SR 87/SR 260/SR 377 CORRIDOR PROFILE STUDY

JUNCTION SR 202L TO JUNCTION I-40

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DRAFT WORKING PAPER 4: PERFORMANCE-BASED NEEDS ASSESSMENT

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PREPARED FOR:

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APPENDICES

Appendix A: Methodologies for Determining Performance Area Needs (Steps 1-3)

LIST OF ABBREVIATIONS

ABBREVIATION	NAME
ADOT	Arizona Department of Transportation
AZTDM	Arizona Travel Demand Model
BQAZ	Building a Quality Arizona
CAG	Central Arizona Governments
CPS	Corridor Profile Study
DMS	Dynamic Message Sign
FY	Fiscal Year
HCRS	Highway Condition Reporting System
HPMS	Highway Performance Monitoring System
HSM	Highway Safety Manual
LOS	Level of Service
MAG	Maricopa Association of Governments
MP	Milepost
MPD	Multimodal Planning Division
I	Interstate
LRTP	Long-Range Transportation Plan
NACOG	Northern Arizona Council of Governments
POE	Port of Entry
PSR	Pavement Serviceability Rating
PTI	Planning Time Index
P2P Link	Planning to Programming Linkages
SR	State Route
SRPMIC	Salt River Pima Maricopa Indian Community
TTI	Travel Time Index
TPTI	Truck Planning Time Index
TTTI	Truck Travel Time Index
V/C	Volume-to-Capacity

1.0 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of State Route 87 (SR 87)/State Route 260 (SR 260)/State Route 377 (SR 377) between State Route 202L (Loop 202) and Interstate 40 (I-40). This study will look at key performance measures relative to the SR 87/SR 260/SR 377 corridor, and the results of this performance evaluation will be used to identify potential strategic improvements.

The intent of the corridor profile program, and of the Planning to Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network. ADOT is conducting eleven corridor profile studies. The eleven corridors are being evaluated within three separate groupings.

The first three studies (Round 1) began in spring 2014, and encompass:

- I-17: SR 101L to I-40
- I-19: Mexico International Border to I-10
- I-40: California State Line to I-17

The second round (Round 2) of studies, initiated in spring 2015, includes:

- I-8: California State Line to I-10
- I-40: I-17 to the New Mexico State Line
- SR 95: I-8 to I-40

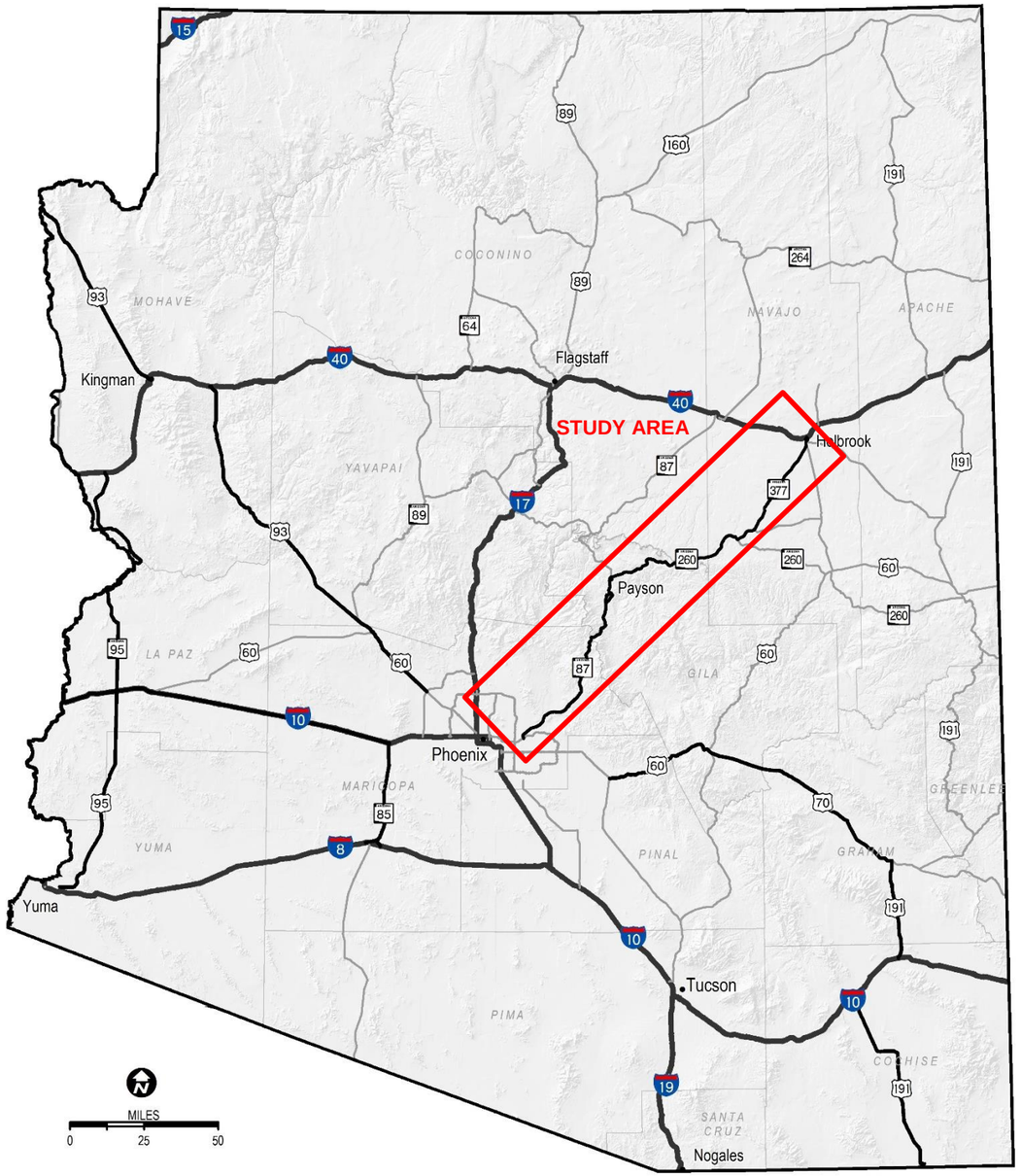
The third round (Round 3) of studies, initiated in fall 2015, includes:

- I-10: California State Line to SR 85 and SR 85: I-10 to I-8
- I-10: SR 202L to the New Mexico State Line
- SR 87/SR 260/SR 377: SR 202L to I-40
- US 60/US 70: SR 79 to US 191 and US 191: US 70 to SR 80
- US 93/US 60: Nevada State Line to SR 303L

The studies under this program will assess the overall health, or performance, of the state's strategic highways. The Corridor Profile Studies will identify candidate projects for consideration in the Multimodal Planning Division's (MPD) Planning to Programming (P2P) project prioritization process, providing information to guide corridor-specific project selection and programming decisions.

SR 87/SR 260/SR 377, Loop 202 to I-40, depicted in **Figure 1**, is one of the strategic statewide corridors identified and is the subject of this Round 3 Corridor Profile Study.

Figure 1: Study Area



1.1 Corridor Study Purpose

The purpose of the SR 87/SR 260/SR 377 Corridor Profile Study is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process established by the previous Round 1 corridor profile studies to:

- Inventory past improvement recommendations.
- Define corridor goals and objectives.
- Assess existing performance based on quantifiable performance measures.
- Propose various solutions to improve corridor performance.
- Identify specific projects that can provide quantifiable benefits relative to the performance measures.
- Prioritize projects for future implementation.

1.2 Corridor Study Goals and Objectives

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The SR 87/SR 260/SR 377 Corridor Profile Study will define solutions and improvements for the corridor that can be evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.
The following goals have been identified as the desired outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals.
- Develop solutions that address identified corridor needs based on measured performance.
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure.

1.3 Working Paper 4 Overview

The purpose of Working Paper 4 is to document the performance-based needs for the SR 87/SR 260/SR 377 corridor within the study limits. Corridor needs are defined through a review of the difference in baseline corridor performance (Task 2) and the performance objectives (Task 3) for each of the five performance areas used to characterize the health of the SR 87/SR 260/SR 377 corridor: pavement, bridge, mobility, safety, and freight. The product of Working Paper 4 is actionable performance needs that can be addressed through strategic investments in corridor preservation, modernization, and expansion.

1.4 Corridor Overview

The SR 87/SR 260/SR 377 corridor between Loop 202 and I-40 provides movement for freight, tourism, and recreation needs within Arizona. It provides a key link between the Phoenix metropolitan area and the northeast region of the state and serves intrastate, interstate and international commerce. The corridor connects Mesa, Fountain Hills, Payson, Heber-Overgaard, and Holbrook as well as the Salt River Pima Maricopa Indian Community (SRPMIC), Fort McDowell-Yavapai, and Tonto Apache tribes. This corridor also serves a number of recreational areas and National Forests. The SR 87/SR 260/SR 377 corridor includes portions of SR 87, SR 260, SR 277, SR 377, SR 77, and I-40 Business Route (40B).

1.5 Study Location and Corridor Segments

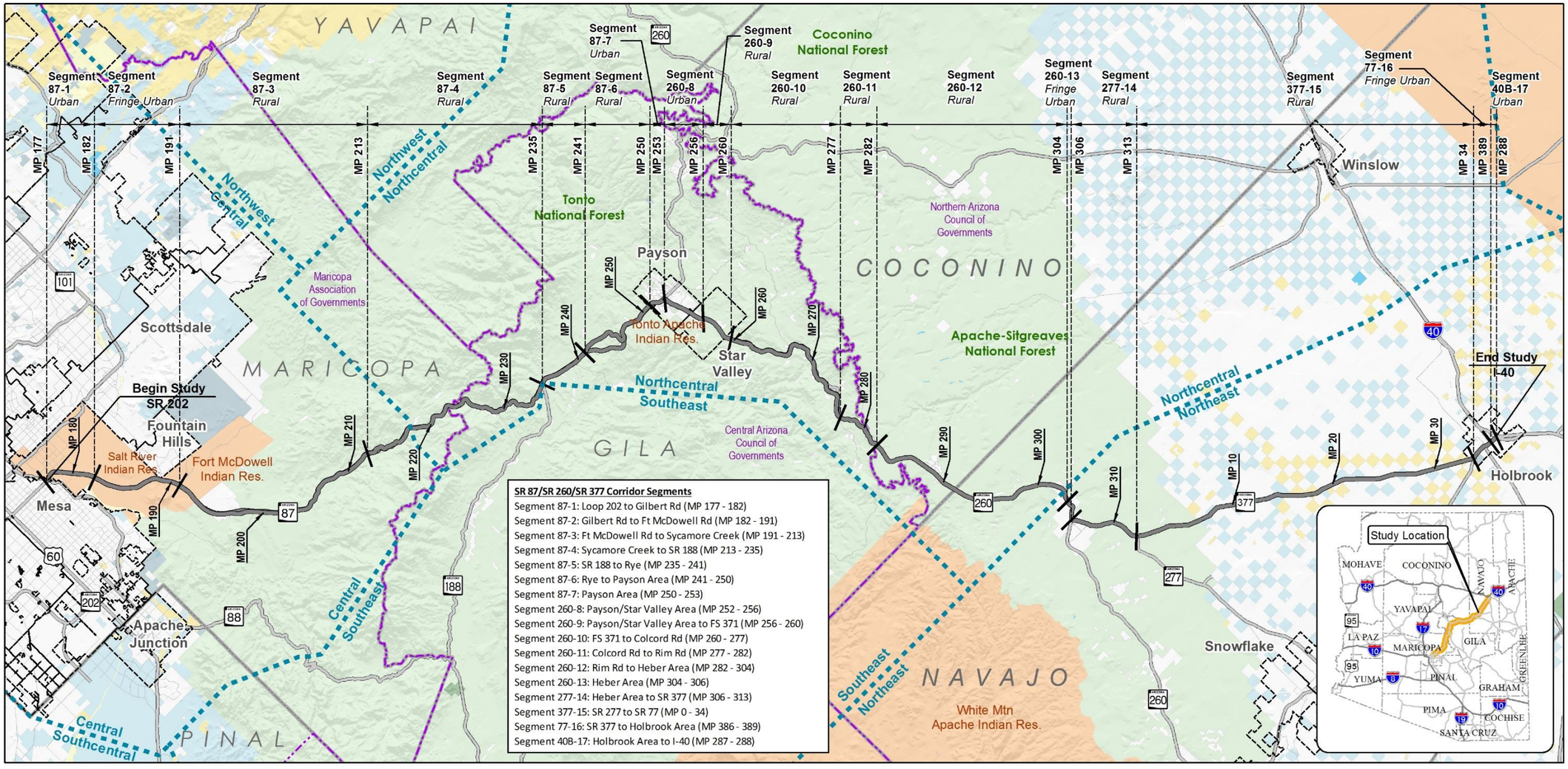
The SR 87/SR 260/SR 377 corridor between Loop 202 and I-40 is approximately 175 miles in length. The SR 87/SR 260/SR 377 corridor is located in three ADOT Districts (Central, Northcentral, and Northeast); three planning areas (Maricopa Association of Governments [MAG], Central Arizona Governments [CAG], and Northern Arizona Council of Governments [NACOG]); and four counties (Maricopa, Gila, Coconino, and Navajo).

The SR 87/SR 260/SR 377 study corridor has been divided into 17 segments to allow for an appropriate level of detailed needs analysis, performance evaluation, and comparison between different segments of the corridor. These corridor segments are described in **Table 1** and shown in **Figure 2**.

Table 1: SR 87/SR 260/SR 377 Corridor Segmentation

Segment	Route	Begin	End	Approximate Begin Milepost	Approximate End Milepost	Approximate Length (miles)	Typical Through Lanes (NB/EB, SB/WB)	2014 Average Annual Daily Traffic Volume (vpd)	Character Description
87-1	SR 87	Loop 202	Gilbert Rd	177	182	5	2,2	15,000 – 16,000	This segment has interrupted flow, numerous access points, consistent traffic volumes, a five-lane undivided or four-lane divided section, and is located in the Phoenix metropolitan urban area.
87-2	SR 87	Gilbert Rd	Fort McDowell Rd	182	191	9	2,2	15,000 – 16,000	This segment has interrupted flow characteristics, access points, consistent traffic volumes, a four-lane divided section, and is located in the fringes of the Phoenix metropolitan urban area.
87-3	SR 87	Fort McDowell Rd	Sycamore Creek	191	213	22	2,2	9,000 – 10,000	This rural four-lane divided segment with uninterrupted flow has consistent topography and traffic volumes.
87-4	SR 87	Sycamore Creek	SR 188	213	235	22	2,2	10,000 – 11,000	This rural four-lane divided segment with uninterrupted flow has steep terrain and a curvy alignment.
87-5	SR 87	SR 188	Rye	235	241	6	2,2	11,000 – 12,000	This rural four-lane divided segment with uninterrupted flow has flatter terrain than surrounding segments.
87-6	SR 87	Rye	Green Valley Pkwy/BIA 101	241	250	9	2,2	11,000 – 12,000	This rural segment with uninterrupted flow is a climbing four-lane divided section.
87-7	SR 87	Green Valley Pkwy/BIA 101	SR 260	250	253	3	2,2	19,000 – 20,000	This segment has interrupted flow, numerous access points, is comprised of a five-lane undivided section and is located in the Payson urban area.
260-8	SR 260	SR 87	Mayfield Canyon Rd	252	256	4	2,2	14,000 – 15,000	This segment is comprised of a five-lane undivided section. It is located in the Payson/Star Valley urban area.
260-9	SR 260	Mayfield Canyon Rd	FS 371	256	260	4	1,1	13,000 – 14,000	This rural segment with uninterrupted flow is comprised of a two-lane undivided section.
260-10	SR 260	FS 371	Colcord Rd	260	277	17	2,2	6,000 – 7,000	This rural segment with uninterrupted flow is comprised of a four-lane divided section. It is a climbing section.
260-11	SR 260	Colcord Rd	Rim Rd	277	282	5	2,2	6,000 – 7,000	This rural segment with uninterrupted flow is comprised of a four-lane undivided section. It includes a climbing section to the top of Mogollon Rim.
260-12	SR 260	Rim Rd	Black Canyon Ln	282	304	22	1,1	5,000 – 6,000	This rural segment with uninterrupted flow is comprised of a two-lane undivided section.
260-13	SR 260	Black Canyon Ln	SR 277	304	306	2	2,2	7,000 – 8,000	This segment with uninterrupted flow is comprised of a five-lane undivided section. It is located in the fringes of the Heber-Overgaard urban area.
277-14	SR 277	SR 260	SR 377	306	313	7	1,1	1,000 – 2,000	This rural segment with uninterrupted flow is a two-lane undivided section.
377-15	SR 377	SR 277	SR 77	0	34	34	1,1	2,000 – 3,000	This rural segment with uninterrupted flow is a two-lane undivided section.
77-16	SR 77	SR 377	I-40 Business	386	389	3	1,1	7,000 – 8,000	This segment has interrupted flow, numerous access points, a two-lane or four-lane undivided section, and is located in the fringes of the Holbrook urban area.
40B-17	40B	SR 77	I-40/Navajo Blvd TI	287	288	1	2,2	10,000 – 11,000	This segment has interrupted flow, numerous access points, a four-lane or five-lane undivided section, and is located in the Holbrook urban area.

Figure 2: Segmentation Map



SR 87/SR 260/SR 377 Corridor Profile Study: Loop 202 to I-40
Project Vicinity and Segmentation

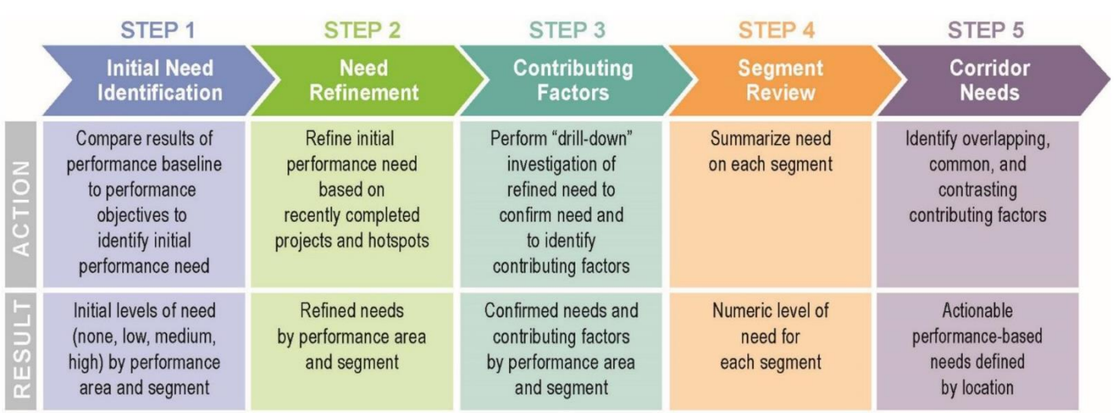
2.0 NEEDS ASSESSMENT PROCESS

A collaborative process involving ADOT MPD staff and the corridor profile study teams was used to develop a framework for the performance-based needs assessment process. The following guiding principles were developed as an initial step in process development:

- Corridor needs are defined as the difference between corridor performance and the performance objectives.
- The needs assessment process should be systematic, progressive, and repeatable, but also include engineering judgment.
- The process should consider all primary and secondary performance measures developed for the study.
- The process should develop multiple need levels including programmatic needs for the entire length of the corridor, performance area-specific needs, segment-specific needs, and location-specific needs (defined by milepost limits).
- The process should produce actionable needs that can be addressed through strategic investments in corridor preservation, modernization, and expansion.

The performance-based needs assessment process is illustrated in **Figure 3** and described in the following sections of the working paper.

Figure 3: Needs Assessment Process



2.1 Step 1: Initial Need Identification

The first step in the needs assessment process links baseline (existing) corridor performance documented in Working Paper 2 with performance objectives documented in Working Paper 3. In this step, the baseline corridor performance is compared to the performance objectives to provide a starting point for the identification of initial performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process for the bridge performance measure is shown in **Figure 4**.

Figure 4: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
6.5	Good	None	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
	Fair		
	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
5.0	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

Initial levels of needs for each performance measure are combined to produce a weighted initial need rating for each segment. Values of 0, 1, 2, and 3 are assigned to the initial need levels of None, Low, Medium, and High, respectively. A weight of 1.0 is applied to the Performance Index need and equal weights of 0.20 are applied to each need for each secondary performance measure. For directional secondary performance measures, each direction of travel receives a weight of 0.10. The secondary performance measure needs are added to the need from the Primary Index to create a cumulative measure of need. The resulting weighted initial level of need is assigned a level of None, Low, Medium, or High. With this approach, the resulting segment level of need is always equal to or higher than the Primary Index need.

2.2 Step 2: Need Refinement

In Step 2, the initial level of need for each segment is refined using the following information and engineering judgment.

- If an initial need is not identified, the existence of hot spots in the segment is justification for increasing the level of need from None to Low
- Recently completed projects or projects under construction may be justification for lowering or eliminating a need
- Programmed projects should not be used to lower the initial need because the project may not be implemented as planned. In addition, further investigations may suggest that changes in the scope of a programmed project may be warranted

The resulting final need (potential increase, decrease, or no change from initial need) is carried forward for further evaluation in Step 3.

2.3 Step 3: Contributing Factors

In Step 3, a more detailed review of the condition and performance data available from ADOT is conducted to identify contributing factors to the need. Typically, the same databases that are used to develop the baseline performance serve as the principal sources for the more detailed analysis. The databases used for diagnostic analysis are listed below.

Pavement Performance Area

- Pavement Rating Database

Bridge Performance Area

- Bridge Information and Storage System

Mobility Performance Area

- Highway Performance Monitoring System (HPMS) Database
- Arizona Travel Demand Model (AZTDM)
- HERE Travel Time Database
- Highway Condition Reporting System (HCRS) Closure Database

Safety Performance Area

- Crash Database

Freight Performance Area

- HERE Database
- HCRS Database

In addition, other sources are considered to help identify the contributing factors, such as:

- Maintenance history (from ADOT PeCos for pavement), the level of past investments, or trends in historical data are used to help provide context for pavement and bridge history.
- Field observations from ADOT district personnel could be used to provide additional information regarding a need that has been identified
- Previous studies could be used to provide additional information regarding contributing factors to a need that has been identified

Step 3 results in the identification of contributing factors to needs by segment (and milepost locations, if appropriate) that can be addressed through investments in preservation, modernization, and expansion projects to improve corridor performance.

2.4 Step 4: Segment Review

In this step, the needs from Step 2 are quantified for each segment to numerically estimate the level of need for each segment. Values of 0, 1, 2, and 3 are assigned to the final need levels (from Step 2) of None, Low, Medium, and High, respectively. A weight factor of 1.5 is applied to the performance areas that are identified as Emphasis Areas in Working Paper 3 and a weighted average need is calculated for each segment. The resulting average need value can be used to compare needs across corridors and to determine the location of the highest needs.

2.5 Step 5: Corridor Needs

In this step, the needs and contributing factors for each performance area are reviewed on a segment-by-segment basis to identify actionable needs and to facilitate the formation of solutions that address multiple performance areas and contributing factors. The intent of this process is to identify overlapping, common, and contrasting needs to help develop strategic solutions. This step results in the identification of corridor needs by specific location.

3.0 PAVEMENT PERFORMANCE AREA NEEDS (STEPS 1-3)

The following sections describe Steps 1 through 3 of the Needs Assessment process for the SR 87/SR 260/SR 377 corridor for the Pavement Performance Area. The methodology for performing Steps 1 through 3 is provided in **Appendix A**.

3.1 Step 1: Initial Pavement Needs

The baseline performance scores (from Working Paper 2) and performance objectives (from Working Paper 3) for the SR 87/SR 260/SR 377 corridor were used to determine the initial pavement needs, as described in Section 2.1. The pavement condition data used to calculate baseline performance was provided by ADOT for the timeframe of 2014 and 2015.

Step 1 uses the scores for the Pavement Index primary performance measure and two secondary performance measures to determine the initial level of need by segment for each performance measure individually as well as for all performance measures combined. The two secondary performance measures are Directional Pavement Serviceability Rating (PSR) and Percent Pavement Failure.

The performance scores, performance objectives, and initial levels of need for each pavement performance measure and for all pavement performance measures combined are shown in **Table 2**.

For the Pavement Index, one segment reports a high level of need and two segments report a low level of need. For the Directional PSR, two segments in both the northbound/eastbound and southbound/westbound directions report a medium level of need. For Percent Pavement Failure, three segments report a high level of need. For all pavement performance measures combined, one segment reports a high level of need and two segments report medium levels of need. There is one segment on the corridor where data was not available to be considered in the performance needs.

3.2 Step 2: Final Pavement Needs

Once the initial pavement needs by segment for the SR 87/SR 260/SR 377 corridor were established, they were then refined in Step 2 as described in Section 2.2 to more accurately reflect existing needs. An evaluation of pavement hot spots as well as relevant recently completed and under-construction projects was performed to determine if segment need levels required adjustment. The initial needs were then refined based on this assessment to determine the final need for each segment. Planned and programmed future projects and other issues identified in previous reports were noted for future reference in developing solutions that address identified needs. The Step 2 process is described in more detail below and summarized in **Table 3**.

Pavement Hot Spots

There are seven segments containing pavement failure hot spots. The locations of pavement hot sports are listed in **Table 3**. In three cases the hots spots were within segments that did not have a level of need, so adjustments were made to the need level of those segments to account for hot spots.

Recently Completed and Under-Construction Projects

ADOT provided information on potentially relevant recently completed and under-construction projects that were not previously reflected in the baseline performance data. This includes any projects completed or under construction after 2014 that have the potential to mitigate a pavement need on a corridor segment.

There is one segment, 260-12, containing an under-construction project which would supersede the pavement condition data, as shown in **Table 3**. The project, consisting of pavement preservation on SR 260 at MP 282-290, is within a segment with no level of need except for a hot spot at MP 288-289. The under-construction project is anticipated to address the hot spot at MP 288-289. The final pavement need for segment 260-12 has a level of None.

Planned or Programmed Projects

Information was noted in **Table 3** on pavement-related planned and programmed projects and other issues identified in previous reports in Working Paper 1. Planned and programmed projects and identified issues do not influence the level of need, but were documented for future reference in developing solutions that address identified needs.

