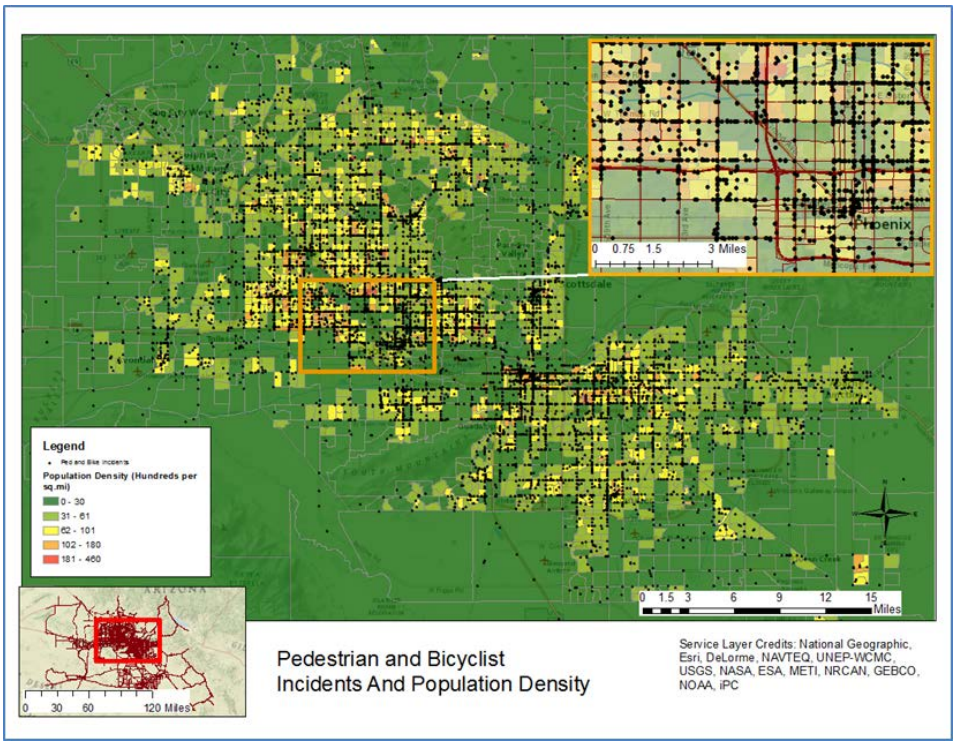

Figure 7. Pedestrian and Bicycle Crashes by Population Density

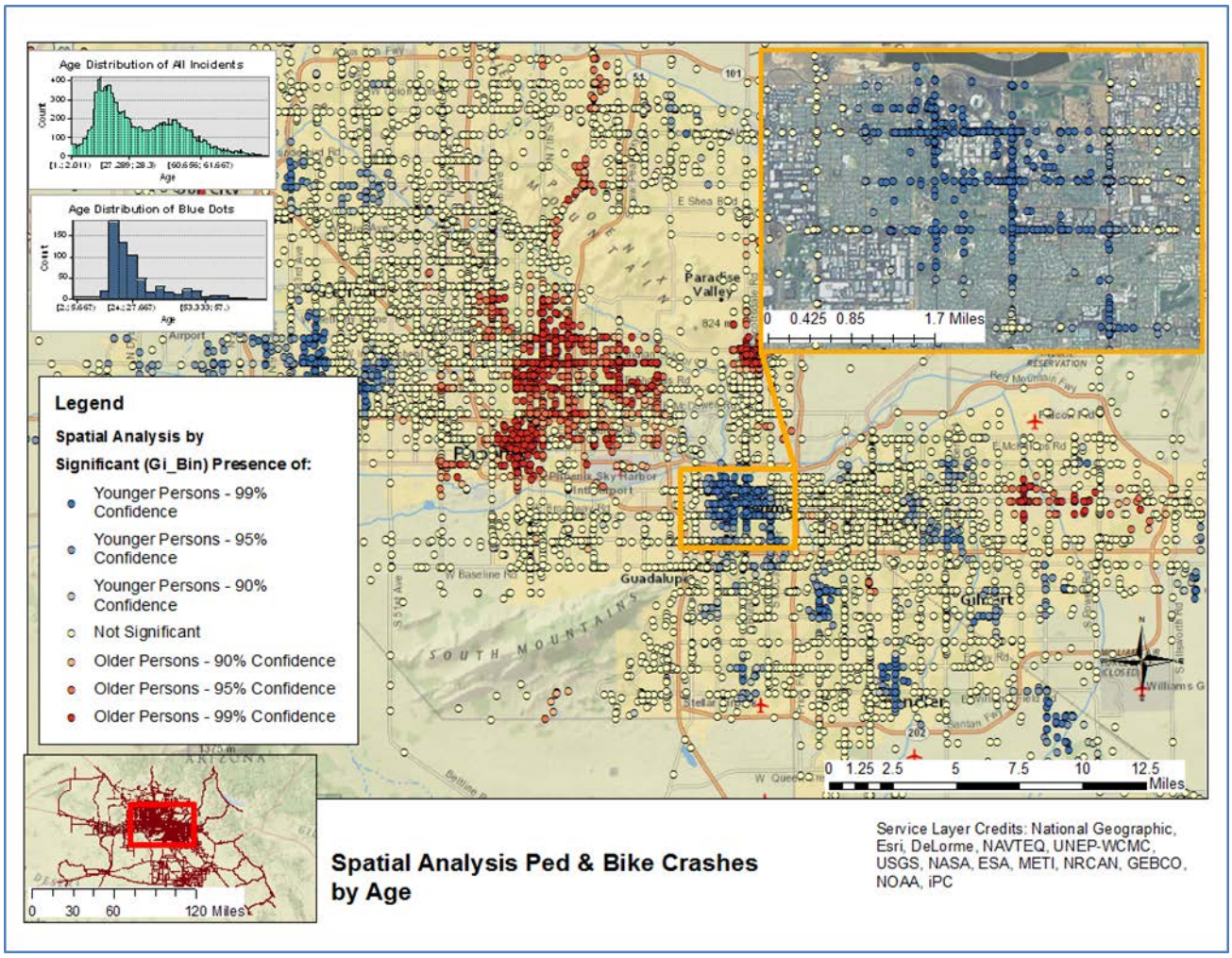

Figure 8. Pedestrian and Bicycle Crashes by Age

An additional diagnostic technique may be to contrast pedestrian and bicycle crashes against specific topographic features in the region. As an example, Figure 9 shows a map of waterways located in the Phoenix area (many of which are canals with mid-block street crossings). The pedestrian and bicycle crashes are shown as they relate to these locations. This type of analysis can be used to help pinpoint targeted improvement projects such as grade separated canal crossings.

As shown, there are a wide variety of ways to evaluate pedestrian and bicycle crashes using spatial analysis tools. The use of density maps shows promise as an initial screening tool. Once dense crash locations are known, contrasting the crashes to exposure, population density, age, and unique features can collectively help identify key locations that merit safety enhancement efforts.

A future enhancement to pedestrian and bicycle screening may be to adopt an indices technique similar to the Ottawa, Canada example (see Section 4.6.1). Because this indices approach requires significant infrastructure data (traffic control information, speeds, volumes, etc.), it may not be practical to implement at this time; however, a framework could be established so that MAG can begin to acquire this data for future implementation efforts.