Missing Pavement Data

No pavement rating data was provided by ADOT for segment 40B-17 so no performance rating or initial need rating was determined. With pavement rating data not available for segment 40B-17, a field review was conducted to provide an estimated level of need based on visual observation of pavement condition. Based on the field review findings, the final need level for segment 40B-17 was determined to be Low, as noted in **Table 3**.

3.3 Step 3: Pavement Contributing Factors

The final needs for the SR 87/SR 260/SR 377 corridor were further investigated as described in Section 2.3. ADOT provided pavement rehabilitation project data for the last 20 years which was used to estimate the level of historical investment in each segment and is summarized in **Figure 5**. Reference numbers and a legend for the figure are provided at the end of the figure.

In addition, PeCos data was collected for each segment to estimate the level of pavement maintenance activity. If the PeCos data showed a high level of maintenance investment, the overall historical investment was elevated by one need level (from “Medium” to “High”, for example). The resulting historical investment was increased one level for segments 2, 3, 4, and 17 based on the PeCos data. There is one segment with a high level of overall historical investment. Additional information regarding the determination of the level of historical investment is contained in **Appendix A**.

For the Pavement Performance Area, no additional data is readily available so the contributing factors simply identify the specific locations of needs, the level of historical investment, and any additional supporting information available from the ADOT Districts. A summary of this process is shown in **Table 4**.

Table 2: Initial Pavement Needs (Step 1)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Facility Type	Pavement Index			Directional PSR					% Pavement Failure			Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score		Performance Objective	Level of Need		Performance Score	Performance Objective	Level of Need	
							NB/EB	SB/WB		NB/EB	SB/WB				
87-1	5.28	177-182	Highway	4.19	Fair or Better	None	4.03	4.11	Fair or Better	None	None	10.00%	Fair or Better	None	None
87-2	8.73	182-191	Highway	4.25	Fair or Better	None	4.01	4.14	Fair or Better	None	None	0.00%	Fair or Better	None	None
87-3	21.61	191-213	Highway	3.80	Fair or Better	None	3.80	3.88	Fair or Better	None	None	11.36%	Fair or Better	Low	Low
87-4	22.02	213-235	Highway	4.05	Fair or Better	None	3.84	3.93	Fair or Better	None	None	0.00%	Fair or Better	None	None
87-5	5.24	235-241	Highway	4.55	Fair or Better	None	4.35	4.36	Fair or Better	None	None	0.00%	Fair or Better	None	None
87-6	9.6	241-250	Highway	4.15	Fair or Better	None	4.10	3.96	Fair or Better	None	None	0.00%	Fair or Better	None	None
87-7	1.64	250-253	Highway	3.54	Fair or Better	None	3.36	3.48	Fair or Better	None	None	0.00%	Fair or Better	None	None
260-8	4.28	252-256	Highway	4.31	Fair or Better	None	4.24	4.24	Fair or Better	None	None	0.00%	Fair or Better	None	None
260-9	3.48	256-260	Highway	4.27	Fair or Better	None	4.12	4.12	Fair or Better	None	None	0.00%	Fair or Better	None	None
260-10	16.53	260-277	Highway	4.03	Fair or Better	None	3.79	3.81	Fair or Better	None	None	0.00%	Fair or Better	None	None
260-11	4.89	277-282	Highway	4.13	Fair or Better	None	3.98	3.98	Fair or Better	None	None	0.00%	Fair or Better	None	None
260-12	21.74	282-304	Highway	3.78	Fair or Better	None	3.52	3.52	Fair or Better	None	None	4.55%	Fair or Better	None	None
260-13	2.05	304-306	Highway	3.11	Fair or Better	Low	2.87	2.87	Fair or Better	Medium	Medium	50.00%	Fair or Better	High	Medium
277-14	6.83	306-313	Highway	2.05	Fair or Better	High	3.03	3.03	Fair or Better	Medium	Medium	71.43%	Fair or Better	High	High
377-15	33.83	0-34	Highway	4.12	Fair or Better	None	4.03	4.03	Fair or Better	None	None	0.00%	Fair or Better	None	None
77-16	2.36	386-389	Highway	3.25	Fair or Better	Low	3.10	3.10	Fair or Better	Low	Low	40.00%	Fair or Better	High	Medium
40B-17	0.75	287-288	Highway	*No Data*	Fair or Better	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A	*No Data*	Fair or Better	N/A	N/A
Emphasis Area?	*No*	*Weighted Corridor Average*		*3.94*	*Fair or Better*	*None*									

Table 3: Final Pavement Needs (Step 2)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Initial Need	Need Adjustments		Final Need	Comments (may include programmed projects or issues from previous reports)
				Hot Spots	Previous Projects (which supersede condition data)		
87-1	5.28	177-182	None	1 mile: NB MP 177-178		Low	
87-2	8.73	182-191	None			None	
87-3	21.61	191-213	Low	5 miles: SB MP 195-199, SB MP 200-201		Low	
87-4	22.02	213-235	None	2 miles: MP 224-226		Low	MP 224-226 (missing data) known to have landslide issues and poor pavement;
87-5	5.24	235-241	None			None	MP 236 Jct. SR 188 Pavement preservation completed in 2013
87-6	9.6	241-250	None			None	
87-7	1.64	250-253	None			None	Fatigue cracking present, crack filled since 2014
260-8	4.28	252-256	None			None	
260-9	3.48	256-260	None			None	
260-10	16.53	260-277	None			None	
260-11	4.89	277-282	None			None	
260-12	21.74	282-304	None	1 mile: EB MP 288-289	Spot repair pavement preservation project for MP 282-291 is currently underway that will address the identified hot spot	None	May have underground spring drainage issues MP 282-290; no geotech study has been done.
260-13	2.05	304-306	Medium	1 mile: EB MP 304-305		Medium	
277-14	6.83	306-313	High	5 miles: NB MP 307-310, NB MP 311-313		High	
377-15	33.83	0-34	None			None	
77-16	2.36	386-389	Medium	1 mile: NB MP 388-389		Medium	
40B-17	0.75	287-288	N/A			Low	With pavement rating data not available, a field review was conducted to provide an estimated level of need based on visual observation of pavement condition

Figure 5: Pavement History

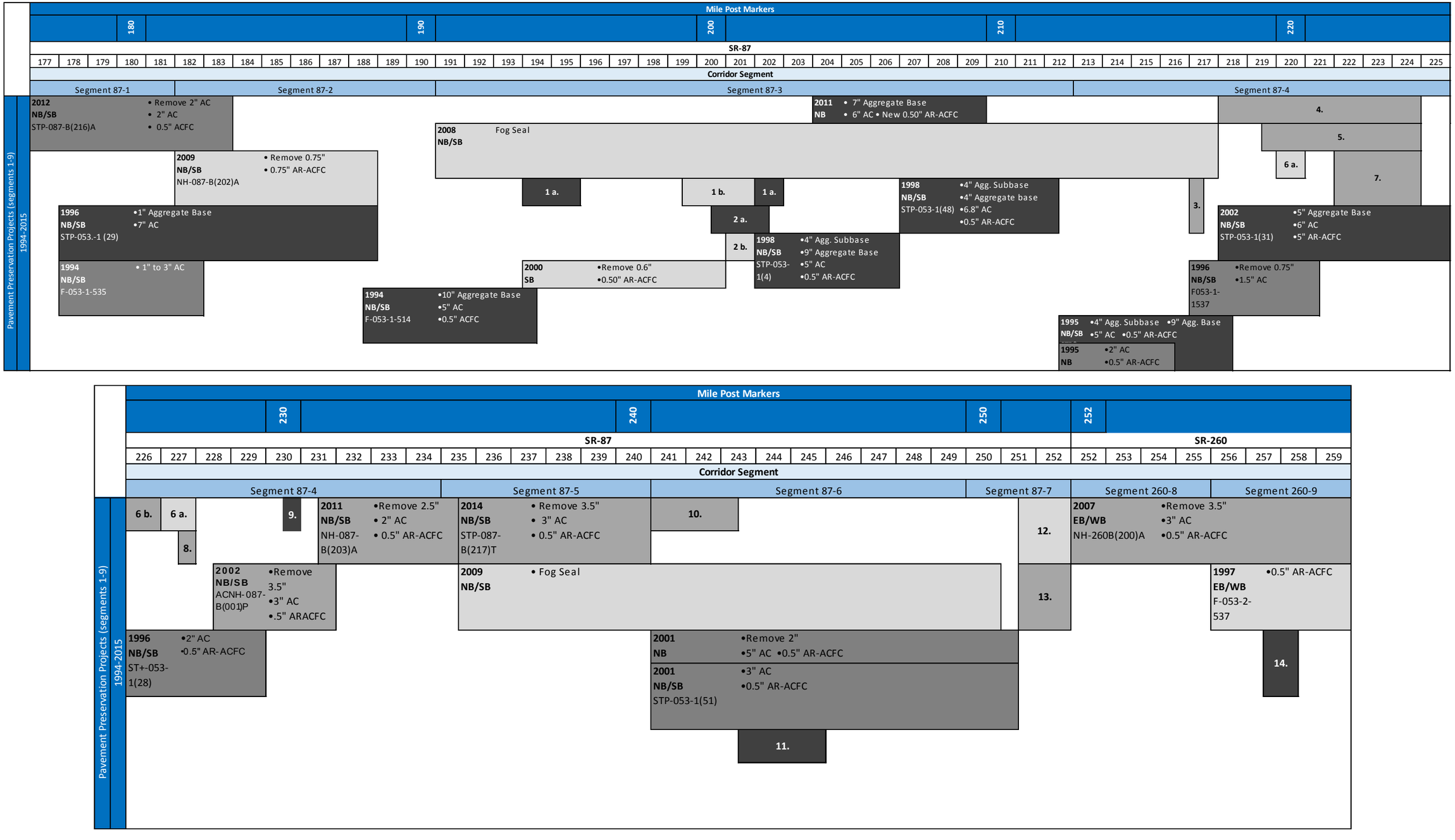
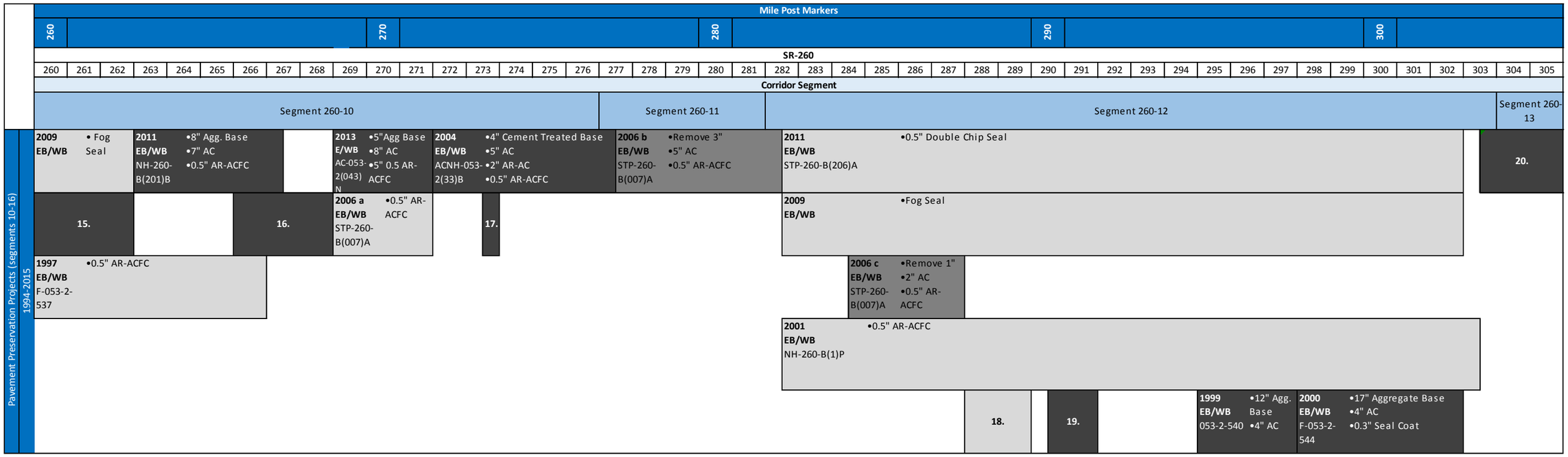


Figure 5: Pavement History, (continued)



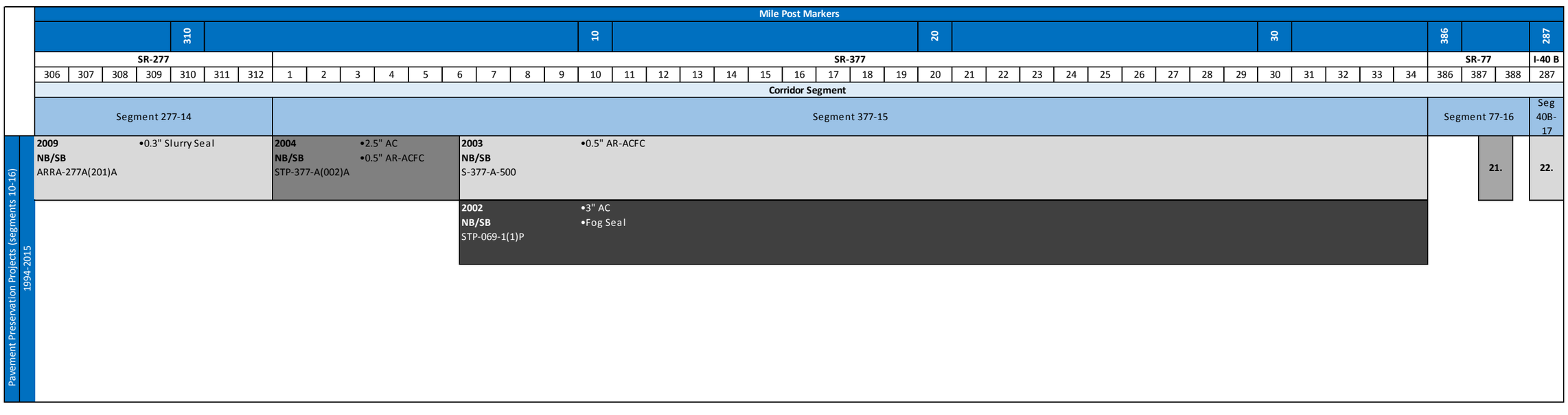


Figure 5: Pavement History, (continued)

Pavement Treatment Reference Numbers	
1 a. 2006 (NB): 8" Aggregate Base, 5" AC, 0.5" AR-ACFC	**11. 2001 (SB)**: 12" Aggregate Base, 3" AC
1 b. 2006 (NB): 2" AC, 0.5" AR-ACFC	**12. 2002 (NB/SB)**: 0.5" AR-ACFC
2 a. 2004 (SB): 4" Aggregate Subbase, 10" Aggregate Base, 6" AC, 0.5" AR-ACFC	**13. 2001 (SB)**: Remove 3.5", 3.5" AC, Fog Seal
2 b. 2004 (NB): Remove 0.5", 0.5" AR-ACFC	**14. 1995 (EB/WB)**: 6" Aggregate Base, 4" AC, 0.3" Seal Coat
3. 2004 (NB/SB): Remove 3.5", 3" AC, 0.5" ACFC	**15. 2004 (EB/WB)**: 6" Cement Treated Subgrade, 3" AC, 2" AR-AC, 0.5" AR-ACFC
4. 2012 (NB): Remove 3.5", 3" AC, 0.50" AR-ACFC	**16. 2006 (EB/WB)**: 6" Aggregate Base, 5" AC, 2" AR-AC, 0.5" AR-ACFC
5. 2012 (SB): Outside Lane: Remove 3.5", 3" AC, 0.50" AR-ACFC	**17. 1995 (EB/WB)**: 12" Aggregate Base, 5" AC, 0.3" Seal Coat
6 a. 2004 (NB): 1" Seal Coat, 0.5" ACFC	**18. 1994 (EB/WB)**: 0.5" Double Chip Seal
6 b. 2004 (NB): Remove 3.5", 3" AC, 1" Seal Coat, 0.5" ACFC	**19. 2000 (EB/WB)**: 12" Aggregate Base, 4" AC, 0.3" Seal Coat
7. 2006 (SB): Remove 3.5", 3" AC, 0.3" Bituminous Membrane, 0.5" ACFC	**20. 1996 (EB/WB)**: 12" Aggregate Base, 4" AC, 0.3" Seal Coat
8. 2003 (NB): Remove 4", 3.5" AC, 0.5" AR-ACFC	**21. 2008 (NB/SB)**: Remove 3", 3" AC, Fog Seal
9. 2010 (SB): 0.5" ACFC, 6.5" AC, 10" Aggregate Base	**22. 2009 (NB/SB)**: 0.5" AR-ACFC
10. 2009 (SB): Remove 5", 4.5" AC, 0.5" AR-ACFC	

Legend

- New Paving or Reconstruction
- Mill and Overlay (Adding Structural Thickness)
- Mill and Replace (No Change Structural Thickness)
- Fog Coat or Thin Overlay Treatments
- PCCP Pavement Border
- AC Pavement Border

Table 4: Pavement Needs Contributing Factors (Step 3)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Final Need	Bid History Investment	PeCos History Investment	Resulting Historical Investment	Contributing Factors and Comments
87-1	5.28	177-182	Low	Low	Medium	Low	Hot spot 1 mile NB MP 177-178
87-2	8.73	182-191	None	Low	High	Medium	
87-3	21.61	191-213	Low	Low	High	Medium	Hot spot 5 miles SB MP 195-199, SB MP 200-201
87-4	22.02	213-235	Low	Low	High	Medium	Hot spot 2 miles NB/SB MP 224-226
87-5	5.24	235-241	None	Low	Low	Low	
87-6	9.6	241-250	None	High	High	High	
87-7	1.64	250-253	None	Medium	Medium	Medium	
260-8	4.28	252-256	None	Low	Low	Low	
260-9	3.48	256-260	None	Medium	Low	Medium	
260-10	16.53	260-277	None	Low	Medium	Low	
260-11	4.89	277-282	None	Low	Low	Low	
260-12	21.74	282-304	None	Low	Medium	Low	Hot spot 1 mile EB, MP 288-289
260-13	2.05	304-306	Medium	Low	Low	Low	Hot spot 1 mile EB MP 304-305
277-14	6.83	306-313	High	Low	Low	Low	Hot spot 5 miles NB MP 307-310, NB MP 311-313
377-15	33.83	0-34	None	Low	Low	Low	
77-16	2.36	386-389	Medium	Low	Medium	Low	Hot spot 1 mile NB MP 388-389
40B-17	0.75	287-288	Low	Low	High	Medium	

4.0 BRIDGE PERFORMANCE AREA NEEDS (STEPS 1-3)

The following sections describe Steps 1 through 3 of the Needs Assessment process for the SR 87/SR 260/SR 377 corridor for the Bridge Performance Area. The methodology for performing Steps 1 through 3 is provided in **Appendix A**.

4.1 Step 1: Initial Bridge Needs

The baseline performance scores (from Working Paper 2) and performance objectives (from Working Paper 3) for the SR 87/SR 260/SR 377 corridor were used to determine the initial bridge needs, as described in Section 2.1. The bridge condition data used to calculate baseline performance was provided by ADOT for the timeframe from 2011 to 2014.

Step 1 uses the scores for the Bridge Index primary performance measure and three secondary performance measures to determine the initial level of need by segment for each performance measure individually as well as for all performance measures combines. The three secondary performance measures are Bridge Rating, Bridge Sufficiency, and Percent Functionally Obsolete Bridges).

The performance scores, performance objectives, and initial levels of need for each bridge performance measure and for all bridge performance measures combined are shown in **Table 5**.

For the Bridge Index and Bridge Rating, zero segments report any level of need. For the Bridge Sufficiency and Percent Functionally Obsolete Bridges, one segment reports a high or medium level of need. For all bridge performance measures combined, zero segments report a high or medium level of initial need. Seven segments along the corridor contain no bridges so performance scores could not be calculated and reported.

4.2 Step 2: Final Bridge Needs

Once the initial bridge needs by segment for the SR 87/SR 260/SR 377 corridor were established, they were then refined in Step 2 as described in Section 2.2 to more accurately reflect existing needs. An evaluation of bridge hot spots as well as relevant recently completed and under-construction projects was performed to determine if segment need levels required adjustment. The initial needs were then refined based on this assessment to determine the final need for each segment. Planned and programmed future projects and other issues identified in previous reports were noted for future reference in developing solutions that address identified needs. The Step 2 process is described in more detail below and summarized in **Table 6**.

Bridge Hot Spots

There are no bridge hot spots along the corridor, which are bridges with a single rating of 4 or less, or multiple ratings of 5 between the deck, superstructure, and substructure. As such, no adjustments were made to the need level of any segments to account for hot spots.

Recently Completed and Under-Construction Projects

ADOT provided information on potentially relevant recently completed and under-construction projects that were not previously reflected in the baseline performance data. This includes any projects completed or under construction after 2014 that have the potential to mitigate a bridge need on a corridor segment.

There are zero segments containing recently completed or under-construction projects which would supersede the bridge condition data, as shown in **Table 3**. As such, no adjustments were made to the need level of any segments to account for recently completed or under-construction projects.

Planned or Programmed Projects

Information was noted in **Table 6** on bridge-related planned and programmed projects and other issues identified in previous reports in Working Paper 1. Planned and programmed projects and identified issues do not influence the level of need, but were documented for future reference in developing solutions that address identified needs.

4.3 Step 3: Bridge Contributing Factors

The final needs for the SR 87/SR 260/SR 377 corridor were further investigated as described in Section 2.3. ADOT provided historical bridge rating data for the last 17 years which was used to investigate historical trends for each bridge and is summarized in **Figure 6**.

There are no segments containing bridges identified as having possible historical concerns. There is one segment containing a bridge identified as being functionally obsolete. The number of functionally obsolete bridges is also shown in **Table 6**. While historical concerns and functional obsolescence were not used to adjust the level of need, they were listed in **Table 6** as input to the identification of contributing factors.

The current bridge ratings were reviewed to determine which rating (or ratings) were less than 6 (deck, superstructure, substructure, or structural evaluation rating). **Table 7** provides a summary of this information, identifies the bridges with potential historical concerns, and provides any additional information related to the contributing factors.

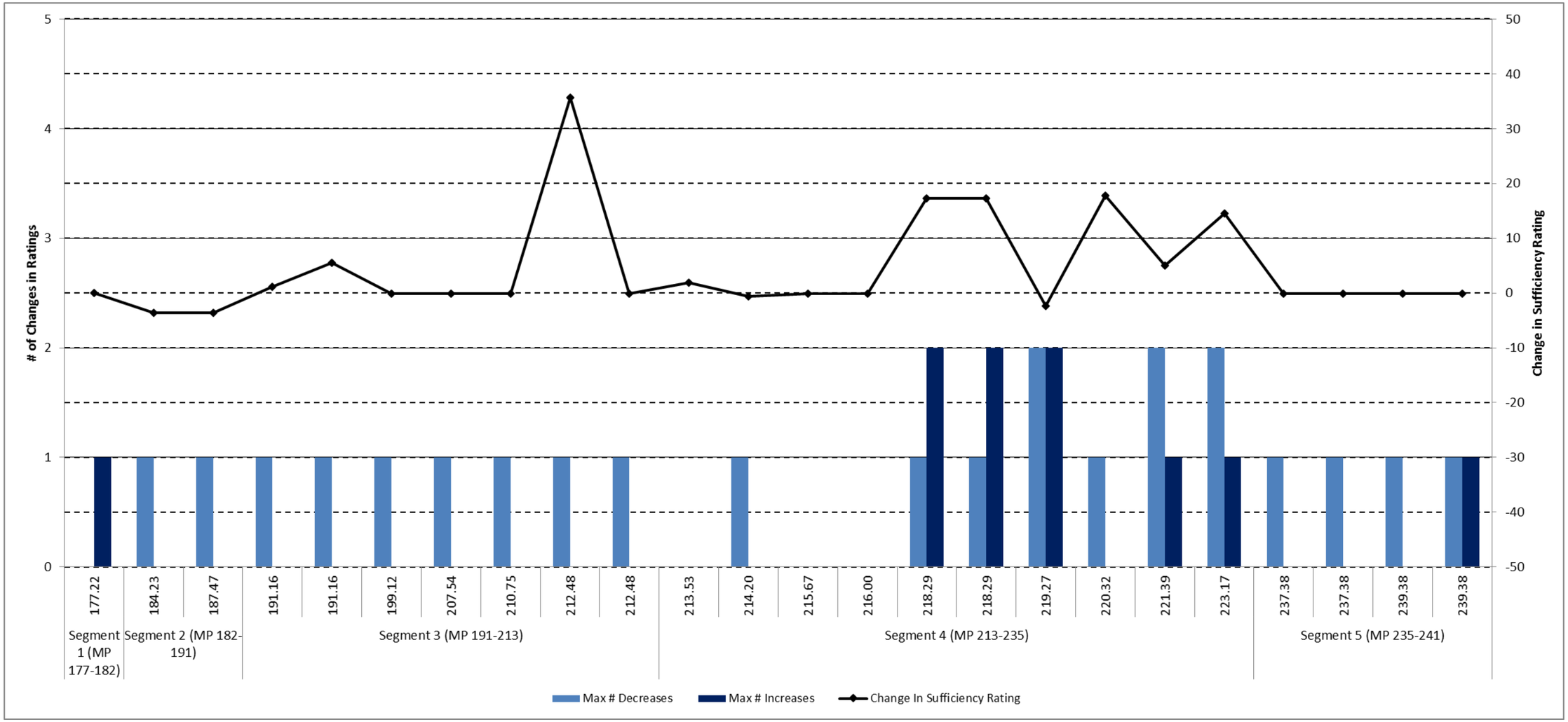
Table 5: Initial Bridge Needs (Step 1)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Number of Bridges in Segment	Bridge Index			Bridge Rating			Bridge Sufficiency			% Functionally Obsolete Bridges			Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	
87-1	5.28	177-182	1	7.00	Fair or Better	None	7	Fair or Better	None	85.00	Fair or Better	None	0.0%	Fair or Better	None	None
87-2	8.73	182-191	2	7.00	Fair or Better	None	7	Fair or Better	None	96.5	Fair or Better	None	0.0%	Fair or Better	None	None
87-3	21.61	191-213	7	6.95	Fair or Better	None	6	Fair or Better	None	96.2	Fair or Better	None	0.0%	Fair or Better	None	None
87-4	22.02	213-235	10	6.31	Fair or Better	None	6	Fair or Better	None	89.2	Fair or Better	None	0.0%	Fair or Better	None	None
87-5	5.24	235-241	4	6.31	Fair or Better	None	6	Fair or Better	None	99.6	Fair or Better	None	0.0%	Fair or Better	None	None
87-6	9.6	241-250	0	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	None
87-7	1.64	250-253	0	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	None
260-8	4.28	252-256	0	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	None
260-9	3.48	256-260	0	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	None
260-10	16.53	260-277	33	6.81	Fair or Better	None	6	Fair or Better	None	99.5	Fair or Better	None	0.0%	Fair or Better	None	None
260-11	4.89	277-282	3	6.73	Fair or Better	None	6	Fair or Better	None	79.1	Fair or Better	None	0.0%	Fair or Better	None	None
260-12	21.74	282-304	1	7.00	Fair or Better	None	7	Fair or Better	None	98.4	Fair or Better	None	0.0%	Fair or Better	None	None
260-13	2.05	304-306	1	6.00	Fair or Better	None	6	Fair or Better	None	93.7	Fair or Better	None	0.0%	Fair or Better	None	None
277-14	6.83	306-313	0	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	None
377-15	33.83	0-34	0	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	None
77-16	2.36	386-389	1	6.00	Fair or Better	None	6	Fair or Better	None	59.0	Fair or Better	Medium	100.0%	Fair or Better	High	Low
40B-17	0.75	287-288	0	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	No Bridges	Fair or Better	None	None
Emphasis Area?	*No*	*Weighted Corridor Average*		*6.74*	*Fair or Better*	*None*										

Table 6: Final Bridge Needs (Step 2)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Number of Bridges in Segment	Initial Need	Need Adjustments		Final Need	Historical Review	# Functionally Obsolete Bridges	Comments
					Hot Spots (Rating of 4 or multiple 5's)	Previous Projects (which supersede condition data)				
87-1	5.28	177-182	1	None	None		None			
87-2	8.73	182-191	2	None	None		None			
87-3	21.61	191-213	7	None	None		None			
87-4	22.02	213-235	10	None	None		None			
87-5	5.24	235-241	4	None	None		None			
87-6	9.6	241-250	0	None	None		None			No bridges in segment
87-7	1.64	250-253	0	None	None		None			No bridges in segment
260-8	4.28	252-256	0	None	None		None			No bridges in segment
260-9	3.48	256-260	0	None	None		None			No bridges in segment
260-10	16.53	260-277	33	None	None		None			MP 262.5, Approach slabs settling and makes for a 'ramp' - expected to be fixed in 2016 per District meeting
260-11	4.89	277-282	3	None	None		None			
260-12	21.74	282-304	1	None	None		None			
260-13	2.05	304-306	1	None	None		None			
277-14	6.83	306-313	0	None	None		None			No bridges in segment
377-15	33.83	0-34	0	None	None		None			No bridges in segment
77-16	2.36	386-389	1	Low	None		Low		1 (Little Colorado River Bridge #2030)	Only one bridge in the entire segment; this is why bridge sufficiency and bridge ratings are low for the entire segment
40B-17	0.75	287-288	0	None	None		None			No bridges in segment

Figure 6: Bridge History



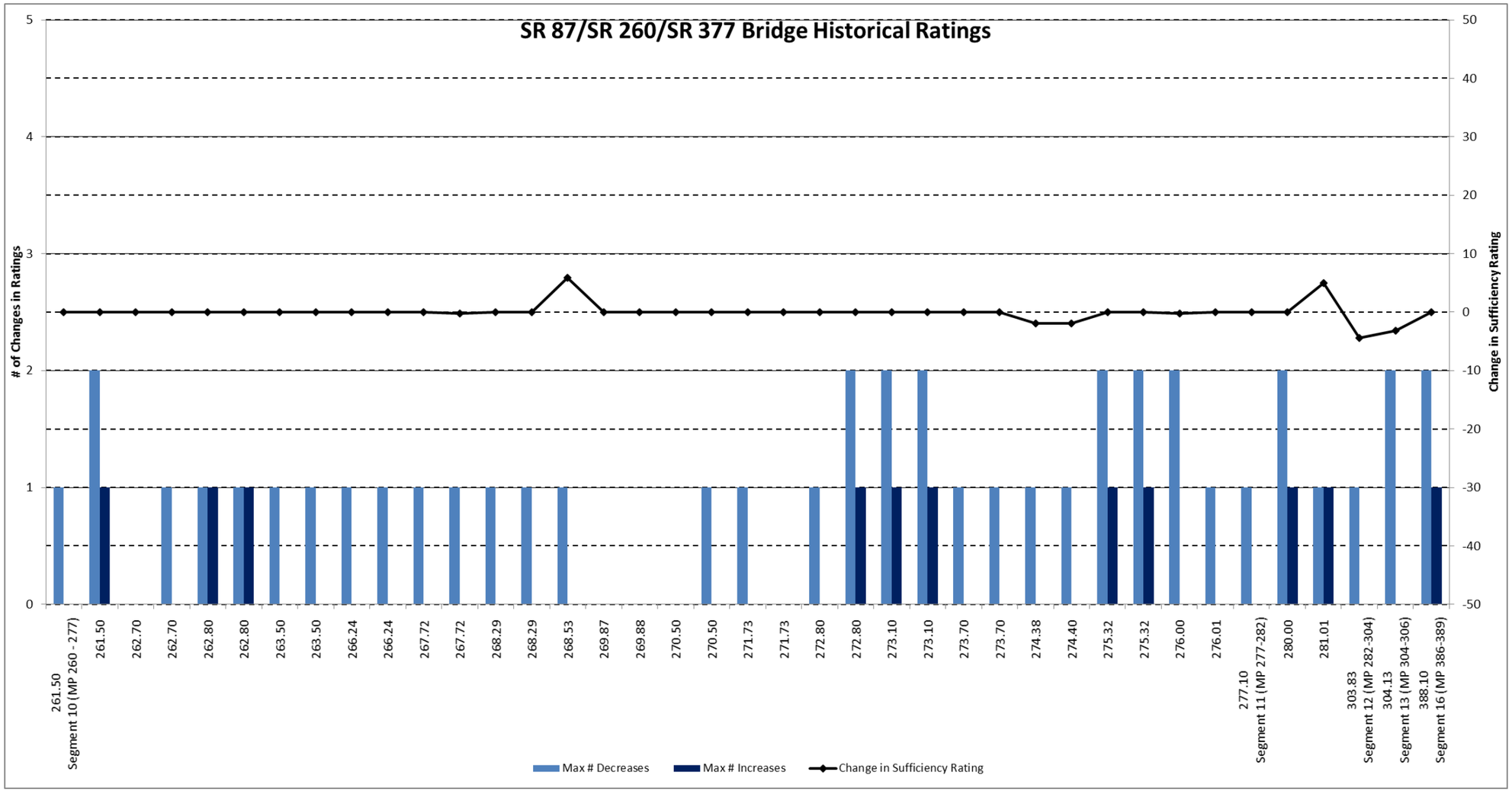
O identifies the bridge indicated is of concern from a historical ratings perspective

Maximum # Decreases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating decreased from 1997 to 2014. (Higher number could indicate a more dramatic decline in the performance of the bridge)

Maximum # Increases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating increased from 1997 to 2014. (Higher number could indicate a higher level of investment)

Change in Sufficiency Rating: Cumulative change in Sufficiency Rating from 1997 to 2014. (Bigger negative number could indicate a more dramatic decline in the performance of the bridge)

Figure 6: Bridge History, (continued)



O identifies the bridge indicated is of concern from a historical ratings perspective

Maximum # Decreases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating decreased from 1997 to 2014. (Higher number could indicate a more dramatic decline in the performance of the bridge)

Maximum # Increases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating increased from 1997 to 2014. (Higher number could indicate a higher level of investment)

Change in Sufficiency Rating: Cumulative change in Sufficiency Rating from 1997 to 2014. (Bigger negative number could indicate a more dramatic decline in the performance of the bridge)

Table 7: Bridge Needs Contributing Factors (Step 3)

Segment	Segment Length (Miles)	Segment Mileposts (MP)	Number of Bridges in Segment	# Functionally Obsolete Bridges	Final Need	Contributing Factors			Comments
						Bridge	Current Ratings	Historical Review	
87-1	5.28	177-182	1	0	None	No bridges with current ratings less than 6 and no historical issues			
87-2	8.73	182-191	2	0	None	No bridges with current ratings less than 6 and no historical issues			
87-3	21.61	191-213	7	0	None	No bridges with current ratings less than 6 and no historical issues			
87-4	22.02	213-235	10	0	None	No bridges with current ratings less than 6 and no historical issues			
87-5	5.24	235-241	4	0	None	No bridges with current ratings less than 6 and no historical issues			
87-6	9.6	241-250	0	0	None	No bridges with current ratings less than 6 and no historical issues			
87-7	1.64	250-253	0	0	None	No bridges with current ratings less than 6 and no historical issues			
260-8	4.28	252-256	0	0	None	No bridges with current ratings less than 6 and no historical issues			
260-9	3.48	256-260	0	0	None	No bridges with current ratings less than 6 and no historical issues			
260-10	16.53	260-277	33	0	None	No bridges with current ratings less than 6 and no historical issues			
260-11	4.89	277-282	3	0	None	No bridges with current ratings less than 6 and no historical issues			
260-12	21.74	282-304	1	0	None	No bridges with current ratings less than 6 and no historical issues			
260-13	2.05	304-306	1	0	None	No bridges with current ratings less than 6 and no historical issues			
277-14	6.83	306-313	0	0	None	No bridges with current ratings less than 6 and no historical issues			
377-15	33.83	0-34	0	0	None	No bridges with current ratings less than 6 and no historical issues			
77-16	2.36	386-389	1	1 (Little Colorado River Bridge #2030)	Low	No bridges with current ratings less than 6 and no historical issues			
40B-17	0.75	287-288	0	0	None	No bridges with current ratings less than 6 and no historical issues			

5.0 MOBILITY PERFORMANCE AREA NEEDS (STEPS 1-3)

The following sections describe Steps 1 through 3 of the Needs Assessment process for the SR 87/SR 260/SR 377 corridor for the Mobility Performance Area. The methodology for performing Steps 1 through 3 is provided in **Appendix A**.

5.1 Step 1: Initial Mobility Needs

The baseline performance scores (from Working Paper 2) and performance objectives (from Working Paper 3) for the SR 87/SR 260/SR 377 corridor were used to determine the initial mobility needs, as described in Section 2.1. The mobility condition data used to calculate baseline performance was provided by ADOT for 2014 for the existing traffic volumes and travel time data, 2014 for bicycle accommodation data, 2035 for future traffic volumes, and 2010-2014 for the closure data.

Step 1 uses the scores for the Mobility Index primary performance measure and six secondary performance measures to determine the level of need for each performance measure by segment. The six secondary performance measures are Future Daily Volume-to-Capacity (V/C), Existing Directional Peak Hour V/C, Directional Closure Extent, Directional Travel Time Index (TTI), Directional Planning Time Index (PTI), and Bicycle Accommodation.

The performance scores, performance objectives, and initial levels of need for each mobility performance measure and for all mobility performance measures combined are shown in **Table 8**.

For the Mobility Index, one segment reports a high level of need and one segment reports a medium level of need. For the Future Daily V/C, three segments report a high level of need and two segments report a medium level of need. For the Existing Directional Peak Hour V/C, one segment reports a high level of need in both the northbound/eastbound and southbound/westbound directions. For Directional Closure Extent, three segments report a medium or high level of need in both the northbound/eastbound and southbound/westbound directions. For Directional TTI, two segments report a medium level of need in the northbound/eastbound direction and one segment reports a medium level of need in the southbound/westbound direction. For Directional PTI, nine segments report a medium or high level of need in the northbound/eastbound direction and eight segments report a medium or high level of need in the southbound/westbound direction. For Bicycle Accommodation, 10 segments report a high level of need and one segment reports a medium level of need. For all mobility performance measures combined, two segments report a high level of initial need.

5.2 Step 2: Final Mobility Needs

Once the initial mobility needs by segment for the SR 87/SR 260/SR 377 corridor were established, they were then refined in Step 2 as described in Section 2.2 to more accurately reflect existing needs. An evaluation of relevant recently completed and under-construction projects was performed to determine if segment need levels required adjustment. The initial needs were then refined based on this assessment to determine the final need for each segment. Planned and programmed future projects were noted for future reference in developing solutions that address identified needs. The Step 2 process is described in more detail below and summarized in **Table 9**.

Recently Completed and Under-Construction Mobility Projects

ADOT provided information on potentially relevant recently completed and under-construction projects that were not previously reflected in the baseline performance data. This includes any projects completed or under construction after 2014 that have the potential to mitigate a mobility need on a corridor segment.

There are two segments containing a recently completed project which would supersede the mobility condition data, as shown in **Table 9**. This recently completed project does not fully address the identified mobility needs for the segments. As such, no adjustments were made to the need level of that segment to account for recently completed or under-construction projects.

Planned or Programmed Projects

Information was noted in **Table 9** on mobility-related planned and programmed projects and other issues identified in previous reports in Working Paper 1. Planned and programmed projects and identified issues do not influence the level of need, but were documented for future reference in developing solutions that address identified needs.

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Table 8: Initial Mobility Needs (Step 1)

Segment	Segment Mileposts	Segment Length (miles)	Environment Type	Facility Operation	Mobility Index			Future Daily V/C			Existing Peak Hour V/C					Closure Extent (occurrences/year/mile)				
											Performance Score			Level of Need		Performance Score			Level of Need	
					Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	NB/EB	SB/WB	Performance Objective	NB/EB	SB/WB	NB/EB	SB/WB	Performance Objective	NB/EB	SB/WB
87-1	177-182	5.28	Urban	Interrupted	0.65	Fair or Better	None	0.86	Fair or Better	Medium	0.34	0.34	Fair or Better	None	None	0.37	0.32	Fair or Better	Low	None
87-2	182-191	8.73	Urban	Interrupted	0.73	Fair or Better	None	1.01	Fair or Better	High	0.45	0.45	Fair or Better	None	None	0.46	0.04	Fair or Better	Low	None
87-3	191-213	21.61	Rural	Uninterrupted	0.21	Fair or Better	None	0.29	Fair or Better	None	0.14	0.13	Fair or Better	None	None	0.87	0.11	Fair or Better	High	None
87-4	213-235	22.02	Rural	Uninterrupted	0.23	Fair or Better	None	0.27	Fair or Better	None	0.20	0.21	Fair or Better	None	None	1.47	0.15	Fair or Better	High	None
87-5	235-241	5.24	Rural	Uninterrupted	0.15	Fair or Better	None	0.14	Fair or Better	None	0.15	0.15	Fair or Better	None	None	0.23	0.07	Fair or Better	None	None
87-6	241-250	9.6	Rural	Uninterrupted	0.21	Fair or Better	None	0.21	Fair or Better	None	0.19	0.19	Fair or Better	None	None	0.18	0.27	Fair or Better	None	None
87-7	250-253	1.64	Urban	Interrupted	0.75	Fair or Better	None	0.94	Fair or Better	Medium	0.57	0.50	Fair or Better	None	None	0.07	0.20	Fair or Better	None	None
260-8	252-256	4.28	Urban	Interrupted	0.54	Fair or Better	None	0.68	Fair or Better	None	0.47	0.51	Fair or Better	None	None	0.05	0.00	Fair or Better	None	None
260-9	256-260	3.48	Rural	Uninterrupted	0.94	Fair or Better	High	1.15	Fair or Better	High	1.29	1.33	Fair or Better	High	High	0.30	0.55	Fair or Better	None	Medium
260-10	260-277	16.53	Rural	Uninterrupted	0.08	Fair or Better	None	0.08	Fair or Better	None	0.13	0.11	Fair or Better	None	None	0.49	0.48	Fair or Better	Medium	Low
260-11	277-282	4.89	Rural	Uninterrupted	0.12	Fair or Better	None	0.14	Fair or Better	None	0.14	0.13	Fair or Better	None	None	0.40	0.88	Fair or Better	Low	High
260-12	282-304	21.74	Rural	Uninterrupted	0.36	Fair or Better	None	0.39	Fair or Better	None	0.34	0.34	Fair or Better	None	None	0.43	0.85	Fair or Better	Low	High
260-13	304-306	2.05	Urban	Uninterrupted	0.14	Fair or Better	None	0.15	Fair or Better	None	0.14	0.14	Fair or Better	None	None	0.00	0.40	Fair or Better	None	Low
277-14	306-313	6.83	Rural	Uninterrupted	0.09	Fair or Better	None	0.10	Fair or Better	None	0.07	0.06	Fair or Better	None	None	0.11	0.00	Fair or Better	None	None
377-15	0-34	33.83	Rural	Uninterrupted	0.09	Fair or Better	None	0.10	Fair or Better	None	0.13	0.13	Fair or Better	None	None	0.04	0.05	Fair or Better	None	None
77-16	386-389	2.36	Urban	Interrupted	0.85	Fair or Better	Medium	1.09	Fair or Better	High	0.60	0.65	Fair or Better	None	None	0.00	0.00	Fair or Better	None	None
40B-17	287-288	0.75	Urban	Interrupted	0.45	Fair or Better	None	0.57	Fair or Better	None	0.32	0.32	Fair or Better	None	None	*No Data*	*No Data*	Fair or Better	N/A	N/A
Emphasis Area?		*Yes*	*Weighted Corridor Average*		*0.26*	*Good*	*None*													

Table 8: Initial Mobility Needs (Step 1), (continued)

Segment	Segment Mileposts	Segment Length (miles)	Environment Type	Facility Operation	Directional TTI (all vehicles)					Directional PTI (all vehicles)					Bicycle Accommodation			Initial Need
					Performance Score		Performance Objective	Level of Need		Performance Score		Performance Objective	Level of Need		Performance Score	Performance Objective	Level of Need	
					NB/EB	SB/WB		NB/EB	SB/WB	NB/EB	SB/WB		NB/EB	SB/WB				
87-1	177-182	5.28	Urban	Interrupted	1.22	1.06	Fair or Better	None	None	4.01	3.03	Fair or Better	Low	None	45%	Fair or Better	High	Low
87-2	182-191	8.73	Urban	Interrupted	1.15	1.23	Fair or Better	None	None	2.36	3.86	Fair or Better	None	None	93%	Fair or Better	None	Low
87-3	191-213	21.61	Rural	Uninterrupted	1.05	1.04	Fair or Better	None	None	1.54	1.48	Fair or Better	Medium	Medium	99%	Fair or Better	None	Low
87-4	213-235	22.02	Rural	Uninterrupted	1.17	1.05	Fair or Better	None	None	2.05	1.47	Fair or Better	High	Medium	86%	Fair or Better	None	Low
87-5	235-241	5.24	Rural	Uninterrupted	1.01	1.08	Fair or Better	None	None	1.42	1.51	Fair or Better	Low	Medium	92%	Fair or Better	None	Low
87-6	241-250	9.6	Rural	Uninterrupted	1.31	1.15	Fair or Better	Medium	None	2.38	1.94	Fair or Better	High	High	79%	Fair or Better	Low	Low
87-7	250-253	1.64	Urban	Interrupted	1.18	1.86	Fair or Better	None	Medium	4.43	6.48	Fair or Better	Low	Medium	56%	Fair or Better	Medium	Low
260-8	252-256	4.28	Urban	Interrupted	1.46	1.10	Fair or Better	None	None	7.15	4.97	Fair or Better	High	Low	16%	Fair or Better	High	Low
260-9	256-260	3.48	Rural	Uninterrupted	1.12	1.00	Fair or Better	None	None	1.61	1.16	Fair or Better	High	None	2%	Fair or Better	High	High
260-10	260-277	16.53	Rural	Uninterrupted	1.13	1.06	Fair or Better	None	None	1.64	1.40	Fair or Better	High	Low	93%	Fair or Better	None	Low
260-11	277-282	4.89	Rural	Uninterrupted	1.23	1.00	Fair or Better	Low	None	2.16	1.14	Fair or Better	High	None	49%	Fair or Better	High	Low
260-12	282-304	21.74	Rural	Uninterrupted	1.00	1.05	Fair or Better	None	None	1.18	1.36	Fair or Better	None	None	2%	Fair or Better	High	Low
260-13	304-306	2.05	Urban	Uninterrupted	1.02	1.21	Fair or Better	None	None	1.63	2.98	Fair or Better	High	High	15%	Fair or Better	High	Low
277-14	306-313	6.83	Rural	Uninterrupted	*No Data*	*No Data*	Fair or Better	N/A	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A	0%	Fair or Better	High	Low
377-15	0-34	33.83	Rural	Uninterrupted	*No Data*	*No Data*	Fair or Better	N/A	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A	0%	Fair or Better	High	Low
77-16	386-389	2.36	Urban	Interrupted	1.08	1.49	Fair or Better	None	None	3.84	6.79	Fair or Better	None	Medium	1%	Fair or Better	High	High
40B-17	287-288	0.75	Urban	Interrupted	1.80	1.31	Fair or Better	Medium	None	12.93	10.56	Fair or Better	High	High	27%	Fair or Better	High	Low

Table 9: Final Mobility Needs (Step 2)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Need	Need Adjustments: Recent Projects Since 2013	Final Need	Planned and Programmed Future Projects
87-1	177-182	5.28	Low		Low	Planned: DMS, SR 87 SB, MP 180; Widen/upgrade to six lanes (Building a Quality Arizona (BQAZ), 2010)
87-2	182-191	8.73	Low		Low	Widen/upgrade to six lanes (BQAZ)
87-3	191-213	21.61	Low		Low	Widen/upgrade to six lanes (BQAZ)
87-4	213-235	22.02	Low		Low	Widen/upgrade to six lanes (BQAZ); Construct landslide mitigation measures (Project Assessment, 2012)
87-5	235-241	5.24	Low		Low	Widen/upgrade to six lanes (BQAZ)
87-6	241-250	9.6	Low		Low	Widen/upgrade to six lanes (BQAZ)
87-7	250-253	1.64	Low		Low	Widen/upgrade to six lanes (BQAZ); SR 87/Aero Drive intersection - conduct a traffic signal warrant study. Intersection needs to be reconstructed to fix sight distance issues if traffic signal not warranted (Payson Transportation Study, 2011); Construct an alternative route to SR 87/SR260 corridor in Payson (BQAZ and Payson Transportation Study); SR87, Main Street to SR 260 - incorporate recommendations from Road Safety Assessment (RSA) and Traffic Operational Analysis Study (TOAS) (Payson Transportation Study); SR 87/SR 260 intersection - incorporate recommendations from RSA and TOAS (Payson Transportation Study)
260-8	252-256	4.28	Low		Low	SR 260, SR 87 to Manzanita Drive - incorporate recommendations from RSA and TOAS (Payson Transportation Study); SR 260/Manzanita Drive intersection - incorporate recommendations from RSA and TOAS (Payson Transportation Study)
260-9	256-260	3.48	High		High	Programmed: SR 260, Lion Springs Section (MP 258-260) - reconstruct to 4-lane divided highway – FY 2021 for design with construction tentatively planned for FY 2024 in 6-10 year program (ADOT Five Year Facility Construction Program 2017-2021); Widen/upgrade road to four lanes (BQAZ)
260-10	260-277	16.53	Low		Low	Widen/upgrade road to four lanes (BQAZ)
260-11	277-282	4.89	Low		Low	Widen/upgrade road to four lanes (BQAZ)
260-12	282-304	21.74	Low		Low	Shoulder widening, MP 282-304 (Project Assessment, 2014); Widen/upgrade road to four lanes (BQAZ)
260-13	304-306	2.05	Low		Low	Widen/upgrade road to four lanes (BQAZ)
277-14	306-313	6.83	Low		Low	Widen/upgrade road to four lanes (BQAZ)
377-15	0-34	33.83	Low		Low	Programmed: Reconstruct horizontal curves and widen shoulders to 8 ft in both directions (MP 3.17-3.42, 5.04-5.20, 7.40-7.60, 13.33-13.61, 14.97-15.12, 17.69-18.56, 18.64-18.91, 20.87-21.29, 27.99-28.22, 33.68-33.82) FY 2018 (ADOT Five Year Facility Construction Program 2017-2021); Widen/upgrade road to four lanes (BQAZ)
77-16	386-389	2.36	High		High	Widen SR 77, Holbrook to Tucson (BQAZ); Construct an alternate route to SR 77/40B-17 in Holbrook (ADOT, unpublished)
40B-17	287-288	0.75	Low		Low	Provide a major transit center in Holbrook (BQAZ); Construct an alternate route to SR 77/40B-17 in Holbrook (ADOT, unpublished)

5.3 Step 3: Mobility Contributing Factors

As described in Section 2.3, Step 3 identifies potential contributing factors to the performance needs calculated in Step 2. These contributing factors provide information on what types of improvements may help improve performance. Contributing factors include:

- Roadway variables
- Traffic variables
- Relevant freight-related existing infrastructure
- Closure type
- Non-actionable conditions

Roadway Variables

Roadway variables include functional classification, environmental type (e.g., urban, rural), terrain, number of lanes, speed limit, presence of auxiliary lanes, if a roadway is divided or non-divided, and how often passing is not allowed. These variables are described in more detail below:

- Functional classification indicates if a roadway is an interstate, state highway, or arterial. Capacity equations and parameters differ depending on a roadway's functional classification.
- Environmental type refers to how developed the land is adjacent to the roadway. Environmental types include urban, fringe urban, and rural. Capacity thresholds differ depending on the environmental type as higher congestion levels are more acceptable in urbanized areas than in rural areas.
- Terrain (described as level, rolling, or mountainous) indicates the general roadway grade, which influences how quickly vehicles can accelerate or decelerate or maintain a constant speed.
- The number of lanes in each direction indicates how many general purpose through lanes exist.
- The speed limit indicates the posted speed limit.
- The presence of auxiliary lanes for turning, weaving, or passing can improve mobility performance by maintaining more consistent speeds in mainline through lanes.
- A roadway is considered divided if it has a raised or depressed median separating the directions of traffic that cannot easily be traversed. A roadway with a painted paved median is considered a non-divided roadway. Dividing a roadway generally increases the roadway capacity.
- The presence of no-passing zones restricts the movement of vehicles around slower-moving vehicles.