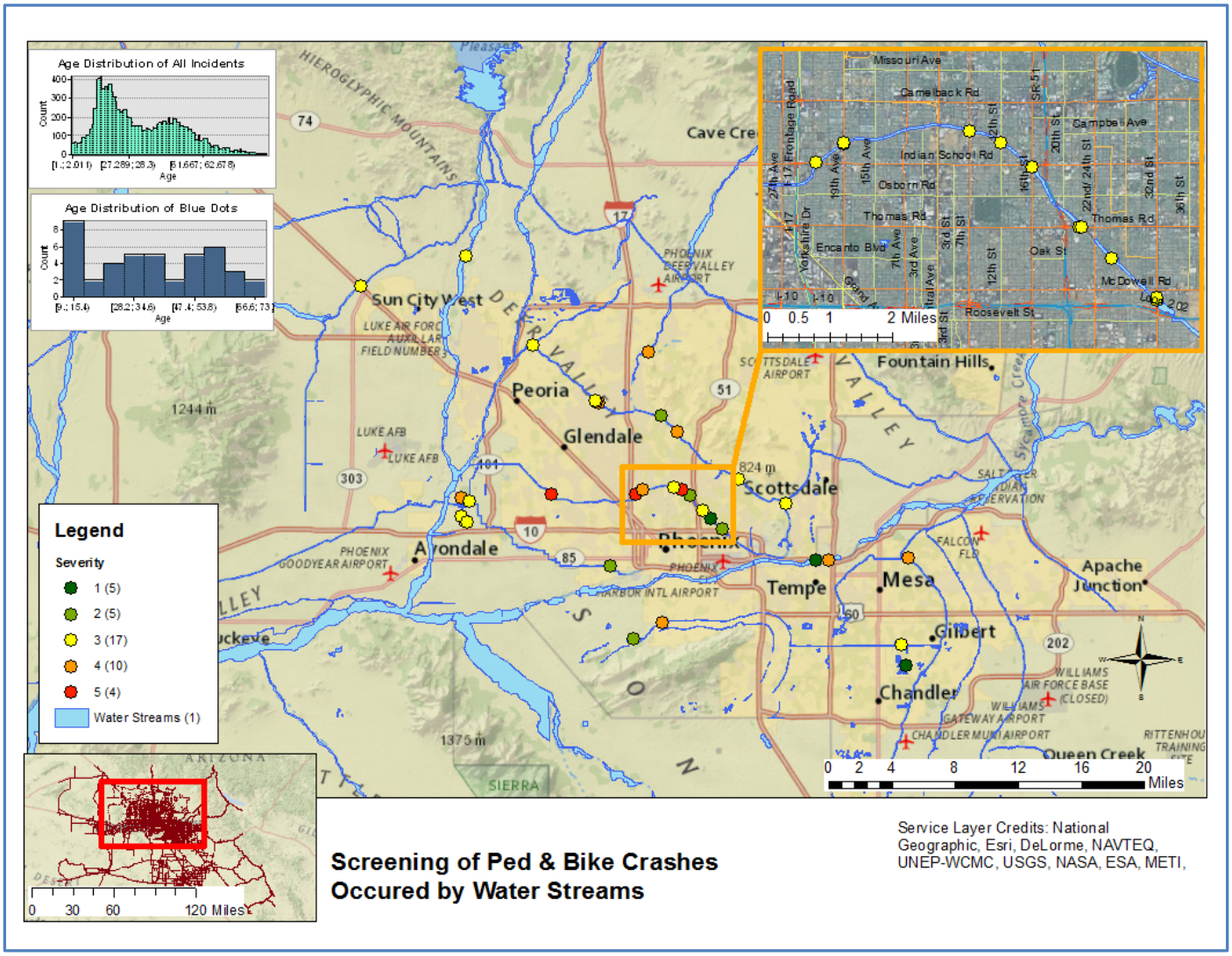

Figure 9. Pedestrian and Bicycle Crashes Contrasted to Waterways

4.7 Appendix I

Acronyms and Definitions

A	Incapacitating Injury (Serious Injury) Crash
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ALISS	Arizona DOT Accident Location Identification Surveillance System
CF	Crash Frequency
CMF	Crash Modification Factor
CV	Coefficient of Variation
CS	Crash Severity
CT	Crash Type
CR	Crash Rate
DOT	Department of Transportation
EB	Empirical Bayes
EMS	Emergency Medical Services
FARS	(USDOT) Fatal Analysis Reporting System
FHWA	Federal Highway Administration
GIS	Geographic Information Systems
HPMS	(FHWA) Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
HSM	(AASHTO) Highway Safety Manual
ISS	Intersection Safety Score
K	Fatal Crash
KABCO	Crash severity scale where “K” represents fatal crash, “A” represents serious injury crash, “B” & “C” represent descending levels of crash severity, and “O” represents property damage only
MAG	Maricopa Association of Governments
MAP-21	Moving Ahead for Progress in the 21st Century
MEV	Million Entering Vehicles (Intersection Crash Rate)
MPO	Metropolitan Planning Organization. MPOs are designated by the governor to coordinate transportation planning in an urbanized area of the state. MAG is an MPO
MVMT	Million Vehicle Miles Traveled (Roadway Segment Crash Rate)
NCHRP	National Cooperative Highway Research Program
NSM-I	(MAG) Network Screening Methodology for Intersections
NSM-S	(MAG) Proposed Network Screening for Segments
PAR	Police Accident Report
PDO	Property Damage Only
Ped ISI	Pedestrian Intersection Safety Indices
SHSP	(ADOT) Strategic Highway Safety Plan
SPF	Safety Performance Function
SSS	Segment Safety Score
STSP	(MAG) Strategic Transportation Safety Plan
VMT	Vehicle miles traveled