Traffic Variables

Traffic variables include existing and future level of service (LOS), percent (%) trucks, and the buffer index (difference between PTI and TTI). The existing and future LOS, percentage of trucks, and buffer index can indicate how well a corridor is performing in terms of overall mobility and why certain segments of a corridor may be performing worse than others.

Existing and Future LOS

The existing and future LOS provide a letter "grade" between "A" and "F" for mobility that is generally reflective of Existing and Future V/C calculations. LOS values of "A", "B", and "C" are generally considered highly acceptable. A LOS value of "D" is generally considered moderately acceptable. LOS values of "E" and "F" are generally considered unacceptable.

Truck Traffic

The amount of truck traffic in a given segment of the corridor can be represented as a percentage of the overall total traffic volume for that specific segment. The truck volume on a corridor can impact overall mobility based on truck travel speed, corridor grades, required inspection points and number of lanes.

Buffer Index

The Buffer Index is calculated by subtracting the segment level TTI value (ratio of peak hour speed to free flow speed) from the segment level PTI value (95th percentile speed). The TTI and PTI values were determined in Working Paper 2. The buffer index expresses the amount of extra time necessary to be on-time 95 percent of the time for any given trip. This calculation provides information on the reliability of a corridor.

Mobility-Related Infrastructure

Mobility-related infrastructure refers to devices or features at specific locations that influence mobility performance. Examples include dynamic message signs (DMS), passing lanes, climbing lanes, ports of entry (POE), rest areas, and parking areas.

Closure Type

The relative frequency of types of closures within each segment helps indicate potential causes of mobility-related needs. Closure types consist of closures due to an incident/crash, obstruction, or weather condition. The number of each type of closure and the corresponding percentage of all closures that are of each type are noted.

Non-Actionable Conditions

Non-actionable conditions are features or characteristics that result in poor mobility performance that cannot be addressed through an engineered solution. Examples include border patrol checkpoints that require all vehicles to slow down or stop for inspection.

Mobility Needs Contributing Factors

Table 10 summarizes the potential contributing factors to mobility needs on the SR 87/SR 260/SR 377 corridor.

Table 10: Mobility Needs Contributing Factors (Step 3)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Roadway Variables								Traffic Variables					Relevant Mobility Related Existing Infrastructure
				Functional Classification	Environmental Type (Urban/Rural)	Terrain	# of Lanes/ Direction	Weighted Average Speed Limit	Aux Lanes	Divided/ Non-Divided	% No Passing	Existing LOS	Future 2035 LOS	% Trucks	NB Buffer Index (PTI-TTI)	SB Buffer Index (PTI-TTI)	
87-1	177-182	5.28	Low	State Highway	Urban	Level	4	59	No	Divided	-	A-C	D	5%	2.80	1.98	
87-2	182-191	8.73	Low	State Highway	Fringe Urban	Level	4	65	No	Divided	-	D	E/F	5%	1.22	2.63	
87-3	191-213	21.61	Low	State Highway	Rural	Level	4	65	No	Divided	-	A/B	A/B	10%	0.49	0.44	DMS NB, MP 191.2; Climbing Lane SB, MP 205.4-207.0
87-4	213-235	22.02	Low	State Highway	Rural	Mountainous	4	63	No	Divided	-	A/B	A/B	10%	0.88	0.42	Safety pullout area SB, MP 223 and MP 217 Brake check area NB, MP 223
87-5	235-241	5.24	Low	State Highway	Rural	Level	4	65	No	Divided	-	A/B	A/B	10%	0.41	0.43	Mazatzal Rest Area EB, MP 235 (currently closed)
87-6	241-250	9.6	Low	State Highway	Rural	Mountainous	4	65	No	Divided	-	A/B	A/B	10%	1.07	0.79	Safety pullout SB, MP 248
87-7	250-253	1.64	Low	State Highway	Urban	Level	4	39	Yes	Non-Divided	-	D	E/F	8%	3.25	4.62	
260-8	252-256	4.28	Low	State Highway	Urban	Level	4	51	Yes	Non-Divided	-	A-C	A-C	2%	5.70	3.87	DMS EB, MP 255.0 Speed cameras EB/WB, MP 255.5 and 255.9
260-9	256-260	3.48	High	State Highway	Rural	Level	2	53	No	Non-Divided	-	D-F	D-F	2%	0.49	0.16	Elk crossing EB/WB MP 259.5
260-10	260-277	16.53	Low	State Highway	Rural	Level	4	60	No	Divided	-	A/B	A/B	4%	0.51	0.34	
260-11	277-282	4.89	Low	State Highway	Rural	Mountainous	4	55	No	Non-Divided	-	A/B	A/B	6%	0.92	0.14	
260-12	282-304	21.74	Low	State Highway	Rural	Level	2	54	No	Non-Divided	73%	A/B	A/B	9%	0.18	0.30	DMS EB/WB, MP 302.4; CCTV EB/WB, MP 302.4; Safety pullout EB/WB, MP 282 Passing Lane: EB, MP 284.8 - 285.4; WB, MP 288.5 - 287.9; WB, MP 291.0 - 291.8; EB, MP 290.4 - 291.3; EB, MP 295.0 - 295.8; WB, MP 296.6 - 297.8; EB, MP 297.8 - 299.4; WB, MP 301.0 - 302.1
260-13	304-306	2.05	Low	State Highway	Fringe Urban	Level	4	45	Yes	Non-Divided	-	A-C	A-C	12%	0.61	1.77	
277-14	306-313	6.83	Low	State Highway	Rural	Level	2	52	No	Non-Divided	54%	A/B	A/B	10%	*No Data*	*No Data*	
377-15	0-34	33.83	Low	State Highway	Rural	Level	2	64	No	Non-Divided	30%	A/B	A/B	10%	*No Data*	*No Data*	RWIS NB, MP 0.1 Flash flood warning sign NB/SB, MP 12.5
77-16	386-389	2.36	High	State Highway	Fringe Urban	Level	2	49	No	Non-Divided	40%	D	E/F	13%	2.76	5.31	DMS SB, MP 387.5; CCTV NB/SB, MP 387.5 Speed feedback sign, NB/SB MP 388
40B-17	287-288	0.75	Low	State Highway	Urban	Level	4	35	Yes	Non-Divided	-	A-C	A-C	9%	11.13	9.25	

Table 10: Mobility Needs Contributing Factors (Step 3) (continued)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Closure Extent							Non-Actionable Conditions	Programmed and Planned Projects or Issues from Previous Documents Relevant to Final Need	Contributing Factors
				Total Number of Closures	# Incidents/ Accidents	% Incidents/ Accidents	# Obstructions/ Hazards	% Obstructions/ Hazards	# Weather Related	% Weather Related			
87-1	177-182	5.28	Low	12	12	100%	0	0%	0	0%		Planned: DMS SR 87 SB, MP 180	Percentage of closures due to incidents above the statewide average (100% to 96%)
87-2	182-191	8.73	Low	17	16	94%	1	6%	0	0%			Percentage of closures due to obstructions/hazards above the statewide average (6% to 3%)
87-3	191-213	21.61	Low	27	21	78%	6	22%	0	0%			Percentage of closures due to obstructions/hazards above the statewide average (22% to 3%)
87-4	213-235	22.02	Low	36	31	86%	5	14%	0	0%			Percentage of closures due to obstructions/hazards above the statewide average (14% to 3%)
87-5	235-241	5.24	Low	9	8	89%	1	11%	0	0%			Percentage of closures due to obstructions/hazards above the statewide average (11% to 3%)
87-6	241-250	9.6	Low	18	17	94%	0	0%	1	6%			Percentage of closures due to weather above the statewide average (6% to 1%)
87-7	250-253	1.64	Low	2	1	50%	0	0%	1	50%			Percentage of closures due to weather above the statewide average (50% to 1%)
260-8	252-256	4.28	Low	1	1	100%	0	0%	0	0%			Percentage of closures due to incidents above the statewide average (100% to 96%)
260-9	256-260	3.48	High	13	11	85%	0	0%	2	15%		Programmed: SR 260, Lion Springs Section (MP 258-260) - reconstruct to 4-lane divided highway – FY 2021 for design (ADOT Five Year Facility Construction Program 2017-2021)	Percentage of closures due to weather above the statewide average (6% to 1%)
260-10	260-277	16.53	Low	19	14	74%	2	11%	3	16%			Percentage of closures due to obstructions/hazards above the statewide average (11% to 3%) Percentage of closures due to weather above the statewide average (16% to 1%)
260-11	277-282	4.89	Low	11	7	64%	0	0%	4	36%			Percentage of closures due to weather above the statewide average (36% to 1%)
260-12	282-304	21.74	Low	27	21	78%	0	0%	6	22%		Planned: Shoulder widening, MP 282-304 (Project Assessment, 2014)	Percentage of closures due to weather above the statewide average (22% to 1%)
260-13	304-306	2.05	Low	3	2	67%	0	0%	1	33%			Percentage of closures due to weather above the statewide average (33% to 1%)
277-14	306-313	6.83	Low	4	3	75%	1	25%	0	0%			Percentage of closures due to obstructions/hazards above the statewide average (25% to 3%)
377-15	0-34	33.83	Low	14	14	100%	0	0%	0	0%		Programmed: Reconstruct horizontal curves and widen shoulders to 8 ft in both directions (MP 3-34) FY 2018 (ADOT Five Year Facility Construction Program 2017-2021); Widen/upgrade road to four lanes (BQAZ)	Percentage of closures due to incidents above the statewide average (100% to 96%)
77-16	386-389	2.36	High	0	0	0%	0	0%	0	0%		Planned: Widen SR 77, Holbrook to Tucson (BQAZ); Construct an alternate route to SR 77/40B-17 in Holbrook (ADOT, unpublished)	At-grade railroad crossing
40B-17	287-288	0.75	Low	No Data									At-grade railroad crossing

6.0 SAFETY PERFORMANCE NEEDS (STEPS 1-3)

The following sections describe Steps 1 through 3 of the Needs Assessment process for the SR 87/SR 260/SR 377 corridor for the Safety Performance Area. The methodology for performing Steps 1 through 3 is provided in **Appendix A**.

6.1 Step 1: Initial Safety Needs

The baseline performance scores (from Working Paper 2) and performance objectives (from Working Paper 3) for the SR 87/SR 260/SR 377 corridor were used to determine the initial safety needs, as described in Section 2.1. The safety data used to calculate baseline performance was provided by ADOT for the timeframe from 2010 through 2014.

Step 1 uses the scores for the Safety Index primary performance measure and three of the five secondary safety performance measures to determine the initial level of need by segment for each performance measure individually as well as for all performance measures combined. The three secondary performance measures used are the Directional Safety Index, Strategic Highway Safety Plan (SHSP) Top 5 Emphasis Area Behaviors, and Motorcycle-Involved Crashes. The two other secondary safety performance measures (Truck-Involved Crashes and Non-Motorized Crashes) exhibited small crash sample sizes in their entirety and were not considered in the Safety Performance Area needs assessment (refer to sample size criteria documented in Working Paper 2). Corridor segments that exhibited small crash sample sizes for the SHSP Top 5 Emphasis Area Behaviors were also excluded from the safety needs assessment.

The performance scores, performance objectives, and initial levels of need for each safety performance measure and for all safety performance measures combined are shown in **Table 11**.

For the Safety Index, five segments report a high level of need and two segments report a medium level of need. For the secondary Directional Safety Index, four segments report a high level of need in the northbound/eastbound direction and six segments report a high level of need in the southbound/westbound direction, with one northbound/eastbound medium level of need and one southbound/westbound medium level of need. For the SHSP Top 5 Emphasis Area Behaviors, two segments report a high level of need. For the Motorcycle-Involved Crashes, two segments report a high level of need. As mentioned, Truck-Involved Crashes and Non-Motorized Crashes were not considered in the needs assessment due to small crash sample sizes. For all safety performance measures combined, six segments report a high level of initial need and one segment reports a medium level of initial need. The weighted corridor average reports a high level of need.

6.2 Step 2: Final Safety Needs

Once the initial safety needs by segment for the SR 87/SR 260/SR 377 corridor were established, they were then refined in Step 2 as described in Section 2.2 to more accurately reflect existing needs. An evaluation of crash hot spots as well as relevant recently completed and under-construction projects was performed to determine if segment need levels required adjustment. The initial needs were then refined based on this assessment to determine the final need for each segment. Planned and programmed future projects and other issues identified in previous reports were noted for future reference in developing solutions that address identified needs. The Step 2 process is described in more detail below and summarized in **Table 12**.

Safety Hot Spots

There are three segments containing a safety hot spot. The location of the safety hot spots are listed in **Table 12**. Two of the safety hot spots are within segments that already have an identified initial need. One safety hot spot is within a segment with no initial need, so an adjustment was made to the need level of the segment to account for the hot spot.

Recently Completed and Under-Construction Projects

ADOT provided information on potentially relevant recently completed and under-construction projects that were not previously reflected in the baseline performance data. This includes any projects completed or under construction after 2014 that have the potential to mitigate a safety need on a corridor segment.

There are two segments containing a recently completed project which would supersede the safety data, as shown in **Table 12**. This recently completed project does not fully address the identified safety needs for the segments. As such, no adjustments were made to the need level of that segment to account for recently completed or under-construction projects.

Planned or Programmed Projects

Information was noted in **Table 12** on safety-related planned and programmed projects and other issues identified in previous reports in Working Paper 1. Planned and programmed projects and identified issues do not influence the level of need, but were documented for future reference in developing solutions that address identified needs.

Table 11: Initial Safety Needs (Step 1)

Segment	Operating Environment	Segment Length (miles)	Segment Mileposts (MP)	Safety Index			Directional Safety Index					% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors		
				Performance Score	Performance Objective	Level of Need	NB/EB Performance Score	SB/WB Performance Score	Performance Objective	NB/EB Level of Need	SB/WB Level of Need	Performance Score	Performance Objective	Level of Need
87-1	2 or 3 or 4 Lane Divided Highway	5.28	177-182	3.01	Average or Better	High	4.05	1.98	Average or Better	High	High	29%	Average or Better	None
87-2	2 or 3 or 4 Lane Divided Highway	8.73	182-191	0.62	Average or Better	None	1.21	0.04	Average or Better	Medium	None	*Insufficient Data*	Average or Better	N/A
87-3	2 or 3 or 4 Lane Divided Highway	21.61	191-213	1.19	Average or Better	Medium	0.48	1.90	Average or Better	None	High	44%	Average or Better	None
87-4	2 or 3 or 4 Lane Divided Highway	22.02	213-235	1.62	Average or Better	High	1.48	1.76	Average or Better	High	High	30%	Average or Better	None
87-5	2 or 3 or 4 Lane Divided Highway	5.24	235-241	1.22	Average or Better	Medium	0.08	2.36	Average or Better	None	High	*Insufficient Data*	Average or Better	N/A
87-6	2 or 3 or 4 Lane Divided Highway	9.6	241-250	2.11	Average or Better	High	0.09	4.13	Average or Better	None	High	71%	Average or Better	High
87-7	4 or 5 Lane Undivided Highway	1.64	250-253	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	*Insufficient Data*	Average or Better	N/A	N/A	*Insufficient Data*	Average or Better	N/A
260-8	4 or 5 Lane Undivided Highway	4.28	252-256	0.28	Average or Better	None	0.56	0.00	Average or Better	None	None	43%	Average or Better	None
260-9	2 or 3 Lane Undivided Highway	3.48	256-260	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	*Insufficient Data*	Average or Better	N/A	N/A	*Insufficient Data*	Average or Better	N/A
260-10	2 or 3 or 4 Lane Divided Highway	16.53	260-277	0.93	Average or Better	Low	0.62	1.24	Average or Better	None	Medium	50%	Average or Better	Low
260-11	4 or 5 Lane Divided Highway	4.89	277-282	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	*Insufficient Data*	Average or Better	N/A	N/A	*Insufficient Data*	Average or Better	N/A
260-12	2 or 3 Lane Undivided Highway	21.74	282-304	1.43	Average or Better	High	2.25	0.62	Average or Better	High	None	46%	Average or Better	None
260-13	4 or 5 Lane Undivided Highway	2.05	304-306	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	*Insufficient Data*	Average or Better	N/A	N/A	*Insufficient Data*	Average or Better	N/A
277-14	2 or 3 Lane Undivided Highway	6.83	306-313	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	*Insufficient Data*	Average or Better	N/A	N/A	*Insufficient Data*	Average or Better	N/A
377-15	2 or 3 Lane Undivided Highway	33.83	0-34	1.18	Average or Better	High	1.21	1.16	Average or Better	High	High	82%	Average or Better	High
77-16	2 or 3 Lane Undivided Highway	2.36	386-389	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	*Insufficient Data*	Average or Better	N/A	N/A	*Insufficient Data*	Average or Better	N/A
40B-17	4 or 5 Lane Undivided Highway	0.75	287-288	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	*Insufficient Data*	Average or Better	N/A	N/A	*Insufficient Data*	Average or Better	N/A
Emphasis Area?		*Yes*	*Weighted Corridor Average*	*1.34*	*Above Average*	*High*								

Table 11: Initial Safety Needs (Step 1) (continued)

Segment	Operating Environment	Segment Length (miles)	Segment Mileposts (MP)	% of Fatal + Incapacitating Injury Crashes Involving Trucks			% of Fatal + Incapacitating Injury Crashes Involving Motorcycles			% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers			Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	
87-1	2 or 3 or 4 Lane Divided Highway	5.28	177-182	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	High
87-2	2 or 3 or 4 Lane Divided Highway	8.73	182-191	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	Low
87-3	2 or 3 or 4 Lane Divided Highway	21.61	191-213	*Insufficient Data*	Average or Better	N/A	39%	Average or Better	High	*Insufficient Data*	Average or Better	N/A	High
87-4	2 or 3 or 4 Lane Divided Highway	22.02	213-235	*Insufficient Data*	Average or Better	N/A	50%	Average or Better	High	*Insufficient Data*	Average or Better	N/A	High
87-5	2 or 3 or 4 Lane Divided Highway	5.24	235-241	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	Medium
87-6	2 or 3 or 4 Lane Divided Highway	9.6	241-250	*Insufficient Data*	Average or Better	N/A	14%	Average or Better	None	*Insufficient Data*	Average or Better	N/A	High
87-7	4 or 5 Lane Undivided Highway	1.64	250-253	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	N/A
260-8	4 or 5 Lane Undivided Highway	4.28	252-256	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	None
260-9	2 or 3 Lane Undivided Highway	3.48	256-260	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	N/A
260-10	2 or 3 or 4 Lane Divided Highway	16.53	260-277	*Insufficient Data*	Average or Better	N/A	13%	Average or Better	None	*Insufficient Data*	Average or Better	N/A	Low
260-11	4 or 5 Lane Divided Highway	4.89	277-282	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	N/A
260-12	2 or 3 Lane Undivided Highway	21.74	282-304	*Insufficient Data*	Average or Better	N/A	15%	Average or Better	None	*Insufficient Data*	Average or Better	N/A	High
260-13	4 or 5 Lane Undivided Highway	2.05	304-306	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	N/A
277-14	2 or 3 Lane Undivided Highway	6.83	306-313	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	N/A
377-15	2 or 3 Lane Undivided Highway	33.83	0-34	*Insufficient Data*	Average or Better	N/A	0%	Average or Better	None	*Insufficient Data*	Average or Better	N/A	High
77-16	2 or 3 Lane Undivided Highway	2.36	386-389	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	N/A
40B-17	4 or 5 Lane Undivided Highway	0.75	287-288	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	N/A

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Table 12: Final Safety Needs (Step 2)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Initial Need	Hot Spots	Relevant Recently Completed or Under Construction Projects (which supersede performance data)*	Final Need	Comments (may include tentatively programmed projects with potential to address need or other relevant issues identified in previous reports)
87-1	5.28	177-182	High			High	Planned: DMS, SR 87 SB, MP 180; Planned: Widen/upgrade to six lanes (Building a Quality Arizona (BQAZ), 2010)
87-2	8.73	182-191	Low			Low	Planned: Widen/upgrade to six lanes (BQAZ)
87-3	21.61	191-213	High			High	Planned: Widen/upgrade to six lanes (BQAZ)
87-4	22.02	213-235	High	Hot spot: NB, MP 213-215	Signage, rumble strips, and turn lanes added in 2016 at SR 188/SR 87 intersection	High	Planned: Widen/upgrade to six lanes (BQAZ); At SR 188/SR 87 intersection, high crash rate (5 fatals recently) per District meeting. RSA recently completed to extend the right turn lane. Drivers run the stop sign, many trailers/boats, grade separation requested. Programmed: Rehabilitation of Mazatzal Rest Area at MP 235, design wastewater system FY 2019, construct wastewater system FY 2020.
87-5	5.24	235-241	Medium		Signage, rumble strips, and turn lanes added in 2016 at SR 188/SR 87 intersection	Medium	Planned: Widen/upgrade to six lanes (BQAZ); At SR 188/SR 87 intersection, high crash rate (5 fatals recently) per District meeting. RSA recently completed to extend the right turn lane. Drivers run the stop sign, many trailers/boats, grade separation requested. Programmed: Rehabilitation of Mazatzal Rest Area at MP 235, design wastewater system FY 2019, construct wastewater system FY 2020.
87-6	9.6	241-250	High	Hot spot: SB, MP 245-248 crash concentration		High	Planned: Widen/upgrade to six lanes (BQAZ); Temporary jersey barriers were placed before at MP 246, Corvaire Curve, but have since been removed.
87-7	1.64	250-253	N/A			N/A	
260-8	4.28	252-256	None	Hot spot: NB, MP 252-253 crash concentration		Low	SR 87/260 intersection exhibits bad congestion, particularly on weekends and holidays. - Per District meeting notes
260-9	3.48	256-260	N/A			N/A	Programmed: SR 260, Lion Springs Section (MP 258-260) - reconstruct to 4-lane divided highway – FY 2021 for design (ADOT Five Year Facility Construction Program 2017-2021)
260-10	16.53	260-277	Low			Low	SR 260 was widened from a 2-lane undivided highway to a 4-lane divided highway in 2010-2011 at MP 263-267 and in 2011-2012 at MP 269-272. One crash occurred at MP 271 when the road was a 2-lane undivided highway that involved a vehicle crossing the centerline, resulting in a head on crash - this crash likely would have been avoided if the 4-lane divided highway were in place. One crash occurred at MP 272 when the road was a 2-lane undivided highway that involved a vehicle running off the road to the left with the driver under the influence - not clear if this crash would have been avoided if the 4-lane divided highway were in place
260-11	4.89	277-282	N/A			N/A	
260-12	21.74	282-304	High		Spot repair pavement preservation project for MP 282-291 is currently underway	High	Planned: Shoulder widening, MP 282-304 (Project Assessment, 2014)
260-13	2.05	304-306	N/A			N/A	
277-14	6.83	306-313	N/A			N/A	
377-15	33.83	0-34	High			High	Programmed: Reconstruct horizontal curves and widen shoulders to 8 ft in both directions (MP 3-34) FY 2018 (ADOT Five Year Facility Construction Program 2017-2021); Planned: Widen/upgrade road to four lanes (BQAZ)
77-16	2.36	386-389	N/A			N/A	
40B-17	0.75	287-288	N/A			N/A	

6.3 Step 3: Safety Contributing Factors

As described in Section 2.3, Step 3 identifies potential contributing factors to the performance needs calculated in Step 2. These contributing factors provide information on what types of improvements may help improve performance. Contributing factors can be derived from:

- Hot spot crash summaries
- Previously completed safety-related projects
- District input on safety concerns
- Segment crash type summaries
- Section 6.2 of the 2010 Highway Safety Manual

Hot Spot Crash Summaries

Crash summaries were developed for each identified crash hot spot to identify observable crash patterns. These crash summaries are based on crashes of all severity levels (not just fatal and incapacitating injury) to provide more information for use in identifying crash patterns.

Previously Completed Safety-Related Projects

Recently completed safety-related projects may provide insight into previously identified contributing factors along the corridor. Some recently completed safety-related projects may already address some of the crash patterns evident in the crash analysis. Other safety-related projects completed before the crash analysis time period (i.e., more than five years old) may have exceeded their respective design life and rehabilitation or replacement could increase their effectiveness. Examples include rumble strips that are worn down or retroreflective materials that have lost their retroreflectivity.

District Input on Safety Concerns

ADOT maintenance personnel provided information on locations where they had observed potential safety needs. Locations were defined by approximate milepost limits and assigned to the appropriate corridor segment. District safety concerns that corroborated the segment crash type summaries or crash hot spots summaries were noted.

Segment Crash Type Summaries

Crash frequencies for each possible crash type descriptor within each of the eight crash type summary categories were summarized for fatal and incapacitating injury crashes for each corridor segment that contained at least five crashes of that crash type descriptor (lower crash totals were not considered to have a sufficient sample size for analysis purposes). For an even more robust data set, crash types for crashes of all severity levels (not just fatal and incapacitating injury) can be reviewed to determine if crash patterns are readily identifiable. If this more detailed analysis is conducted, it is recommended that it only be conducted on segments with medium or high levels of need to minimize analysis effort.

The proportional occurrence of each possible crash type descriptor compared to the total number of fatal plus incapacitating injury crashes occurring in that respective segment was also calculated and expressed as a percentage. These segment-level crash type descriptor frequency percentages were then compared with the corresponding statewide crash type descriptor frequency percentages for all state highways with similar operating environments (as defined in the baseline corridor performance in Working Paper 2). Segment crash type descriptor frequency percentages that exceeded the corresponding statewide frequency percentage were identified as likely contributing factors to the level of need (illustrated with a red font). The crash type descriptors include the following components:

- First Harmful Event Type
  - Collision with Motor Vehicle
  - Overturning
  - Collision with Pedestrian
  - Collision with Pedalcyclist
  - Collision With Animal
  - Collision with Fixed Object
  - Collision with Non-Fixed Object
  - Vehicle Fire or Explosion
  - Other Non-Collision
  - Unknown
- Collision Type
  - Single Vehicle Collisions
  - Angle
  - Left Turn
  - Rear End
  - Head On
  - Sideswipe (same)
  - Sideswipe (opposite)
  - Rear to Side
  - Rear to Rear
  - Other
  - Unknown
- Violation or Behavior Type
  - No Improper Action
  - Speed too Fast for Conditions
  - Exceeded Lawful Speed
  - Failure to Yield Right-of-Way
  - Followed Too Closely
  - Ran Stop Sign
  - Disregarded Traffic Signal
  - Made Improper Turn
  - Drove in Opposing Lane
  - Faulty/Missing Equipment
  - Motorcycle Safety Equipment Use
  - Passed in No Passing Zone
  - Unsafe Lane Change
  - Failure to Keep in Proper Lane

  - Other Unsafe Passing
  - Inattention/Distraction
  - Electronic Communications Device
  - Other

- Type of Lighting Conditions
  - Daylight
  - Dawn
  - Dusk
  - Dark-Lighted
  - Dark-Unlighted
  - Dark-Unknown Lighting

- Type of Road Surface Conditions
  - Dry
  - Wet
  - Snow
  - Slush
  - Ice/Frost
  - Water (standing or moving)
  - Sand
  - Mud, Dirt, Gravel
  - Oil
  - Other
  - Unknown

- First Unit Event Description
  - Collision with Animal
  - Collision with Fixed Object
  - Ran Off the Road (Left)
  - Ran Off the Road (Right)
  - Crossed Centerline
  - Crossed Median
  - Collision with Pedestrian
  - Motor Vehicle in Transport
  - Overturn
  - Equipment Failure
  - Collision with Falling Object
  - Other Non-Collision
  - Other Non-Fixed Object
  - Unknown

- Driver Physical Condition
  - Under the Influence of Drugs or Alcohol
  - Fatigued/Fell Asleep
  - No Apparent Influence
  - Had Been Drinking
  - Medications
  - Illness
  - Physical Impairment
  - Other
  - Unknown

- Safety Device Usage
  - Shoulder and Lap Belt
  - Child Restraint System
  - None Used
  - Helmet Used
  - Air Bag Deployed/Shoulder-Lap Belt
  - Air Bag Deployed
  - Other
  - Unknown
  - Not Applicable
  - Lap Belt
  - Not Reported

Section 6.2 of the 2010 Highway Safety Manual

Section 6.2 of the 2010 Highway Safety Manual (HSM) provides potential contributing factors for corresponding crash types and patterns. Crash patterns within the corridor that match crash patterns in the HSM can reasonably be expected to have similar potential contributing factors to those listed in the HSM.

Safety Needs Contributing Factors

Likely contributing factors were developed based on the information obtained through the hot spot crash summaries, previously completed safety-related projects, District input on safety concerns, segment crash type summaries, and HSM potential contributing factors. These contributing factors provide guidance on the types of solutions that will likely promote improved safety performance. **Table 13** summarizes the likely contributing factors to safety needs on the SR 87/SR 260/SR 377 corridor.

Table 13: Safety Needs Contributing Factors (Step 3)

Segment Number		87-1	87-2	87-3	87-4	87-5	87-6	87-7	260-8	260-9
Segment Length (miles)		5.28	8.73	21.61	22.02	5.24	9.6	1.64	4.28	3.48
Segment Milepost (MP)		177-182	182-191	191-213	213-235	235-241	241-250	250-253	252-256	256-260
Final Need		High	Low	High	High	Medium	High	N/A	Low	N/A
Segment Crash Overview		6 Crashes were fatal 1 Crashes had incapacitating injuries 0 Crashes involve trucks 1 Crashes involve Motorcycles	2 Crashes were fatal 2 Crashes had incapacitating injuries 0 Crashes involve trucks 1 Crashes involve Motorcycles	7 Crashes were fatal 11 Crashes had incapacitating injuries 0 Crashes involve trucks 7 Crashes involve Motorcycles	9 Crashes were fatal 21 Crashes had incapacitating injuries 1 Crashes involve trucks 15 Crashes involve Motorcycles	2 Crashes were fatal 1 Crashes had incapacitating injuries 0 Crashes involve trucks 1 Crashes involve Motorcycles	6 Crashes were fatal 8 Crashes had incapacitating injuries 0 Crashes involve trucks 2 Crashes involve Motorcycles	1 Crashes were fatal 2 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	0 Crashes were fatal 7 Crashes had incapacitating injuries 1 Crashes involve trucks 1 Crashes involve Motorcycles	1 Crashes were fatal 2 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles
Segment Crash Summaries (Fatal and Serious Injury Crashes)	First Harmful Event Type	29% Involve Collision with Pedestrian 29% Involve Collision with Fixed Object 29% Involve Collision with Motor Vehicle	N/A - Sample size too small	39% Involve Overturning 28% Involve Other Non-Collision 22% Involve Collision with Motor Vehicle	30% Involve Collision with Fixed Object 27% Involve Other Non-Collision 23% Involve Overturning	N/A - Sample size too small	36% Involve Overturning 29% Involve Collision with Fixed Object 21% Involve Other Non-Collision	N/A - Sample size too small	57% Involve Collision with Motor Vehicle 29% Involve Collision With Animal 14% Involve Other Non-Collision	N/A - Sample size too small
	Collision Type	43% Involve Other 29% Involve Single Vehicle 14% Involve Angle	N/A - Sample size too small	72% Involve Single Vehicle 11% Involve Sideswipe (same) 6% Involve Rear End	80% Involve Single Vehicle 13% Involve Other 3% Involve Angle	N/A - Sample size too small	86% Involve Single Vehicle 7% Involve Sideswipe (same) 7% Involve Rear End	N/A - Sample size too small	43% Involve Single Vehicle 14% Involve Head On 14% Involve Angle	N/A - Sample size too small
	Violation or Behavior	43% Involve Unknown 29% Involve Failure to Yield Right-of- 14% Involve Speed too Fast for Conditions	N/A - Sample size too small	28% Involve Speed too Fast for Conditions 22% Involve No Improper Action 11% Involve Failure to Keep in Proper Lane	53% Involve Speed too Fast for Conditions 20% Involve No Improper Action 10% Involve Inattention/Distraction	N/A - Sample size too small	29% Involve Speed too Fast for Conditions 21% Involve Inattention/Distraction 14% Involve Unknown	N/A - Sample size too small	29% Involve No Improper Action 29% Involve Unknown 14% Involve Speed too Fast for Conditions	N/A - Sample size too small
	Lighting Conditions	29% Occur in Dark-Lighted Conditions 29% Occur in Dark-Unlighted Conditions 29% Occur in Dark-Unknown Lighting Conditions	N/A - Sample size too small	72% Occur in Daylight Conditions 22% Occur in Dark-Unlighted Conditions 6% Occur in Dawn Conditions	73% Occur in Daylight Conditions 20% Occur in Dark-Unlighted Conditions 7% Occur in Dawn Conditions	N/A - Sample size too small	86% Occur in Daylight Conditions 14% Occur in Dark-Unlighted Conditions	N/A - Sample size too small	71% Occur in Daylight Conditions 14% Occur in Dawn Conditions 14% Occur in Dark-Unlighted Conditions	N/A - Sample size too small
	Surface Conditions	71% Involve Dry Conditions 29% Involve Unknown Conditions	N/A - Sample size too small	78% Involve Dry Conditions 17% Involve Wet Conditions 6% Involve Mud, Dirt, Gravel	80% Involve Dry Conditions 13% Involve Wet Conditions 7% Involve Ice/Frost Conditions	N/A - Sample size too small	79% Involve Dry Conditions 21% Involve Wet Conditions	N/A - Sample size too small	83% Involve Dry Conditions 17% Involve Wet Conditions	N/A - Sample size too small
	First Unit Event	43% Involve a first unit event of Motor Vehicle in Transport 14% Involve a first unit event of Collision with Pedestrian 14% Involve a first unit event of Ran Off the Road (Right)	N/A - Sample size too small	28% Involve a first unit event of Ran Off the Road (Left) 28% Involve a first unit event of Motor Vehicle in Transport 22% Involve a first unit event of Ran Off the Road (Right)	57% Involve a first unit event of Ran Off the Road (Right) 23% Involve a first unit event of Ran Off the Road (Left) 7% Involve a first unit event of Other Non-Collision	N/A - Sample size too small	57% Involve a first unit event of Ran Off the Road (Right) 29% Involve a first unit event of Ran Off the Road (Left) 7% Involve a first unit event of Crossed Centerline	N/A - Sample size too small	57% Involve a first unit event of Motor Vehicle in Transport 29% Involve a first unit event of Collision with Animal 14% Involve a first unit event of Other Non-Collision	N/A - Sample size too small
	Driver Physical Condition	57% Unknown 29% Under the Influence of Drugs or Alcohol 14% No Apparent Influence	N/A - Sample size too small	44% No Apparent Influence 33% Unknown 11% Under the Influence of Drugs or Alcohol	63% No Apparent Influence 33% Unknown 3% Fatigued/Fell Asleep	N/A - Sample size too small	50% Under the Influence of Drugs or Alcohol 21% No Apparent Influence 21% Unknown	N/A - Sample size too small	71% No Apparent Influence 14% Under the Influence of Drugs or Alcohol 14% Unknown	N/A - Sample size too small
	Safety Device Usage	43% Air Bag Deployed/Shoulder-Lap 29% Shoulder And Lap Belt Used 14% Unknown	N/A - Sample size too small	22% Helmet Used 22% Shoulder And Lap Belt Used 17% None Used	40% Helmet Used 27% Shoulder And Lap Belt Used 17% None Used	N/A - Sample size too small	50% Shoulder And Lap Belt Used 36% None Used 7% Helmet Used	N/A - Sample size too small	57% Shoulder And Lap Belt Used 29% None Used 14% Helmet Used	N/A - Sample size too small
Hot Spot Crash Summaries					Hot spot NB MP 213-215		Hot spot SB MP 245-245		Hot spot NB MP 252-253	
Previously Completed Safety-Related Projects					Signage and rumble strips just added - per District meeting	Signage and rumble strips just added - per District meeting				
District Interviews/Discussions					The SR 87/SR 188 intersection has experienced high numbers of crashes. A grade separated intersection is desired by the District. Many vehicles run the stop sign on SR 188. The area experiences heavy recreational use (trucks with trailers or boats).	The SR 87/SR 188 intersection has experienced high numbers of crashes. A grade separated intersection is desired by the District. Many vehicles run the stop sign on SR 188. The area experiences heavy recreational use (trucks with trailers or boats).	Temporary Jersey barriers have been placed along Corvair curve (MP 246 SB) in the past to help promote safety but they have since been removed.			
Contributing Factors		• Roadway departure • Driver inattention/distraction • Inadequate barrier between pedestrian and vehicle facilities • Shoulder/rumble strip condition • Inadequate lighting • Lack of crossing opportunity • Driving under the influence	N/A - Sample size too small	• Speed too fast for conditions • Driver inattention/distraction • Roadway departure • Pavement surface condition • Improper lane changes • Shoulder/rumble strip condition • Clear zone slopes and obstructions • Slippery/wet pavement surface	• Speed too fast for conditions • Driver inattention/distraction • Roadway departure • Pavement surface condition • Shoulder/rumble strip condition • Clear zone slopes and obstructions • Slippery/wet pavement surface	N/A - Sample size too small	• Speed too fast for conditions • Driver inattention/distraction • Roadway departure • Pavement surface condition • Shoulder/rumble strip condition • Clear zone slopes and obstructions • Slippery/wet pavement surface • Driving under the influence	N/A - Sample size too small	• Speed too fast for conditions • Driver inattention/distraction • Urban operating conditions • High traffic volume operating conditions • Animals on roadway • Inadequate lighting • Slippery/wet pavement surface	N/A - Sample size too small

Table 13: Safety Needs Contributing Factors (Step 3) (continued)

Segment Number		260-10	260-11	260-12	260-13	277-14	377-15	77-16	40B-17	Corridor-Wide Crash Characteristics
Segment Length (miles)		16.53	4.89	21.74	2.05	6.83	33.83	2.36	0.75	
Segment Milepost (MP)		260-277	277-282	282-304	304-306	306-313	0-34	386-389	287-288	
Final Need		Low	N/A	High	N/A	N/A	High	N/A	N/A	
Segment Crash Overview		3 Crashes were fatal 5 Crashes had incapacitating injuries 1 Crashes involve trucks 1 Crashes involve Motorcycles	0 Crashes were fatal 2 Crashes had incapacitating injuries 0 Crashes involve trucks 1 Crashes involve Motorcycles	5 Crashes were fatal 10 Crashes had incapacitating injuries 0 Crashes involve trucks 2 Crashes involve Motorcycles	0 Crashes were fatal 1 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	0 Crashes were fatal 1 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	4 Crashes were fatal 7 Crashes had incapacitating injuries 3 Crashes involve trucks 0 Crashes involve Motorcycles	1 Crashes were fatal 0 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	1 Crashes were fatal 0 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	48 Crashes were fatal 81 Crashes had incapacitating injuries 6 Crashes involve trucks 32 Crashes involve Motorcycles
Segment Crash Summaries (Fatal and Serious Injury Crashes)	First Harmful Event Type	25% Involve Collision with Motor Vehicle 25% Involve Overturning 25% Involve Other Non-Collision	N/A - Sample size too small	33% Involve Collision with Motor Vehicle 27% Involve Overturning 20% Involve Collision with Fixed Object	N/A - Sample size too small	N/A - Sample size too small	73% Involve Overturning 18% Involve Collision with Motor Vehicle 9% Involve Collision with Fixed Object	N/A - Sample size too small	N/A - Sample size too small	26% Involve Collision with Motor Vehicle 26% Involve Overturning 19% Involve Other Non-Collision
	Collision Type	75% Involve Single Vehicle 25% Involve Head On	N/A - Sample size too small	60% Involve Single Vehicle 27% Involve Head On 7% Involve Angle	N/A - Sample size too small	N/A - Sample size too small	73% Involve Single Vehicle 9% Involve Sideswipe (same) 9% Involve Sideswipe (opposite)	N/A - Sample size too small	N/A - Sample size too small	63% Involve Single Vehicle 9% Involve Other 8% Involve Head On
	Violation or Behavior	25% Involve Speed too Fast for Conditions 25% Involve Drove in Opposing Lane 13% Involve Made Improper Turn	N/A - Sample size too small	40% Involve Speed too Fast for Conditions 13% Involve Failure to Yield Right-of- 13% Involve Drove in Opposing Lane	N/A - Sample size too small	N/A - Sample size too small	27% Involve Speed too Fast for Conditions 27% Involve Failure to Keep in Proper 18% Involve Inattention/Distraction	N/A - Sample size too small	N/A - Sample size too small	31% Involve Speed too Fast for Conditions 13% Involve No Improper Action 12% Involve Unknown
	Lighting Conditions	63% Occur in Daylight Conditions 25% Occur in Dark-Unlighted 13% Occur in Dark-Lighted Conditions	N/A - Sample size too small	80% Occur in Daylight Conditions 7% Occur in Dawn Conditions 7% Occur in Dusk Conditions	N/A - Sample size too small	N/A - Sample size too small	73% Occur in Daylight Conditions 27% Occur in Dark-Unlighted Conditions	N/A - Sample size too small	N/A - Sample size too small	68% Occur in Daylight Conditions 20% Occur in Dark-Unlighted 5% Occur in Dawn Conditions
	Surface Conditions	88% Involve Dry Conditions 13% Involve Wet Conditions	N/A - Sample size too small	100% Involve Dry Conditions	N/A - Sample size too small	N/A - Sample size too small	91% Involve Dry Conditions 9% Involve Ice/Frost Conditions	N/A - Sample size too small	N/A - Sample size too small	81% Involve Dry Conditions 12% Involve Wet Conditions 3% Involve Unknown Conditions
	First Unit Event	50% Involve a first unit event of Ran Off the Road (Left) 13% Involve a first unit event of Collision with Animal 13% Involve a first unit event of Crossed Centerline	N/A - Sample size too small	40% Involve a first unit event of Ran Off the Road (Right) 27% Involve a first unit event of Motor Vehicle in Transport 20% Involve a first unit event of Crossed Centerline	N/A - Sample size too small	N/A - Sample size too small	64% Involve a first unit event of Ran Off the Road (Right) 27% Involve a first unit event of Crossed Centerline 9% Involve a first unit event of Motor Vehicle in Transport	N/A - Sample size too small	N/A - Sample size too small	35% Involve a first unit event of Ran Off the Road (Right) 23% Involve a first unit event of Motor Vehicle in Transport 17% Involve a first unit event of Ran Off the Road (Left)
	Driver Physical Condition	38% No Apparent Influence 25% Under the Influence of Drugs or Alcohol 25% Unknown	N/A - Sample size too small	60% No Apparent Influence 20% Unknown 13% Under the Influence of Drugs or Alcohol	N/A - Sample size too small	N/A - Sample size too small	36% Under the Influence of Drugs or Alcohol 36% Unknown 27% No Apparent Influence	N/A - Sample size too small	N/A - Sample size too small	46% No Apparent Influence 32% Unknown 17% Under the Influence of Drugs or Alcohol
	Safety Device Usage	38% Shoulder And Lap Belt Used 25% None Used 13% Helmet Used	N/A - Sample size too small	60% Shoulder And Lap Belt Used 13% Helmet Used 13% Air Bag Deployed/Shoulder-Lap Belt	N/A - Sample size too small	N/A - Sample size too small	55% Shoulder And Lap Belt Used 36% None Used 9% Air Bag Deployed/Shoulder-Lap Belt	N/A - Sample size too small	N/A - Sample size too small	39% Shoulder And Lap Belt Used 19% Helmet Used 19% None Used
Hot Spot Crash Summaries										
Previously Completed Safety-Related Projects		SR 260 was widened from a 2-lane undivided highway to a 4-lane divided highway in 2010-2011 at MP 263-267 and in 2011-2012 at MP 269-272.					Programmed: Design and Reconstruct Curves, entire segment, FY 2018			
District Interviews/Discussions							The intersection of SR 77 and SR 377 has experienced fatalities in the past; Coordinating the traffic signal timing at I-40 Buisiness Loop/SR 77 to the railroad crossing would be beneficial	There is no left-turn lane on SR 77 in Holbrook south of Erie Street (safety and operations concern); Coordinating the traffic signal timing at I-40 Buisiness Loop/SR 77 to the railroad crossing would be beneficial		
Contributing Factors		• Speed too fast for conditions • Driver inattention/distraction • Roadway departure • Inadequate roadway geometry • Pavement surface condition • Shoulder/rumble strip condition • Clear zone slopes and obstructions • Slippery/wet pavement surface • Animals on roadway • Driving under the influence Comment: Conversion from 2-lane undivided to 4-lane divided in 2010-2011 at MP 263-267 and in 2011-2012 at MP 269-272 may have eliminated some of these contributing factors	N/A - Sample size too small	• Speed too fast for conditions • Driver inattention/distraction • Roadway departure • Inadequate roadway geometry • Pavement surface condition • Shoulder/rumble strip condition • Clear zone slopes and obstructions • Driving under the influence	N/A - Sample size too small	N/A - Sample size too small	• Speed too fast for conditions • Driver inattention/distraction • Roadway departure • Pavement surface condition • Shoulder/rumble strip condition • Clear zone slopes and obstructions • Slippery/wet pavement surface • Driving under the influence • Lack of restraint usage	N/A - Sample size too small	N/A - Sample size too small	• Speed too fast for conditions • Driver inattention/distraction • Roadway departure • Inadequate roadway geometry • Pavement surface condition • Shoulder/rumble strip condition • Clear zone slopes and obstructions • Slippery/wet pavement surface • Animals on roadway • Driving under the influence

7.0 FREIGHT PERFORMANCE NEEDS (STEPS 1-3)

The following sections describe Steps 1 through 3 of the Needs Assessment process for the SR 87/SR 260/SR 377 corridor for the Freight Performance Area. The methodology for performing Steps 1 through 3 is provided in **Appendix A**.

7.1 Step 1: Initial Freight Needs

The baseline performance scores (from Working Paper 2) and performance objectives (from Working Paper 3) for the SR 87/SR 260/SR 377 corridor were used to determine the initial freight needs, as described in Section 2.1. The freight data used to calculate baseline performance was provided by ADOT for 2014 for the existing travel time data, 2010-2014 for the closure data, and 2014 for bridge clearance data.

Step 1 uses the scores for the Freight Index primary performance measure and four secondary performance measures to determine the initial level of need by segment for each performance measure individually as well as for all performance measures combined. The four secondary performance measures are Directional Truck Travel Time Index (TTTI), Directional Truck Planning Time Index (TPTI), Directional Closure Duration, and Bridge Vertical Clearance.

The performance scores, performance objectives, and initial levels of need for each freight performance measure and for all freight performance measures combined are shown in **Table 14**.

For the Freight Index, nine segments report a high level of need and three segments report a medium level of need. For Directional TTTI, two segments have a high level of need in the northbound/eastbound direction and two segments in each northbound/eastbound and southbound/westbound direction report a medium level of need. For Directional TPTI, eight segments have a high level of need in the northbound/eastbound direction and seven segments have a high level of need in the southbound/westbound direction, with one segment reporting a medium level of need northbound/eastbound and two segments reporting a medium level of need southbound/westbound. For Directional Closure Duration, three segments report a high level of need in the northbound/eastbound direction and seven segments report a high level of need in the southbound/westbound direction, with four segments northbound/eastbound and one segment southbound/westbound reporting medium levels of need. For Bridge Vertical Clearance, no segments report a level of need. For all freight performance measures combined, 11 segments report a high level of initial need and one segment reports a medium level of initial need. The weighted corridor average reports a high level of need.

7.2 Step 2: Final Freight Needs

Once the initial freight needs by segment for the SR 87/SR 260/SR 377 corridor were established, they were then refined in Step 2 as described in Section 2.2 to more accurately reflect existing needs. An evaluation of vertical clearance hot spots as well as relevant recently completed and under-construction projects was performed to determine if segment need levels required adjustment. The initial needs were then refined based on this assessment to determine the final need for each segment. Planned and programmed future projects and other issues identified in previous reports were noted for future reference in developing solutions that address identified needs. The Step 2 process is described in more detail below and summarized in **Table 15**.

Vertical Clearance Hot Spots

There are zero segments containing vertical clearance hot spots, which are bridges that provide less than 16.25 feet of vertical clearance above the corridor mainline through lanes and that cannot be ramped around. The locations of vertical clearance hot spots would have been listed in **Table 15** if there were any hot spots. As there are no vertical clearance hot spots, no adjustments were made to the need level of any segments to account for hot spots.

Recently Completed and Under-Construction Freight Projects

ADOT provided information on potentially relevant recently completed and under-construction projects that were not previously reflected in the baseline performance data. This includes any projects completed or under construction after 2014 that have the potential to mitigate a freight need on a corridor segment.

There is one segment containing a recently completed project which would supersede the freight condition data, as shown in **Table 15**. This recently completed project does not fully address the identified freight needs for the segment. As such, no adjustments were made to the need level of that segment to account for recently completed or under-construction projects.

Planned or Programmed Projects

Information was noted in **Table 15** on freight-related planned and programmed projects and other issues identified in previous reports in Working Paper 1. Planned and programmed projects and identified issues do not influence the level of need, but were documented for future reference in developing solutions that address identified needs.