MAG Strategic Transportation Safety Plan (STSP)
Task 5 Working Group
List of Recommended Practices

Practice	Notes:	Implementation Timeframe	Funding Source	Lead Agency
1. Prepare best practices guide specific to the MAG Region for high risk intersections and high exposure bike/ped crossing nodes employing safety countermeasures: i) Consistent traffic signal operations for pedestrians and bicyclists ii) Installation of enhanced crossings (lighting, widened crosswalks for pedestrians and bicyclists, bulb outs, ladder style crosswalk markings.)	None	0-5 years	MAG Planning Funds	MAG
2. Develop on-going training and public information bicycle and pedestrian safety campaigns. (Note: the campaign would focus on multiple audiences, e.g., elementary schools, MVD, AAA, Bicyclists, Drivers, Police, Engineers, Planners, Teachers, Health Care Industry)	GOHS funding could be utilized for this.	0-5 years	GOHS	GOHS
3. Encourage submittal of TIP projects that include safety elements, for improving safer access for all modes, by including safety as an explicit project evaluation criteria for all TIP projects.	**This could be easily done by MAG with support of committees that evaluate projects that are incorporated into the TIP. MAG staff, with oversight by the Safety Committee, will develop the Safety Evaluation Criteria including guidelines for scoring projects. The actual safety scoring could be done by individual modal committees as part of their normal TIP project review process.**	**1 year**	**N/A**	**MAG**
4. Prepare best practices guide for Road Diet and Complete Streets projects that incorporates safety countermeasures in project development.	The intent would be to outline what kind of corridors would be good canditates for these practices with consideration of connecting or abutting conditions as well as how complete streets policies are implemented/enforced, and incorporating known safety countermeasures. The resulting best practices could be incorporated in #3.	0-5 years	MAG Planning Funds	MAG
5. Develop short-range action program oriented to 1) high transit activity stops and 2) new routes that would enhance transit stop safety with focus on amenities, safe access and connections. (Note: The intent of this program would be to employ the checklist from the MAG Designing Accessible Communities and tie to Valley Metro Service Standards.)	The intent of this would be to employ the checklist from the MAG Designing Accessible Communities and tie to the Valley Metro Service Standards. This would be heavily reliant on the support of RPTA as the administrators of the Public Transportation Funds (PTF) and agreement with local agencies and towns who own the facilities.	0-5 years	PTF Local	RPTA Local Agencies

MAG Strategic Transportation Safety Plan (STSP)
Task 5 Working Group
List of Recommended Practices

Practice	Notes:	Implementation Timeframe	Funding Source	Lead Agency
6. Develop Bicyclist Safety Assessment (BSA) program that focuses on bicyclist safety countermeasures at high risk intersections. (Examples: leading bicycle phase to coincide with leading pedestrian phase; countdown signals; continuous bike lanes through intersection, bicycle detectors/sensors.)	Could be incorporated into existing MAG RSA program and possibly be expanded for high exposure intersections as the bicycle counts and RSA programs increase the amount of data available.	1 year	MAG Planning Funds	MAG
7. Develop update of regional bus stop design and location guidelines to promote a greater emphasis on safety and consistent practices by local jursidictions in cooperation with bus operators.	This in part is already being done by Valley Metro and greater emphasis on safety for bicyclists and pedestrians can be added to this effort.	0-5 years	PTF	RPTA Local Agencies
8. Prepare technical resource that summarizes and documents regional and national research on effectiveness of safety countermeasures.	This is already being done at the national level but could be done through a MAG project at a regional level as more safety countermeasures are implemented. As of now, we could only document the systemic countermeasures that have been installed through the HSIP. A more comprehensive program would need to be defined to align determination of safety countermesure effectiveness with what is being implemented regionally and national standards.	5-10 years	MAG Planning Funds	MAG