Table 14: Initial Freight Needs (Step 1)

Segment	Facility Operations	Segment Mileposts (MP)	Segment Length (miles)	Freight Index			Directional TTI (trucks only)					Directional PTI (trucks only)				
				Performance Score	Performance Objective	Level of Need	Performance Score		Performance Objective	Level of Need		Performance Score		Performance Objective	Level of Need	
							NB/EB	SB/WB		NB/EB	SB/WB	NB/EB	SB/WB		NB/EB	SB/WB
87-1	Interrupted	177-182	5.28	0.28	Fair or Better	Low	1.29	1.10	Fair or Better	None	None	3.88	3.38	Fair or Better	None	None
87-2	Interrupted	182-191	8.73	0.29	Fair or Better	None	1.19	1.32	Fair or Better	None	None	2.72	4.06	Fair or Better	None	Low
87-3	Uninterrupted	191-213	21.61	0.53	Fair or Better	High	1.11	1.23	Fair or Better	None	Low	1.38	2.38	Fair or Better	Low	High
87-4	Uninterrupted	213-235	22.02	0.51	Fair or Better	High	1.37	1.14	Fair or Better	Medium	None	2.38	1.56	Fair or Better	High	Medium
87-5	Uninterrupted	235-241	5.24	0.56	Fair or Better	High	1.12	1.21	Fair or Better	None	Low	1.45	2.13	Fair or Better	Medium	High
87-6	Uninterrupted	241-250	9.6	0.44	Fair or Better	High	1.55	1.22	Fair or Better	High	Low	2.52	2.01	Fair or Better	High	High
87-7	Interrupted	250-253	1.64	0.28	Fair or Better	None	1.20	1.91	Fair or Better	None	Medium	3.29	3.88	Fair or Better	None	None
260-8	Interrupted	252-256	4.28	0.15	Fair or Better	Medium	1.66	1.17	Fair or Better	Low	None	9.64	4.11	Fair or Better	High	Low
260-9	Uninterrupted	256-260	3.48	0.47	Fair or Better	High	1.20	1.00	Fair or Better	None	None	3.09	1.21	Fair or Better	High	None
260-10	Uninterrupted	260-277	16.53	0.58	Fair or Better	High	1.23	1.12	Fair or Better	Low	None	1.82	1.61	Fair or Better	High	High
260-11	Uninterrupted	277-282	4.89	0.54	Fair or Better	High	1.45	1.00	Fair or Better	High	None	2.53	1.18	Fair or Better	High	None
260-12	Uninterrupted	282-304	21.74	0.69	Fair or Better	Medium	1.00	1.10	Fair or Better	None	None	1.19	1.69	Fair or Better	None	High
260-13	Uninterrupted	304-306	2.05	0.36	Fair or Better	High	1.09	1.35	Fair or Better	None	Medium	2.75	2.82	Fair or Better	High	High
277-14	Uninterrupted	306-313	6.83	*No Data*	Fair or Better	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A
377-15	Uninterrupted	0-34	33.83	*No Data*	Fair or Better	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A
77-16	Interrupted	386-389	2.36	0.22	Fair or Better	Medium	1.12	1.54	Fair or Better	None	Low	3.52	5.65	Fair or Better	None	Medium
40B-17	Interrupted	287-288	0.75	0.05	Fair or Better	High	2.15	1.51	Fair or Better	Medium	None	29.93	8.45	Fair or Better	High	High
Emphasis Area?	*Yes*	*Weighted Corridor Average*		*0.50*	*Good*											

Table 14: Initial Freight Needs (Step 1) (continued)

Segment	Facility Operations	Segment Mileposts (MP)	Segment Length (miles)	Closure Duration (minutes/mile/year)					Bridge Clearance (feet)			Initial Need
				Performance Score		Performance Objective	Level of Need		Performance Score	Performance Objective	Level of Need	
				NB/EB	SB/WB		NB/EB	SB/WB				
87-1	Interrupted	177-182	5.28	129.19	61.92	Fair or Better	Medium	None	No UP	Fair or Better	None	Low
87-2	Interrupted	182-191	8.73	119.84	147.44	Fair or Better	Medium	Medium	No UP	Fair or Better	None	Low
87-3	Uninterrupted	191-213	21.61	2674.13	59.23	Fair or Better	High	None	16.97	Fair or Better	None	High
87-4	Uninterrupted	213-235	22.02	4359.89	34.01	Fair or Better	High	None	18.75	Fair or Better	None	High
87-5	Uninterrupted	235-241	5.24	49.20	21.67	Fair or Better	None	None	No UP	Fair or Better	None	High
87-6	Uninterrupted	241-250	9.6	37.16	287.98	Fair or Better	None	High	No UP	Fair or Better	None	High
87-7	Interrupted	250-253	1.64	21.33	693.60	Fair or Better	None	High	No UP	Fair or Better	None	Low
260-8	Interrupted	252-256	4.28	11.45	0.00	Fair or Better	None	None	No UP	Fair or Better	None	High
260-9	Uninterrupted	256-260	3.48	71.85	726.90	Fair or Better	Low	High	No UP	Fair or Better	None	High
260-10	Uninterrupted	260-277	16.53	157.49	797.71	Fair or Better	High	High	No UP	Fair or Better	None	High
260-11	Uninterrupted	277-282	4.89	144.40	922.04	Fair or Better	Medium	High	No UP	Fair or Better	None	High
260-12	Uninterrupted	282-304	21.74	117.01	901.62	Fair or Better	Medium	High	No UP	Fair or Better	None	High
260-13	Uninterrupted	304-306	2.05	0.00	739.30	Fair or Better	None	High	No UP	Fair or Better	None	High
277-14	Uninterrupted	306-313	6.83	20.03	0.00	Fair or Better	None	None	No UP	Fair or Better	None	N/A
377-15	Uninterrupted	0-34	33.83	10.14	9.29	Fair or Better	None	None	No UP	Fair or Better	None	N/A
77-16	Interrupted	386-389	2.36	0.00	0.00	Fair or Better	None	None	No UP	Fair or Better	None	Medium
40B-17	Interrupted	287-288	0.75	*No Data*	*No Data*	Fair or Better	N/A	N/A	No UP	Fair or Better	None	High

Table 15: Final Freight Needs (Step 2)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Initial Need	Truck Height Restriction Hot Spots (Clearance < 16.25')	Relevant Recently Completed or Under Construction Projects (which supersede performance data)*	Final Need	Comments (may include tentatively programmed projects with potential to address needs or other relevant issues identified in previous reports)
87-1	5.28	177-182	Low	None		Low	Planned: DMS, SR 87 SB, MP 180; Widen/upgrade to six lanes (Building a Quality Arizona (BQAZ), 2010)
87-2	8.73	182-191	Low	None		Low	Widen/upgrade to six lanes (BQAZ)
87-3	21.61	191-213	High	None		High	Widen/upgrade to six lanes (BQAZ)
87-4	22.02	213-235	High	None	MP 227 Construction of NB truck escape ramp (FY 2014)	High	Widen/upgrade to six lanes (BQAZ); Construct landslide mitigation measures (Project Assessment, 2012)
87-5	5.24	235-241	High	None		High	Widen/upgrade to six lanes (BQAZ)
87-6	9.6	241-250	High	None		High	Widen/upgrade to six lanes (BQAZ)
87-7	1.64	250-253	Low	None		Low	Widen/upgrade to six lanes (BQAZ); SR 87/Aero Drive intersection - conduct a traffic signal warrant study. Intersection needs to be reconstructed to fix sight distance issues if traffic signal not warranted (Payson Transportation Study, 2011); Construct an alternative route to SR 87/SR260 corridor in Payson (BQAZ and Payson Transportation Study); SR87, Main Street to SR 260 - incorporate recommendations from Road Safety Assessment (RSA) and Traffic Operational Analysis Study (TOAS) (Payson Transportation Study); SR 87/SR 260 intersection - incorporate recommendations form RSA and TOAS (Payson Transportation Study)
260-8	4.28	252-256	High	None		High	Widen/upgrade road to four lanes (BQAZ); SR 260, SR 87 to Manzanita Drive - incorporate recommendations from RSA and TOAS (Payson Transportation Study); SR 260/Manzanita Drive intersection - incorporate recommendations from RSA and TOAS (Payson Transportation Study)
260-9	3.48	256-260	High	None		High	Programmed: SR 260, Lion Springs Section (MP 258-260) - reconstruct to 4-lane divided highway – FY 2021 for design with construction tentatively planned for FY 2024 in 6-10 year program (ADOT Five Year Facility Construction Program 2017-2021); Widen/upgrade road to four lanes (BQAZ)
260-10	16.53	260-277	High	None		High	Widen/upgrade road to four lanes (BQAZ); Planned: MP 268-270 NB Climbing lane (Initial PA, 2008)
260-11	4.89	277-282	High	None		High	Widen/upgrade road to four lanes (BQAZ)
260-12	21.74	282-304	High	None		High	Shoulder widening, MP 282-304 (Project Assessment, 2014); Widen/upgrade road to four lanes (BQAZ)
260-13	2.05	304-306	High	None		High	Widen/upgrade road to four lanes (BQAZ)
277-14	6.83	306-313	N/A	None		N/A	Widen/upgrade road to four lanes (BQAZ)
377-15	33.83	0-34	N/A	None		N/A	Programmed: Reconstruct horizontal curves and widen shoulders to 8 ft in both directions (MP 3.17-3.42, 5.04-5.20, 7.40-7.60, 13.33-13.61, 14.97-15.12, 17.69-18.56, 18.64-18.91, 20.87-21.29, 27.99-28.22, 33.68-33.82) FY 2018 (ADOT Five Year Facility Construction Program 2017-2021); Widen/upgrade road to four lanes (BQAZ)
77-16	2.36	386-389	Medium	None		Medium	Widen SR 77, Holbrook to Tucson (BQAZ); Construct an alternate route to SR 77/40B-17 in Holbrook (ADOT, unpublished)
40B-17	0.75	287-288	High	None		High	Provide a major transit center in Holbrook (BQAZ); Construct an alternate route to SR 77/40B-17 in Holbrook (ADOT, unpublished)

7.3 Step 3: Freight Contributing Factors

As described in Section 2.3, Step 3 identifies potential contributing factors to the performance needs calculated in Step 2. These contributing factors provide information on what types of improvements may help improve performance. Contributing factors include:

- Roadway variables
- Traffic variables
- Relevant freight-related existing infrastructure
- Closure type
- Non-actionable conditions

Roadway Variables

Roadway variables include functional classification, environmental type (e.g., urban, rural), terrain, number of lanes, speed limit, presence of auxiliary lanes, if a roadway is divided or non-divided, and how often passing is not allowed. These variables are described in more detail below:

- Functional classification indicates if a roadway is an interstate, state highway, or arterial. Capacity equations and parameters differ depending on a roadway's functional classification.
- Environmental type refers to how developed the land is adjacent to the roadway. Environmental types include urban, fringe urban, and rural. Capacity thresholds differ depending on the environmental type as higher congestion levels are more acceptable in urbanized areas than in rural areas.
- Terrain (described as level, rolling, or mountainous) indicates the general roadway grade, which influences how quickly vehicles can accelerate or decelerate or maintain a constant speed.
- The number of lanes in each direction indicates how many general purpose through lanes exist.
- The speed limit indicates the posted speed limit.
- The presence of auxiliary lanes for turning, weaving, or passing can improve mobility performance by maintaining more consistent speeds in mainline through lanes.
- A roadway is considered divided if it has a raised or depressed median separating the directions of traffic that cannot easily be traversed. A roadway with a painted paved median is considered a non-divided roadway. Dividing a roadway generally increases the roadway capacity.
- The presence of no-passing zones restricts the movement of vehicles around slower-moving vehicles.

Traffic Variables

Traffic variables include existing and future level of service (LOS), percent (%) trucks, and the buffer index (difference between PTI and TTI). The existing and future LOS, percentage of trucks, and buffer index can indicate how well a corridor is performing in terms of overall mobility and why certain segments of a corridor may be performing worse than others.

Existing and Future LOS

The existing and future LOS provide a letter "grade" between "A" and "F" for mobility that is generally reflective of Existing and Future V/C calculations. LOS values of "A", "B", and "C" are generally considered highly acceptable. A LOS value of "D" is generally considered moderately acceptable. LOS values of "E" and "F" are generally considered unacceptable.

Truck Traffic

The amount of truck traffic in a given segment of the corridor can be represented as a percentage of the overall total traffic volume for that specific segment. The truck volume on a corridor can impact overall mobility based on truck travel speed, corridor grades, required inspection points and number of lanes.

Buffer Index

The Buffer Index is calculated by subtracting the segment level TTI value (ratio of peak hour speed to free flow speed) from the segment level PTI value (95th percentile speed). The TTI and PTI values were determined in Working Paper 2. The buffer index expresses the amount of extra time necessary to be on-time 95 percent of the time for any given trip. This calculation provides information on the reliability of a corridor.

Freight-Related Infrastructure

Freight related infrastructure refers to devices or features at specific locations that influence freight performance. Examples include DMS, passing lanes, climbing lanes, POE, weigh stations, rest areas, and parking areas.

Closure Type

The relative frequency of types of closures within each segment helps indicate potential causes of freight-related needs. Closure types consist of closures due to an incident/crash, obstruction, or weather condition. The number of each type of closure and the corresponding percentage of all closures that are of each type are noted.

Non-Actionable Conditions

Non-actionable conditions are features or characteristics that result in poor freight performance that cannot be addressed through an engineered solution. Examples include border patrol checkpoints that require all vehicles to slow down or stop for inspection.

Freight Needs Contributing Factors

Table 16 summarizes the potential contributing factors to freight needs on the SR 87/SR 260/SR 377 corridor.

Table 16: Freight Needs Contributing Factors (Step 3)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Roadway Variables								Traffic Variables					Relevant Freight Related Existing Infrastructure
				Functional Classification	Environmental Type (Urban/Rural)	Terrain	# of Lanes/ Direction	Weighted Average Speed Limit	Aux Lanes	Divided/ Non-Divided	% No Passing	Existing LOS	Future 2035 LOS	% Trucks	NB/EB Buffer Index (TPTI-TTTI)	SB/WB Buffer Index (TPTI-TTTI)	
87-1	177-182	5.28	Low	State Highway	Urban	Level	4	59	No	Divided	-	A-C	D	5%	2.59	2.28	
87-2	182-191	8.73	Low	State Highway	Fringe Urban	Level	4	65	No	Divided	-	D	E/F	5%	1.53	2.75	
87-3	191-213	21.61	High	State Highway	Rural	Level	4	65	No	Divided	-	A/B	A/B	10%	0.26	1.14	DMS NB, MP 191.2; Climbing Lane SB, MP 205.4-207.0
87-4	213-235	22.02	High	State Highway	Rural	Mountainous	4	63	No	Divided	-	A/B	A/B	10%	1.00	0.42	Truck Escape Ramp NB, MP 227 (currently closed) Safety pullout area SB, MP 223 and MP 217 Brake check area NB, MP 223
87-5	235-241	5.24	High	State Highway	Rural	Level	4	65	No	Divided	-	A/B	A/B	10%	0.34	0.92	Mazatzal Rest Area EB, MP 235.7 (currently closed)
87-6	241-250	9.6	High	State Highway	Rural	Mountainous	4	65	No	Divided	-	A/B	A/B	10%	0.97	0.79	Safety pullout SB, MP 248
87-7	250-253	1.64	Low	State Highway	Urban	Level	4	39	Yes	Non-Divided	-	D	E/F	8%	2.10	1.97	
260-8	252-256	4.28	High	State Highway	Urban	Level	4	51	Yes	Non-Divided	-	A-C	A-C	2%	7.98	2.94	DMS EB, MP 255.0 Speed cameras EB/WB, MP 255.5 and 255.9
260-9	256-260	3.48	High	State Highway	Rural	Level	2	53	No	Non-Divided	-	D-F	D-F	2%	1.89	0.21	Elk crossing EB/WB MP 259.5
260-10	260-277	16.53	High	State Highway	Rural	Level	4	60	No	Divided	-	A/B	A/B	4%	0.59	0.50	
260-11	277-282	4.89	High	State Highway	Rural	Mountainous	4	55	No	Non-Divided	-	A/B	A/B	6%	1.08	0.18	
260-12	282-304	21.74	High	State Highway	Rural	Level	2	54	No	Non-Divided	73%	A/B	A/B	9%	0.19	0.59	DMS EB/WB, MP 302.4; CCTV EB/WB, MP 302.4 Safety pullout EB/WB MP 282 Climbing/Passing Lane: EB MP 284.8 - MP 285.4; WB MP 288.5 - MP 287.9; WB MP 291.0 - MP 291.8; EB MP 290.4 - MP 291.3; EB MP 295.0 - MP 295.8; WB MP 296.6 - MP 297.8; EB MP 297.8 - MP 299.4; WB MP 301.0 - MP 302.1
260-13	304-306	2.05	High	State Highway	Fringe Urban	Level	4	45	Yes	Non-Divided	-	A-C	A-C	12%	1.65	1.46	
277-14	306-313	6.83	N/A	State Highway	Rural	Level	2	52	No	Non-Divided	54%	A/B	A/B	10%	*No Data*	*No Data*	
377-15	0-34	33.83	N/A	State Highway	Rural	Level	2	64	No	Non-Divided	30%	A/B	A/B	10%	*No Data*	*No Data*	RWIS NB, MP 0.1 Flash flood warning signs NB/SB, MP 12.5
77-16	386-389	2.36	Medium	State Highway	Fringe Urban	Level	2	49	No	Non-Divided	40%	D	E/F	13%	2.41	4.11	DMS SB, MP 387.5; CCTV NB/SB, MP 387.5 Speed Feedback sign NB/SB, MP 388
40B-17	287-288	0.75	High	State Highway	Urban	Level	4	35	Yes	Non-Divided	-	A-C	A-C	9%	27.78	6.94	

Table 16: Freight Needs Contributing Factors (Step 3) (continued)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Closure Extent							Non-Actionable Conditions	Programmed and Planned Projects or Issues from Previous Documents Relevant to Final Need	Contributing Factors
				Total Number of Closures	# Incidents/ Accidents	% Incidents/ Accidents	# Obstructions/ Hazards	% Obstructions/ Hazards	# Weather Related	% Weather Related			
87-1	177-182	5.28	Low	12	12	100%	0	0%	0	0%		Planned: DMS SR 87 SB MP 180	Percentage of closures due to incidents above the statewide average (100% to 96%)
87-2	182-191	8.73	Low	17	16	94%	1	6%	0	0%			Percentage of closures due to obstructions/hazards above the statewide average (6% to 3%)
87-3	191-213	21.61	High	27	21	78%	6	22%	0	0%		Planned: Widen/upgrade to six lanes (BQAZ)	Percentage of closures due to obstructions/hazards above the statewide average (22% to 3%)
87-4	213-235	22.02	High	36	31	86%	5	14%	0	0%		Planned: Widen/upgrade to six lanes (BQAZ); Construct landslide mitigation measures (Project Assessment, 2012)	Percentage of closures due to obstructions/hazards above the statewide average (14% to 3%)
87-5	235-241	5.24	High	9	8	89%	1	11%	0	0%		Planned: Widen/upgrade to six lanes (BQAZ)	Percentage of closures due to obstructions/hazards above the statewide average (11% to 3%)
87-6	241-250	9.6	High	18	17	94%	0	0%	1	6%		Planned: Widen/upgrade to six lanes (BQAZ)	Percentage of closures due to weather above the statewide average (6% to 1%)
87-7	250-253	1.64	Low	2	1	50%	0	0%	1	50%			Percentage of closures due to weather above the statewide average (50% to 1%)
260-8	252-256	4.28	High	1	1	100%	0	0%	0	0%		Planned: SR 260, SR 87 to Manzanita Drive - incorporate recommendations from RSA and TOAS (Payson Transportation Study); SR 260/Manzanita Drive intersection - incorporate recommendations from RSA and TOAS (Payson Transportation Study)	Percentage of closures due to incidents above the statewide average (100% to 96%)
260-9	256-260	3.48	High	13	11	85%	0	0%	2	15%		Programmed: SR 260, Lion Springs Section (MP 258-260) - reconstruct to 4-lane divided highway – FY 2021 for design (ADOT Five Year Facility Construction Program 2017-2021); Planned: Widen/upgrade to four lanes (BQAZ)	Percentage of closures due to weather above the statewide average (6% to 1%)
260-10	260-277	16.53	High	19	14	74%	2	11%	3	16%		Planned: Widen/upgrade road to four lanes (BQAZ)	Percentage of closures due to obstructions/hazards above the statewide average (11% to 3%) Percentage of closures due to weather above the statewide average (16% to 1%)
260-11	277-282	4.89	High	11	7	64%	0	0%	4	36%		Planned: Widen/upgrade road to four lanes (BQAZ)	Percentage of closures due to weather above the statewide average (36% to 1%)
260-12	282-304	21.74	High	27	21	78%	0	0%	6	22%		Programmed: Shoulder widening, MP 282-304 (Project Assessment, 2014); Planned: Widen/upgrade road to four lanes (BQAZ)	Percentage of closures due to weather above the statewide average (22% to 1%)
260-13	304-306	2.05	High	3	2	67%	0	0%	1	33%		Planned: Widen/upgrade road to four lanes (BQAZ)	Percentage of closures due to weather above the statewide average (33% to 1%)
277-14	306-313	6.83	N/A	4	3	75%	1	25%	0	0%			Percentage of closures due to obstructions/hazards above the statewide average (25% to 3%)
377-15	0-34	33.83	N/A	14	14	100%	0	0%	0	0%		Programmed: Reconstruct horizontal curves and widen shoulders to 8 ft in both directions (MP 3-34) FY 2018 (ADOT Five Year Facility Construction Program 2017-2021); Widen/upgrade road to four lanes (BQAZ)	Percentage of closures due to incidents above the statewide average (100% to 96%)
77-16	386-389	2.36	Medium	0	0	0%	0	0%	0	0%		Planned: Widen SR 77, Holbrook to Tucson (BQAZ); Construct an alternate route to SR 77/40B-17 in Holbrook (ADOT, unpublished)	At-grade railroad crossing
40B-17	287-288	0.75	High	No Data								Planned: Construct an alternate route to SR 77/40B-17 in Holbrook (ADOT, unpublished)	At-grade railroad crossing

8.0 SEGMENT REVIEW (STEP 4)

As part of Step 4, the final needs results for each segment were combined to estimate the average level of need for each segment of SR 87/SR 260/SR 377, as described in Section 2.4. During the Corridor Goals and Objectives development process for SR 87/SR 260/SR 377, the Mobility, Safety, and Freight Performance Areas were identified as Emphasis Areas. Therefore, a weighting factor of 1.50 was applied to those performance area needs as discussed in Section 2.4. A summary of the segment needs is shown in **Table 17** along with the resulting average need. These results are intended for use to compare the level of need across corridors. The average level of need by segment is shown for the SR 87/SR 260/SR 377 corridor in **Figure 7**.

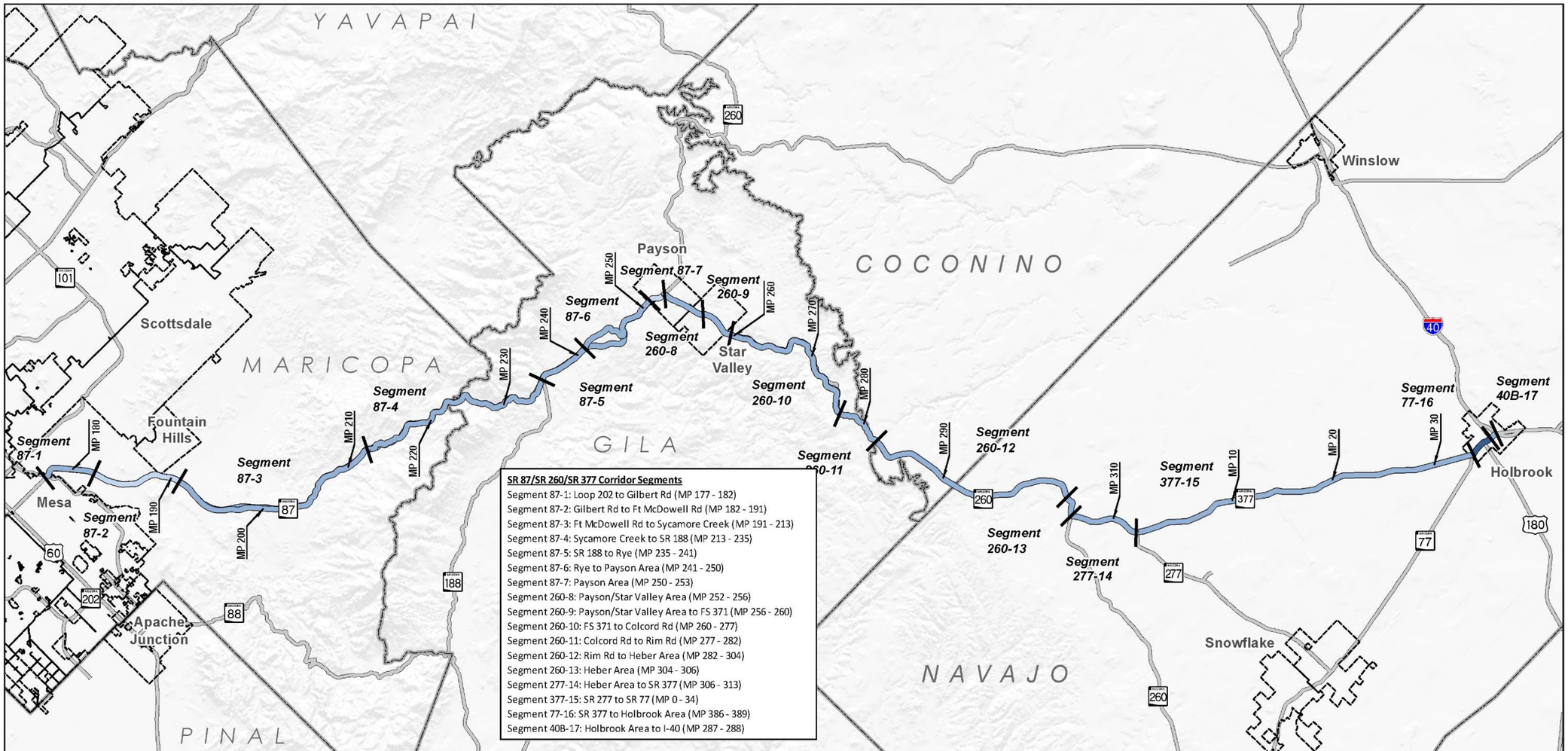
Table 17: Segment Needs Summary

Performance Area	87-1	87-2	87-3	87-4	87-5	87-6	87-7	260-8	260-9	260-10	260-11	260-12	260-13	277-14	377-15	77-16	40B-17
	MP 177-182	MP 182-191	MP 191-213	MP 213-235	MP 235-241	MP 241-250	MP 250-253	MP 252-256	MP 256-260	MP 260-277	MP 277-282	MP 282-304	MP 304-306	MP 306-313	MP 0-34	MP 386-389	MP 287-288
Pavement	Low	None	Low	Low	None	None	None	None	None	None	None	None	Medium	High	None	Medium	Low^
Bridge	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Low	None
Mobility*	Low	Low	Low	Low	Low	Low	Low	Low	High	Low	Low	Low	Low	Low	Low	High	Low
Safety*	High	Low	High	High	Medium	High	N/A#	Low	N/A	Low	N/A	High	N/A	N/A	High	N/A	N/A
Freight*	Low	Low	High	High	High	High	Low	High	High	High	High	High	High	N/A	N/A	Medium	High
Average Need (0-3)	**1.31**	**0.69**	**1.77**	**1.77**	**1.38**	**1.62**	**0.60**	**1.15**	**1.80**	**1.15**	**1.20**	**1.62**	**1.60**	**1.29**	**1.20**	**2.10**	**1.40**

Level of Need	Average Need Range
None+	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

* Identified as Emphasis Areas for SR 87/SR 260/SR 377 Corridor
^ 40B-17 Pavement Need estimated based on field review
# N/A indicates insufficient or no data available to determine level of need
+ A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study

Figure 7: Needs Summary



SR 87/SR 260/SR 377 Corridor Segments

Segment 87-1: Loop 202 to Gilbert Rd (MP 177 - 182)
Segment 87-2: Gilbert Rd to Ft McDowell Rd (MP 182 - 191)
Segment 87-3: Ft McDowell Rd to Sycamore Creek (MP 191 - 213)
Segment 87-4: Sycamore Creek to SR 188 (MP 213 - 235)
Segment 87-5: SR 188 to Rye (MP 235 - 241)
Segment 87-6: Rye to Payson Area (MP 241 - 250)
Segment 87-7: Payson Area (MP 250 - 253)
Segment 260-8: Payson/Star Valley Area (MP 252 - 256)
Segment 260-9: Payson/Star Valley Area to FS 371 (MP 256 - 260)
Segment 260-10: FS 371 to Colcord Rd (MP 260 - 277)
Segment 260-11: Colcord Rd to Rim Rd (MP 277 - 282)
Segment 260-12: Rim Rd to Heber Area (MP 282 - 304)
Segment 260-13: Heber Area (MP 304 - 306)
Segment 277-14: Heber Area to SR 377 (MP 306 - 313)
Segment 377-15: SR 277 to SR 77 (MP 0 - 34)
Segment 77-16: SR 377 to Holbrook Area (MP 386 - 389)
Segment 40B-17: Holbrook Area to I-40 (MP 287 - 288)

Segment Number and Mileposts	87-1	87-2	87-3	87-4	87-5	87-6	87-7	260-8	260-9	260-10	260-11	260-12	260-13	277-14	377-15	77-16	40B-17
	MP 177-182	MP 182-191	MP 191-213	MP 213-235	MP 235-241	MP 241-250	MP 250-253	MP 252-256	MP 256-260	MP 260-277	MP 277-282	MP 282-304	MP 304-306	MP 306-313	MP 0-34	MP 386-389	MP 287-288
Average Need (0-3)	1.31	0.69	1.77	1.77	1.38	1.62	0.60	1.15	1.80	1.15	1.20	1.62	1.60	1.29	1.20	2.10	1.40

Miles
0 9 18

N

Corridor Segment
County Boundary
Interstate/Highway
City Boundary
High Need
Medium Need
Low Need

SR 87/SR 260/SR 377 Corridor Profile Study: Loop 202 to I-40
Needs Summary

9.0 CORRIDOR NEEDS (STEP 5)

Step 5 translates the performance-based needs into corridor needs that are "actionable". These needs can facilitate development of solutions (projects, initiatives, countermeasures, and programs) to improve corridor performance through strategic investments in preserving, modernizing, and/or expanding the corridor. Corridor needs were developed through a segment-by-segment review of needs and contributing factors. This review also identified overlapping, common, and contrasting needs across performance areas.

Figure 8 shows the corridor need locations for each performance area and programmed projects for fiscal year (FY) 2017-2021. Programmed projects have not yet been constructed and may address identified needs or be modified as part of the development of strategic investments.

For additional detail on specific needs by location, refer to the information in Step 3.

9.1 Description of Needs by Performance Area

Pavement Needs

The Pavement Performance Area is not an emphasis area for the SR 87/SR 260/SR 377 corridor. One of the 17 segments of the SR 87/SR 260/SR 377 corridor exhibits a high level of need in Pavement Performance: Segment 277-14. Two segments exhibit a medium level of need and four segments exhibit a low level of need. Segments with need levels include the following (with the level of need in parentheses):

- Segment 87-1 MP 177-182 (low)
- Segment 87-3 MP 191-213 (low)
- Segment 87-4 MP 213-235 (low)
- Segment 260-13 MP 304-306 (medium)
- Segment 277-14 MP 306-313 (high)
- Segment 77-16 MP 386-389 (medium)
- Segment 40B-17 MP 287-288 (low)

Pavement hot spot failure needs are listed below:

- Segment 87-1 MP 177-178 NB
- Segment 87-3 MP 195-199 SB
- Segment 87-3 MP 200-201 SB
- Segment 87-4 MP 225-226 NB/SB
- Segment 260-13 MP 304-305 NB
- Segment 277-14 MP 307-310 NB
- Segment 277-14 MP 311-313 NB
- Segment 77-16 MP 388-389 NB

One segment, Segment 40B-17, did not have pavement rating data but the level of need was estimated based on field observation. Only one segment of the SR 87/SR 260/SR 377 corridor has a high level of historical investment: Segment 87-6. There are no programmed pavement rehabilitation projects.

Bridge Needs

The Bridge Performance Area is not an emphasis area for the SR 87/SR 260/SR 377 corridor. One of the 17 segments of the SR 87/SR 260/SR 377 corridor exhibits a low level of need in Bridge Performance: Segment 77-16. No other segments exhibit bridge performance needs.

The identified need in Segment 77-16 is due to the Little Colorado River Bridge (Structure number 2030) at MP 388, which has a low sufficiency rating.

No bridges exhibit high levels of historical bridge maintenance investment for the SR 87/SR 260/SR 377 corridor.

Mobility Needs

The Mobility Performance Area is an emphasis area for SR 87/SR 260/SR 377. All 17 segments of the SR 87/SR 260/SR 377 corridor exhibit some level of need in Mobility Performance. There are two segments with high need levels. Segments with need levels include the following (with the level of need in parentheses):

- Segment 87-1 MP 177-182 (low)
- Segment 87-2 MP 182-191 (low)
- Segment 87-3 MP 191-213 (low)
- Segment 87-4 MP 213-235 (low)
- Segment 87-5 MP 235-241 (low)
- Segment 87-6 MP 241-250 (low)
- Segment 87-7 MP 250-253 (low)
- Segment 260-8 MP 252-256 (low)
- Segment 260-9 MP 256-260 (high)
- Segment 260-10 MP 260-277 (low)
- Segment 260-11 MP 277-282 (low)
- Segment 260-12 MP 282-304 (low)
- Segment 260-13 MP 304-306 (low)
- Segment 277-14 MP 306-313 (low)
- Segment 377-15 MP 0-34 (low)
- Segment 77-16 MP 386-389 (high)
- Segment 40B-17 MP 287-288 (low)

The percentage of closures on the SR 87/SR 260/SR 377 corridor due to incidents/accidents, obstructions/hazards, or weather is above the statewide average for the following segments:

- Segment 87-1 MP 177-182 (incidents/accidents)
- Segment 87-2 MP 182-191 (obstructions/hazards)
- Segment 87-3 MP 191-213 (obstructions/hazards)
- Segment 87-4 MP 213-235 (obstructions/hazards)
- Segment 87-5 MP 235-241 (obstructions/hazards)
- Segment 87-6 MP 241-250 (weather related)
- Segment 87-7 MP 250-253 (weather related)
- Segment 260-8 MP 252-256 (incidents/accidents)

- Segment 260-9 MP 256-260 (weather related)
- Segment 260-10 MP 260-277 (obstructions/hazards and weather related)
- Segment 260-11 MP 277-282 (weather related)
- Segment 260-12 MP 282-304 (weather related)
- Segment 260-13 MP 304-306 (weather related)
- Segment 277-14 MP 306-313 (obstructions/hazards)
- Segment 377-15 MP 0-34 (incidents/accidents)

A high PTI need indicates a low degree of trip reliability. This could be due in part to the aforementioned closures, operational constraints like an at-grade railroad crossing, lack of climbing/passing lanes, and slow traffic due to steep grade. The following segments have a high directional PTI:

- NB/EB Segments 87-3, 87-4, 87-6, 260-8, 260-9, 260-10, 260-11, 260-13, and 40B-17
- SB/WB Segments 87-5, 87-6, 87-7, 260-13, 77-16, and 40B-17

Safety Needs

The Safety Performance Area is an emphasis area for SR 87/SR 260/SR 377. Ten of 17 segments of the SR 87/SR 260/SR 377 corridor exhibit some level of need in Safety Performance while the other seven segments do not have an identified level of need due to insufficient data. Seven segments have either a medium or high level of need. Likely contributing factors are listed below for those segments with a medium or high level of need that have a large enough sample size to identify potential contributing factors.

- Segment 87-1 MP 177-182
  - Roadway departure
  - Driver inattention/distraction
  - Inadequate barrier between pedestrian and vehicle facilities
  - Shoulder/rumble strip condition
  - Inadequate lighting
  - Lack of crossing opportunity
  - Driving under the influence
- Segment 87-3 MP 191-213
  - Speed too fast for conditions
  - Driver inattention/distraction
  - Roadway department
  - Pavement surface condition
  - Improper lane changes
  - Shoulder/rumble strip condition
  - Clear zone slopes and obstructions
  - Slippery/wet pavement surface
- Segment 87-4 MP 213-235
  - Speed too fast for conditions
  - Driver inattention/distraction
  - Roadway departure
  - Pavement surface condition
  - Shoulder/rumble strip condition
  - Clear zone slopes and obstructions
  - Slippery/wet pavement surface
- Segment 87-6 MP 241-250
  - Speed too fast for conditions
  - Driver inattention/distraction
  - Roadway departure
  - Pavement surface condition
  - Shoulder/rumble strip condition
  - Clear zone slopes and obstructions
  - Slipper/wet pavement surface
  - Driving under the influence
- Segment 260-12 MP 282-304
  - Speed too fast for conditions
  - Driver inattention/distraction
  - Roadway departure
  - Inadequate roadway geometry
  - Pavement surface condition
  - Shoulder/rumble strip condition
  - Clear zone slopes and obstructions
  - Driving under the influence
- Segment 377-15 MP 0-34
  - Speed too fast for conditions
  - Driver inattention/distraction
  - Roadway departure
  - Pavement surface condition
  - Shoulder/rumble strip condition
  - Clear zone slopes and obstructions
  - Slippery/wet pavement surface
  - Driving under the influence
  - Lack of restraint usage

Freight Needs

The Freight Performance Area is an emphasis area for SR 87/SR 260/SR 377. Fifteen of 17 segments of the SR 87/SR 260/SR 377 corridor exhibit some level of need in Freight Performance while the other two segments do not have an identified level of need due to insufficient data. There are 12 segments with either a medium or high level of need.

The percentage of closures on the SR 87/SR 260/SR 377 corridor due to incidents/accidents, obstructions/hazards, or weather above the statewide average for the following segments:

- Segment 87-1 MP 177-182 (incidents/accidents)
- Segment 87-2 MP 182-191 (obstructions/hazards)
- Segment 87-3 MP 191-213 (obstructions/hazards)
- Segment 87-4 MP 213-235 (obstructions/hazards)
- Segment 87-5 MP 235-241 (obstructions/hazards)

- Segment 87-6 MP 241-250 (weather related)
- Segment 87-7 MP 250-253 (weather related)
- Segment 260-8 MP 252-256 (incidents/accidents)
- Segment 260-9 MP 256-260 (weather related)
- Segment 260-10 MP 260-277 (obstructions/hazards and weather related)
- Segment 260-11 MP 277-282 (weather related)
- Segment 260-12 MP 282-304 (weather related)
- Segment 260-13 MP 304-306 (weather related)
- Segment 277-14 MP 306-313 (obstructions/hazards)
- Segment 377-15 MP 0-34 (incidents/accidents)

A high TPTI indicates a low degree of trip reliability for trucks. This could be due in part to the aforementioned closures, operational constraints like an at-grade railroad crossing, lack of climbing/passing lanes, and slow traffic due to steep grades. The following segments have high directional TPTI:

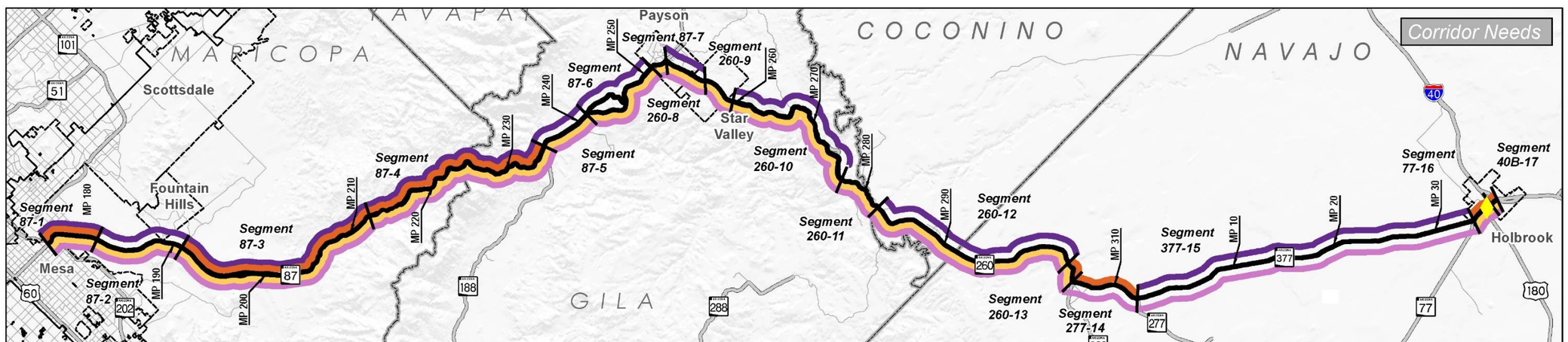
- NB/EB segments: 87-4, 87-6, 260-8, 260-9, 260-10, 260-11, 260-13, and 40B-17
- SB/WB segments: 87-3, 87-4, 87-5, 87-6, 260-10, 260-12, 260-13, and 40B-17

9.2 Overlapping Needs

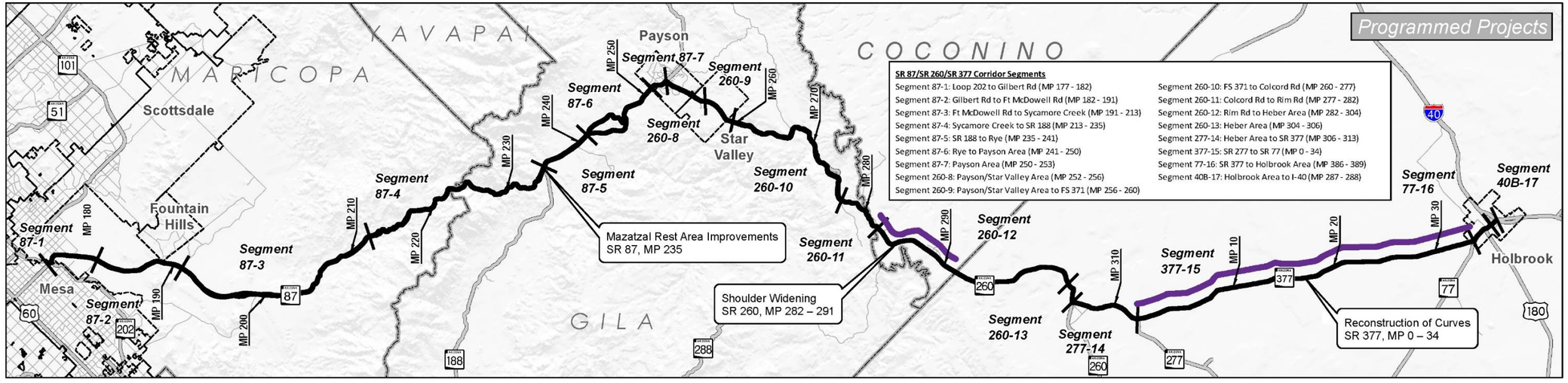
This section identifies overlapping performance needs on the SR 87/SR 260/SR 377 corridor, which provides guidance to develop strategic solutions that address more than one performance area. Completing projects that address multiple needs may present the opportunity for cost savings as well as more effectively improving overall performance. The map in **Figure 8** shows all levels of needs as well as programmed projects per the ADOT FY 2017-2021 Five Year Construction Program. Overlapping high needs are summarized below.

- Segment 260-9, MP 256-260 has overlapping high needs in Mobility and Freight performance areas.
- Segments 87-3, 87-4, 87-6, and 260-12 have overlapping high needs in Safety and Freight performance areas.

Figure 8: Summary of Needs and Programmed Projects



Segment Number and Mileposts	87-1	87-2	87-3	87-4	87-5	87-6	87-7	260-8	260-9	260-10	260-11	260-12	260-13	277-14	377-15	77-16	40B-17
	MP 177-182	MP 182-191	MP 191-213	MP 213-235	MP 235-241	MP 241-250	MP 250-253	MP 252-256	MP 256-260	MP 260-277	MP 277-282	MP 282-304	MP 304-306	MP 306-313	MP 0-34	MP 386-389	MP 287-288
Average Need (0-3)	1.31	0.69	1.77	1.77	1.38	1.62	0.60	1.15	1.80	1.15	1.20	1.62	1.60	1.29	1.20	2.10	1.40



Corridor Segment
County Boundary
Interstate/Highway
City Boundary

Needs Symbology
Safety
Pavement
Freight
Mobility

Bridge

Level of Need	Average Need
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

SR 87/SR 260/SR 377 Corridor Profile Study: Loop 202 to I-40
Summary of Needs and Programmed Projects (FY 2017-2021)

10.0 NEXT STEPS

The principal objective of the corridor profile study is to identify strategic solutions (investments) that are performance-based to ensure that available funds maximize the performance of the State's most strategic transportation corridors.

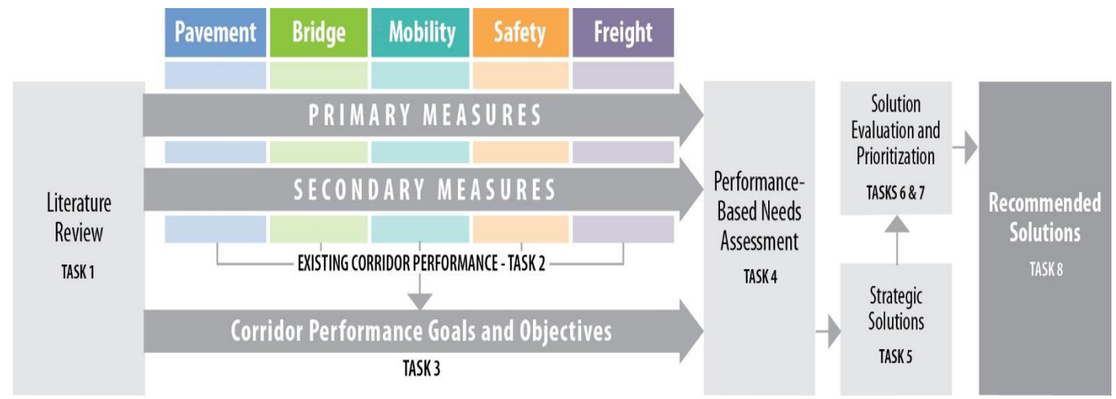
The actionable performance needs documented in Working Paper 4 will serve as a foundation for developing strategic investments for corridor preservation, modernization, and expansion. Strategic investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various candidate projects are developed for consideration in programming in the Planning to Programming (P2P) Link process. Rather, strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic investments will be considered along with other candidate projects in the ADOT programming process.

Illustrative examples of strategic investments are:

- *Projects that address significant performance needs.* Projects that address a medium or high performance need identified in the corridor profile study that have a high probability to significantly improve corridor performance may be identified as strategic investments. These projects may include a project in the current program, a planned project not in the current program, or a new project recommended in the corridor profile study.
- *Projects that address needs in multiple performance areas.* For example, a single project to rehabilitate the roadway pavement surface and multiple bridge decks on a segment of roadway would address multiple performance areas (Pavement and Bridge) and could result in significant cost savings in traffic control (as compared to traffic control costs for separate projects to rehabilitate pavement surface and bridge decks). Another example would be that a travel lane pavement rehabilitation project could be expanded to include shoulder rehabilitation and rumble strip construction to reduce road departure safety needs.
- *Projects that address repetitive issues.* For example, if there is a history of high levels of maintenance activities at a particular bridge or segment of pavement, there may be an underlying need that, if addressed properly, will reduce the need for future maintenance. Higher-cost strategic capital investments to correct repetitive maintenance issues can result in life cycle cost savings by reducing maintenance costs over time.
- *Phased projects that achieve a long-term improvement objective.* For example, a life cycle cost analysis may recommend total pavement reconstruction to address a subgrade failure, however the cost of reconstruction may not be feasible from a funding perspective. A strategic investment may be recommended to extend the life of the current pavement infrastructure until funding availability allows for full pavement reconstruction.
- *Projects that utilize innovative solutions to extend the operational life of infrastructure or improve performance.* Innovative solutions that modernize a segment of roadway may be identified as strategic investments. Examples of modernization activities include widening of shoulders, access control, replacement/enhancement of infrastructure to address obsolescence, hazard elimination, and the application of various traffic control and management technologies to improve traffic flow at a lower cost than traditional expansion solutions.

Strategic investments will be developed in Task 5 of the corridor profile study to address specific performance needs on the SR 87/SR 260/SR 377 corridor. In addition, meetings will be conducted with ADOT staff to discuss alternatives for addressing infrastructure performance needs that can be evaluated through a systematic analysis of life cycle costs and risks in Tasks 6 and 7. **Figure 9** shows the tasks in the Corridor Profile Study process.

Figure 9: Corridor Profile Study Process



APPENDIX A: METHODOLOGIES FOR DETERMINING PERFORMANCE AREA NEEDS (STEPS 1-3)

Pavement Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Pavement Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the existing performance score for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Pavement. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure. If pavement data is not available, put "No Data" as the performance score and color the cell gray.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template. If pavement data is not available, put "N/A" as the level of need and color the cell gray.

To develop an aggregate Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5). The Initial Need should be "N/A" (cell colored gray) if the Pavement Index is "N/A". If secondary measures are "N/A" they should be excluded from the calculation of the Initial Need.

The steps include:

Step 1.1

Enter the appropriate segment information into the columns titled "Segment", "Segment Length", "Segment Mileposts" and "Facility Type".

Step 1.2

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2/WP 2 into the appropriate "Performance Score" columns. Copy the performance score for each segment to the appropriate "Performance Score" column. Paste only the "values" and do not overwrite the formatting.

Step 1.3

Indicate if Pavement is an Emphasis Area by selecting "Yes" or "No" in the row immediately below the segment information.

Step 1.4

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the segment information and the initial needs from the Step 1 template to the "Initial Need" column of the Step 2 template.

Step 2.2

Note in the "Hot Spots" column any pavement failure hot spots identified as part of the baseline corridor performance. For each entry, include the milepost limits of the hot spot. Hot spots are identified in the Pavement Index spreadsheet by the red cells in the columns titled "% Pavement Failure". These locations are based on the following criteria:

Interstates: IRI > 105 or Cracking > 15

Non-Interstates: IRI > 142 or Cracking > 15

Every segment that has a % Pavement Failure greater than 0% will have at least one hot spot. Hot spot locations should be described as extending over consecutive miles. For example, if there is a pavement failure location that extends 5 consecutive miles, it should be identified as one hot spot, not 5 separate hot spots.

Step 2.3

Identify recently completed or under construction paving projects in the "Previous Projects" column. Include only projects that were completed after the pavement condition data period (check dates in pavement condition data provided by ADOT) that would supersede the results of the performance system.

Step 2.5

Update the "Final Need" column using the following criteria:

- If "None" but have a hot spot (or hot spots), the Final Need = Low, and note the reason for the change in the “Comments” column (column H).
- If a recent project has superseded the performance rating data, change the Final Need to “None” and note the reason for the change in the “Comments” column.
- If pavement rating data is not available but a field review can provide an estimated level of need based on visual observation of pavement condition, change the Final Need to reflect the field observation and note the reason for the change in the comments section.

Example Scales for Level of Need

Performance Thresholds		Initial Need	Description
3.75		None	All levels of Good and top 1/3 of Fair (>3.57)
		Low	Middle 1/3rd of Fair Perf. (3.38 - 3.57)
3.2		Medium	Lower 1/3rd of Fair and top 1/3rd of Poor Performance (3.02-3.38)
		High	Lower 2/3rd of Poor Performance (<3.02)

Need Scale for Interstates

Measure	None >=	Low >=	> Medium <		High <=
Pavement Index (corridor non-emphasis area)	3.57	3.38	3.38	3.02	3.02
Pavement Index (corridor emphasis area)	3.93	3.57	3.57	3.20	3.20
Pavement Index (segments)	3.57	3.38	3.38	3.02	3.02
Directional PSR	3.57	3.38	3.38	3.02	3.02
%Pavement Failure	10%	15%	15%	25%	25%

Need Scale for Highways (Non-Interstates)

Measure	None >=	Low >=	> Medium <		High <=
Pavement Index (corridor non-emphasis area)	3.30	3.10	3.10	2.70	2.70
Pavement Index (corridor emphasis area)	3.70	3.30	3.30	2.90	2.90
Pavement Index (segments)	3.30	3.10	3.10	2.70	2.70
Directional PSR	3.30	3.10	3.10	2.70	2.70
%Pavement Failure	10%	15%	15%	25%	25%

Step 2.6

Note any programmed projects that could have the potential to mitigate pavement needs in in the “Comments” column. Programmed projects are provided as information and do not impact the need rating. The program information can be found in ADOT’s 5-year construction program. If there are other comments relevant to the needs analysis (such as information from previous reports), they can be entered in the “Comments” column. However, only include information related to needs that have been identified through this process. Do not add or create needs from other sources.

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab. The steps to complete Step 3 include:

Step 3.1

Input the level of historical investment for each segment. This will be determined from the numeric score from the Pavement History Table based on the following thresholds:

- Low = < 4.60
- Medium = 4.60 – 6.60
- High = > 6.60

If the PeCoS data shows a high level of maintenance investment, increase the historical investment rating by one level.

Step 3.2

Note the milepost ranges of pavement failure hot spots into the column titled “Contributing Factors and Comments.”

Step 3.3

Note any other information that may be contributing to the deficiency, or supplemental information, in the “Contributing Factors and Comments” column. This could come from discussions with ADOT District staff, ADOT Materials/Pavement Group, previous reports, or the historical investment data.

Step 3.4

Include any programmed projects from ADOT’s 5-year construction program in the “Contributing Factors and Comments” column.

Bridge Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Bridge Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the existing performance score for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Bridge. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure. If bridge data is not available, put "No Data" as the performance score and color the cell gray. If no bridges exist on a segment, put "No Bridges" as the performance score and color the cell white.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template. If bridge data is not available, put "N/A" as the level of need and color the cell gray. If there are no bridges in a segment, put "None" as the level of need and color the cell white.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial level of need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5). The Initial Need should be "N/A" (cell colored gray) if the Bridge Index is "N/A". If secondary measures are "N/A", they should be excluded from the calculation of the Initial Need.

The steps include:

Step 1.1

Enter the appropriate segment information into the columns titled "Segment", "Segment Length", "Segment Mileposts" and "Number of Bridges".

Step 1.2

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2/WP 2 into the appropriate "Performance Score" columns. Copy the performance score for each segment to the appropriate "Performance Score" column. Paste only the "values" and do not overwrite the formatting.

Step 1.3

Indicate if Bridge is an Emphasis Area by selecting "Yes" or "No" in the row immediately below the segment information.

Step 1.4

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2 .The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial needs from the Step 1 template to the "Initial Need" column of the Step 2 template.

Step 2.2

Note in the column titled "Hot Spots" any bridge hot spots identified as part of the baseline corridor performance. For each entry, note the specific location. Hot spots are identified as having any bridge rating of 4 or less, or multiple ratings of 5 in the deck, substructure, or superstructure ratings.

Step 2.3

Identify recently completed or under construction bridge projects in the "Previous Projects" column. Include only projects that were completed after the bridge condition data period (check dates in bridge condition data provided by ADOT) that would supersede the results of the performance system.

Step 2.4

Update the Final Need on each segment based on the following criteria:

- If the Initial Need is "None" and there is at least one hot spot located on the segment, change the Final Need to "Low".

- If a recent project has superseded the performance rating data, the performance data should be adjusted to increase the specific ratings and the resulting need should be reduced to account for the project.
- If bridge rating data is not available but a field review can provide an estimated level of need based on visual observation of bridge condition, change the Final Need to reflect the field observation.
- Note the reason for any change in the "Comments" column.

Step 2.5

Historical bridge rating data was tabulated and graphed to find any bridges that had fluctuations in the ratings. Note in the "Historical Review" column any bridge that was identified as having a potential historical rating concern based on the following criteria:

- Ratings increase or decrease (bar chart) more than 2 times
- Sufficiency rating drops more than 20 points

This is for information only and does not affect the level of need.

Step 2.6

Note the number of functionally obsolete bridges in each segment in the column titled "# Functionally Obsolete Bridges". This is for information only and does not affect the level of need.

Step 2.7

Identify each bridge "of concern" in the "Comments" column. Note any programmed projects that could have the potential to mitigate bridge needs. Programmed projects are provided as information and do not impact the need rating. The program information can be found in ADOT's 5-year construction program. If there are other comments relevant to the needs analysis (such as information from previous reports), they can be entered in the "Comments" column. However, only include information related to needs that have been identified through this process. Do not add or create needs from other sources.

Example Scales for Level of Need

Bridge Index Performance Thresholds	Level of Need		Description
6.5	Good	None	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
	Fair		
	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
5.0	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

Need Scale

Measure	None >=	Low >=	> Medium <		High <=
Bridge Index (corridor non-emphasis area)	6.0	5.5	5.5	4.5	4.5
Bridge Index (corridor emphasis area)	7.0	6.0	6.0	5.0	5.0
Bridge Index (segments)	6.0	5.5	5.5	4.5	4.5
Bridge Sufficiency	70	60	60	40	40
Bridge Rating	6.0	5.0	4.0	4.0	3.0
%Functionally Obsolete Bridges	21.0%	31.0%	31.0%	49.0%	49.0%

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab. The steps to compete Step 3 include:

Step 3.1

Input the bridge name, structure number, and milepost information for each bridge "of concern" resulting from Step 2.

Step 3.2

For bridges that have a current rating of 5 or less, enter the specific rating, or state "No current ratings less than 6".

Step 3.3

For bridges that were identified for a historical review (step 2.5), state "Could have a repetitive investment issue". If a bridge was not identified for a historical review, state "This structure was not identified in historical review".

Step 3.4

Input any programmed projects from ADOT's 5-year construction program. Note any other information that may be contributing to the deficiency, or supplemental information. This could come from discussions with ADOT District staff, ADOT Bridge Group, or previous reports.

Mobility Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Mobility Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Refined Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the existing performance score for each segment to the appropriate "Performance Score" columns from Task 2/Working Paper 2. This includes the primary and secondary measures for Mobility. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure. If mobility data is not available, put "No Data" as the performance score and color the cell gray.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" in the Step 1 tab. If mobility data is not available, put "N/A" as the level of need and color the cell gray.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scores, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5). The Initial Need should be "N/A" (cell colored gray) if the Mobility Index is "N/A". If secondary measures are "N/A", they should be excluded from the calculation of the Initial Need.

The steps include:

Step 1.1

Input the accurate number of segments for your corridor in the column titled 'Segment' and the appropriate segment milepost limits and segment lengths in adjacent columns.

Step 1.2

Select the appropriate 'Environment Type' and 'Facility Operation Type' from the drop down menus as defined in Task 2 - Existing Performance Analysis.

Step 1.3

Select 'Yes' or 'No' form the drop down list to not if the Mobility Performance Area is an Emphasis Area for your corridor.

Step 1.4

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2/Working Paper 2. Copy the performance score for each segment to the appropriate "Performance Score" column.

Step 1.5

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2 The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial deficiencies from the Step 1 template to the Step 2 template.

Step 2.2

Identify recently completed or under construction projects that would be considered relevant to mobility performance. Include only projects that were constructed after 2014 for which the 2014 HPMS data used for traffic volumes would not include. Any completed or under construction roadway project after 2014 that has the potential to mitigate a mobility issue on a corridor segment should be listed in the template. Such projects should include the construction of new travel lanes or speed limit changes on the main corridor only. Do not include projects involving frontage roads or crossings as they would not impact the corridor level performance.

Step 2.3

Update the Final Need using the following criteria:

- If a recent project has superseded the performance rating data and it is certain the project addressed the deficiency, change the need rating to "None".
- If a recent project has superseded the performance rating data but it is uncertain that a project addressed the need, maintain the current deficiency rating and note the uncertainty as a comment.

Step 2.4

Note any programmed or planned projects that have the potential to mitigate any mobility needy on the segment. Programmed and Planned projects are provided as information and do not impact the deficiency rating. Future projects will be reviewed in the development of solution sets for identified needs and deficiencies. The source of future projects can be found in ADOT's 5-year construction program or other planning documents. Other comments relevant to the needs analysis can be entered.

Example Scales for Level of Need

Performance Thresholds	Initial Need		Description
0.71		None	All levels of Good and top 1/3 of Fair (<0.77)
		Low	Middle 1/3rd of Fair Perf. (0.77 - 0.83)
0.89		Medium	Lower 1/3rd of Fair and top 1/3rd of Poor Performance (0.83-0.95)
		High	Lower 2/3rd of Poor Performance (>0.95)

Needs Scale

Measure		None <=	Low >=	> Medium <		High <=
Mobility Index (Corridor Emphasis Area)		Weighted calculation for the segment totals in corridor (urban vs. rural)				
Mobility Index (Corridor Non-Emphasis Area)		Weighted calculation for the segment totals in corridor (urban vs. rural)				
Mobility Index (Segment)	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Future Daily V/C	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Existing Peak hour V/C	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Closure Extent		0.35	0.49	0.49	0.75	0.75
Directional TTI	Uninterrupted	1.21	1.27	1.27	1.39	1.39
	Interrupted	1.53	1.77	1.77	2.23	2.23
Directional PTI	Uninterrupted	1.37	1.43	1.43	1.57	1.57
	Interrupted	4.00	5.00	5.00	7.00	7.00
Bicycle Accommodation		80%	70%	70%	50%	50%

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab. The steps to compete Step 3 include:

Step 3.1

Input data from Mobility Index worksheet and corridor observations in appropriate columns for Roadway Variables.

Step 3.2

Input traffic variable data in appropriate columns as indicated, Buffer Index scores will auto populate.

Step 3.3

Input relevant mobility related infrastructure located within each segment as appropriate

Step 3.4

Input the Closure Extents that have occurred along the study corridor. Road closure information can be detailed out by the reason for the closure as documented in Highway Condition Reporting System (HCRS) data analyzed as part of the baseline corridor performance. Closure reasons include incident/accidents, winter storms, obstruction hazards, and undefined closures. Statewide average percentages for the various closure reasons have been calculated for 2009-2013 on ADOT's 11 designated strategic corridors. Compare these statewide average percentages to the corridor percentages for the various closure reasons to identify higher than average percentages of one or more closure reasons on any given segment. Input the closures as follows and use red text to indicate that the segment percentage exceeds statewide averages:

- Total Number of Closures
- % Incidents/Accidents
- % Obstructions/Hazards
- % Weather Related

Step 3.5

List the non-actionable conditions that are present within each segment by milepost if possible. Non-Actionable conditions are conditions that exist within the environment of each segment that cannot be improved through an engineered solution. For example, the border patrol check point in Segment 3 of I-19 is a non-actionable condition.

Step 3.6

Considering all information input, identify and list the contributing factors to the Final Need score.

Safety Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Safety Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the corridor characteristics and existing performance score for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for safety. As each performance score is input into the template, the Level of Need will populate based on the weighted scoring system for each measure. If safety data is not available, put "No Data" as the performance score and color the cell gray.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Scale" within the Step 1 template. If safety data is not available, put "N/A" as the level of need and color the cell gray.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5). The Initial Need should be "N/A" (cell colored gray) if the Safety Index is "N/A". If secondary measures are "N/A" they should be excluded from the calculation of Initial Need.

The steps include:

Step 1.1

Populate the Step 1 template with the corridor characteristics information. This includes segment operating environments and segment length. Also specify if the safety performance area is an emphasis area as determined in Task 3. The "Level of Need" is dependent on the input of the operating environment and "Emphasis Area" as the thresholds dynamically update accordingly.

Input the existing (baseline) performance scores for all primary and secondary performance measures from Task 2. Copy the performance score (paste values only) for each segment to the appropriate "Performance Score" column and conditional formatting should color each cell green, yellow, or red based on the corresponding performance thresholds.

Step 1.2

The thresholds for the corridor safety index are based on the segments' operating environments. To ensure that the correct corridor safety index threshold are applied, input the unique segment operating environments that exist with the corridor. Once the input is complete, the average of the Good/Fair and Fair/Poor thresholds for each of the operating environments is calculated and the "Level of Need" thresholds will be derived and applied to the main Step 1 Table.

Step 1.3

Confirm that the following criteria for "Insufficient Data" has been applied to the Safety Index and that the resulting Level of Need has been shown as "N/A" where applicable and cell colored gray. If the Safety Index is determined to have "Insufficient Data", the Directional Safety Index should also say "Insufficient Data".

- Crash frequency for a segment is less than 5 crashes over the 5-year crash analysis period; and
- The change in +/- 1 crash results in the change of need level of 2 levels (i.e., changes from Good to Poor or changes from Poor to Good)

Confirm that the following criteria for "Insufficient Data" has been applied to all other secondary safety performance measures and that the resulting Level of Need has been shown as "N/A" where applicable and cell colored gray.

- Crash frequency for a segment is less than 5 crashes over the 5-year crash analysis period; or
- The change in +/- 1 crash results in the change of need level of 2 levels (i.e., changes from Good to Poor or changes from Poor to Good); or
- The average segment crash frequency for the overall corridor (total fatal plus incapacitating injury crash frequency divided by the number of corridor segments) is less than 2 per segment over the 5-year crash analysis period.

Step 1.4

Confirm that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial needs from the Step 1 template to the Step 2 template**.**

Step 2.2

Using the crash concentration (hot spot) map developed as part of the baseline corridor performance, note the direction of travel and approximate milepost limits of each hot spot.

Step 2.3

Identify recently completed or under construction projects that would be considered relevant to safety performance. Include only projects that were not taken into account during the crash data analysis period (2010 – 2014). Any completed or under construction roadway project after 2014 that has the potential to mitigate a safety issue on a corridor segment should be listed in the template. Sources of recent or current project activity can include ADOT MPD staff, ADOT public notices, and ADOT District staff.

Step 2.4

Update the Final Need based on the following criteria:

- If there is a crash hot spot concentration on a “None” segment, upgrade the need rating to “Low”.

Step 2.5

Note any programmed projects that could have the potential to mitigate any safety need on the segment. Programmed projects are provided as information and do not impact the need rating. Programmed projects will be reviewed in the development of solution sets for identified needs. The source of the programming information can be found in ADOT’s 5-year construction program. Any other relevant issues identified in previous reports should also be reported.

Needs Scale

Measure	Similar Operating Environment	None <=	Low <=	< Medium >		High >=	Good/Fair Threshold	Fair/Poor Threshold
Corridor Safety Index (Emphasis Area)		Weighted average based on operating environment type						
Corridor Safety Index (Non-Emphasis Area)		Weighted average based on operating environment type						
Safety Index and Directional Safety Index (Segment)	2 or 3 Lane Undivided Highway	0.98	1.02	1.02	1.10	1.10	0.94	1.06
	2 or 3 or 4 Lane Divided Highway	0.92	1.07	1.07	1.38	1.38	0.77	1.23
	4 or 5 Lane Undivided Highway	0.93	1.06	1.06	1.33	1.33	0.80	1.20
	6 Lane Highway	0.85	1.14	1.14	1.73	1.73	0.56	1.44
	Rural 4 Lane Freeway with Daily Volume < 25,000	0.91	1.09	1.09	1.45	1.45	0.73	1.27
	Rural 4 Lane Freeway with Daily Volume > 25,000	0.89	1.10	1.10	1.53	1.53	0.68	1.32
	Urban 4 Lane Freeway	0.93	1.07	1.07	1.35	1.35	0.79	1.21
	Urban or Rural 6 Lane Freeway	0.94	1.06	1.06	1.30	1.30	0.82	1.18
	Urban > 6 Lane Freeway	0.93	1.06	1.06	1.33	1.33	0.80	1.20
% of Fatal + Incap. Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	2 or 3 Lane Undivided Highway	53%	55%	55%	59%	59%	51%	57%
	2 or 3 or 4 Lane Divided Highway	47%	50%	50%	57%	57%	44%	54%
	4 or 5 Lane Undivided Highway	45%	48%	48%	54%	54%	42%	51%
	6 Lane Highway	39%	43%	43%	50%	50%	35%	46%
	Rural 4 Lane Freeway with Daily Volume < 25,000	46%	49%	49%	56%	56%	43%	53%
	Rural 4 Lane Freeway with Daily Volume > 25,000	46%	51%	51%	62%	62%	41%	57%
	Urban 4 Lane Freeway	52%	55%	55%	62%	62%	49%	59%
	Urban or Rural 6 Lane Freeway	42%	50%	50%	65%	65%	34%	57%
	Urban > 6 Lane Freeway	47%	51%	51%	59%	59%	43%	55%
% of Fatal + Incap. Injury Crashes Involving Trucks	2 or 3 Lane Undivided Highway	6%	7%	7%	8%	8%	5%	7%
	2 or 3 or 4 Lane Divided Highway	5%	6%	6%	8%	8%	4%	7%
	4 or 5 Lane Undivided Highway	7%	8%	8%	11%	11%	6%	10%
	6 Lane Highway	3%	6%	6%	12%	12%	0%	9%
	Rural 4 Lane Freeway with Daily Volume < 25,000	14%	15%	15%	18%	18%	13%	17%
	Rural 4 Lane Freeway with Daily Volume > 25,000	9%	11%	11%	15%	15%	7%	13%
	Urban 4 Lane Freeway	8%	9%	9%	12%	12%	7%	11%
	Urban or Rural 6 Lane Freeway	8%	10%	10%	13%	13%	6%	11%
	Urban > 6 Lane Freeway	4%	5%	5%	7%	7%	3%	6%
% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	2 or 3 Lane Undivided Highway	22%	25%	25%	30%	30%	19%	27%
	2 or 3 or 4 Lane Divided Highway	19%	22%	22%	29%	29%	16%	26%
	4 or 5 Lane Undivided Highway	7%	8%	8%	10%	10%	6%	9%
	6 Lane Highway	7%	14%	14%	27%	27%	0%	20%
	Rural 4 Lane Freeway with Daily Volume < 25,000	6%	7%	7%	9%	9%	5%	8%
	Rural 4 Lane Freeway with Daily Volume > 25,000	11%	14%	14%	20%	20%	8%	17%
	Urban 4 Lane Freeway	10%	11%	11%	13%	13%	9%	12%
	Urban or Rural 6 Lane Freeway	9%	11%	11%	15%	15%	7%	13%
	Urban > 6 Lane Freeway	15%	17%	17%	22%	22%	13%	20%
% of Fatal _ Incapacitating Injury Crashes Involving Non-	2 or 3 Lane Undivided Highway	3%	4%	4%	5%	5%	2%	4%
	2 or 3 or 4 Lane Divided Highway	3%	4%	4%	5%	5%	2%	4%
	4 or 5 Lane Undivided Highway	6%	7%	7%	9%	9%	5%	8%
	6 Lane Highway	11%	14%	14%	20%	20%	8%	17%

Needs Scale

Measure	Similar Operating Environment	None <=	Low <=	< Medium >		High >=	Good/Fair Threshold	Fair/Poor Threshold
Motorized Travelers	Rural 4 Lane Freeway with Daily Volume < 25,000	2%	2%	2%	3%	3%	1.7%	2.5%
	Rural 4 Lane Freeway with Daily Volume > 25,000	0%	0%	0%	0%	0%	0%	0%
	Urban 4 Lane Freeway	7%	9%	9%	12%	12%	5%	10%
	Urban or Rural 6 Lane Freeway	3%	5%	5%	9%	9%	1%	7%
	Urban > 6 Lane Freeway	1%	1%	1%	2%	2%	0.5%	1.5%

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab.

Table 3 - Step 3 Template

A separate *Crash Summary Sheet* file contains summaries for 8 crash attributes for the entire corridor, for each corridor segment, and for statewide roadways with similar operating environments (the database of crashes on roadways with similar operating environments was developed in Task 2 (the baseline corridor performance)). The crash attribute summaries are consistent with the annual ADOT Publication, *Crash Facts*. The 8 crash attribute summaries consist of the following:

- First Harmful Event (FHET)
- Crash Type (CT)
- Violation or Behavior (VB)
- Lighting Condition (LC)
- Roadway Surface Type (RST)
- First Unit Event (FUE)
- Driver Physical Condition (Impairment)
- Safety Device Usage (Safety Device)

Non-colored tabs in this spreadsheet auto-populate with filtered crash attributes. Each tab is described below:

- **Step_3_Summary** – This tab contains the filtered summary of crashes that exceed statewide thresholds for crashes on roadways with similar operating environments. Data in this tab are copied into the Step 3 template.
- **Statewide** – This tab contains a summary of statewide crashes from roadways with similar operating environments filtered by the 8 crash type summaries listed above. The crash type summaries calculate statewide crash thresholds (% total for fatal plus incapacitating crashes). The crash thresholds were developed to provide a statewide expected proportion of crash attributes against which the corridor segments' crash attributes can be compared. The crash thresholds were developed using the *Probability of Specific Crash Types Exceeding a Threshold Proportion* as shown in the Highway Safety Manual, Volume 1 (2010). The thresholds are automatically calculated within the spreadsheet. The threshold proportion was calculated as follows:

$$p*_i = \frac{\sum N_{Observed,i}}{\sum N_{Observed,i(total)}}$$

Where:

$p*_i$ = Threshold proportion

$\sum N_{Observed,i}$ = Sum of observed target crash frequency within the population

$\sum N_{Observed,i(total)}$ = Sum of total observed crash frequency within the population

A minimum crash sample size of 5 crashes over the 5-year crash analysis period is required for a threshold exceedance to be displayed in the Step 3 template. The probability of exceeding the crash threshold was not calculated to simplify the process.

- **Corridor** – A summary of corridor-wide crashes filtered by the 8 crash attribute summaries listed above.
- **Segment FHET** – A segment-by-segment summary of crashes filtered by first harmful event attributes.
- **Segment CT** – A segment-by-segment summary of crashes filtered by crash type attributes.
- **Segment VB** - A segment-by-segment summary of crashes filtered by violation or behavior attributes.
- **Segment LC** – A segment-by-segment summary of crashes filtered by lighting condition attributes.
- **Segment RST** – A segment-by-segment summary of crashes filtered by roadway surface attributes.
- **Segment FUE** – A segment-by-segment summary of crashes filtered by first unit event attributes.
- **Segment Impairment** – A segment-by-segment summary of crashes filtered by driver physical condition attributes related to impairment.
- **Segment Safety Device** – A segment-by-segment summary of crashes filtered by safety device usage attributes.

The steps to compete Step 3 include:

Step 3.1

Using the Crash_Summary_Sheet.xlsx, go to the “Step_3_Summary” tab. Input the operating environments for each segment in the table.

Step 3.2

Filter data from the ADOT database for the “CORRIDOR_DATA” tab by inserting the following data in the appropriate columns that are highlighted in gray for the “INPUT_CORRIDOR_DATA” tab:

- Incident ID
- Incident Crossing Feature (MP)
- Segment Number (Non-native ADOT data – must be manually assigned based on the location of the crash)
- Operating Environment (Non-native ADOT data – should already be assigned but if for some reason it isn’t, it will need to be manually assigned)
- Incident Injury Severity
- Incident First Harmful Description
- Incident Collision Manner
- Incident Lighting Condition Description
- Unit Body Style
- Surface Condition
- First Unit Event Sequence
- Person Safety Equipment
- Personal Violation or Behavior
- Impairment

Note that columns highlighted in yellow perform a calculated input to aggregate specific crash descriptions. For example, crashes can contain various attributes for animal-involved crashes. The crash attributes that involve an animal were combined into a common attribute, such as “ANIMAL”. This will allow the summaries to be consistent with the ADOT *Crash Facts*.

The data in the Impairment category contains blank descriptions if it was found that there was “No Apparent Influence” or if it was “Unknown”. Using the crash data fields “PersonPhysicalDescription” 0 - 99, fill in the blank columns to reflect if the physical description is described as “No Apparent Influence” or “Unknown”. Note that the native physical description data from the ADOT database may need to be combined to a single column.

Step 3.3

Confirm that the crash database is being properly filtered by comparing crash frequencies from the summary tables with the frequencies developed in Task 2. For example, the lookup function will fail if the filter is for “NO IMPROPER ACTION” if the database has the attribute of “NO_IMPROPER_ACTION”.

Step 3.4

Copy and paste the Step_3_Summary into the Task 4 – Safety Needs Assessment spreadsheet in the Step 3 tab. Paste values only and remove the summaries with “0%s” for a clean display. Where duplicate values exist, go to the "Calcs" tab in the Crash_Summary_Sheet file to determine which categories have the same %. If there are more crash types with the same % than there is space in the table, select the crash type with the highest difference between the segment % and the statewide average %

Step 3.5

The Step 3 table in the Task 4 – Safety Needs Assessment spreadsheet should be similar to the Step 3 template. In the Segment Crash Summaries row, the top three crash attributes are displayed. Change the font color of the crash attributes that exceed the statewide crash threshold to red for emphasis. The attributes with a red font in the “Calcs” tab have exceeded statewide crash thresholds. Note that corridor-wide values are not compared to statewide values as corridor-wide values are typically a blend of multiple similar operating environments while the statewide values apply to one specific similar operating environment.

Step 3.6

Provide a summary of any observable patterns found within the crash Hot Spots, if any exist in the segments.

Step 3.7

Input any historic projects (going no further back than 2000) that can be related to improving safety. Projects more than five years old may have exceeded their respective design life and could be contributing factors to safety performance needs.

Step 3.8

Input key points from District interviews or any important information from past discussions with District staff that is consistent with needs and crash patterns identified as part of the performance and needs assessment as this may be useful in identifying contributing causes. This information may be obtained from District Maintenance personnel by requesting the mile post locations that may be considered safety issues.

Step 3.9

For segments with one or more of the following characteristics, review crashes of all severity levels (not just fatal and incapacitating injury crashes). Identify likely contributing factors and compare that to the above statewide average comparison findings already calculated for fatal and incapacitating injury crashes. Refine the contributing factors list accordingly.

- Segments with Medium or High need
- Segments with a crash hot spot concentration (but only review crashes at the concentration areas)

- Segments with no apparent predominant contributing factors based on the comparison of fatal and incapacitating crashes to statewide averages if the segment has a Medium or High need.

Step 3.10

Considering all information in Steps 1-3, list the contributing factors using engineering judgment and the information on contributing factors available in Section 6.2 of the 2010 Highway Safety Manual. Additional sources for determining contributing factors may include aerial, “streetview”, and/or ADOT photologs. Other documents such as Design Concept Reports (DCR) or Road Safety Assessments can provide insight into the study corridor’s contributing factors.

Add comments as needed on additional information related to contributing factors that may have been provided by input from ADOT staff.

Freight Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Freight Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the existing performance score and color for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Freight. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure. If freight data is not available, put "No Data" as the performance score and color the cell gray.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scale" within the Step 1 template. If freight data is not available, put "N/A" as the level of need and color the cell gray.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted score, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5). The Initial Need should be "N/A" (cell colored gray) if the Freight Index is "N/A". If secondary measures are "N/A", they should be excluded from the calculation of the Initial Need.

The steps include:

Step 1.1

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2. Copy the performance score for each segment to the appropriate "Performance Score" column. Select the *Facility Operations* for each segment from the drop-down list and input whether or not the performance area is an emphasis area. The corridor needs assessment scales will be updated automatically.

Step 1.2

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial need from the Step 1 template to the Step 2 template.

Step 2.2

Note any bridge vertical clearance restriction hot spots (clearance < 16.25' with no ramp around) identified as part of the baseline corridor performance. For each hot spot, note the milepost of the height restriction and the existing bridge clearance height.

Step 2.3

Identify recently completed or under construction projects that would be considered relevant to freight performance. Include only projects that were not taken into account during the freight data analysis period. Any completed or under construction roadway project after the date of the data that has the potential to mitigate a freight issue on a corridor segment should be listed in the template. Such projects can include the construction of climbing lanes or Dynamic Message Signs (DMS) installation. Sources of recent or current project activity can be ADOT MPD staff, ADOT public notices, and ADOT District staff.

Step 2.4

Update the Final Need using the following criteria:

- If there is one or more bridge vertical clearance restriction hot spots where a truck cannot ramp around on a 'None' segment, increase (i.e., worsen) the need rating to 'Low'.
- If a recent project has superseded the performance rating data and it is certain the project addressed the need, change the need rating to "None".
- If a recent project has superseded the performance rating data but it is uncertain that a project addressed the need, maintain the current need rating and note the uncertainty as a comment.

Step 2.5

Note any programmed projects that could have the potential to mitigate any freight need on the segment. Programmed projects are provided as information and do not impact the need rating. Programmed projects will be reviewed in the development of solution sets for identified needs. The

source of the programming information can be found in ADOT's 5-year construction program. If there are other comments relevant to the needs analysis, they can be entered in the right-most column.

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab.

The steps to compete Step 3 include:

Step 3.1

Input all roadway variable data that describe each segment into the appropriate columns. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Task 4.

Step 3.2

Input all traffic variables for each segment into the appropriate columns. The Buffer Index will auto populate based on the TPTI and TTTI input in the Step 1 tab. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Task 4.

Step 3.3

Input any freight-related infrastructure that currently exists on the corridor for each segment. The relevant infrastructure can include DMS locations, weigh stations, Ports of Entry (POE), rest areas, parking areas, and climbing lanes. Include the mileposts of the listed infrastructure. This data can be extracted from the most recent Highway Log and the 2015 Climbing and Passing Lane Prioritization Study.

Step 3.4

Input the Closure Extents that have occurred along the study corridor. Road closure information can be detailed out by the reason for the closure as documented in Highway Condition Reporting System (HCRS) data analyzed as part of the baseline corridor performance. Closure reasons include incident/accidents, winter storms, obstruction hazards, and undefined closures. Statewide average percentages for the various closure reasons have been calculated for the analysis period on ADOT's 11 designated strategic corridors. Compare these statewide average percentages to the corridor percentages for the various closure reasons to identify higher than average percentages of one or more closure reasons on any given segment. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Task 4. Input the closures as follows and use red text to indicate that the segment percentage exceeds statewide averages:

- Total Number of Closures
- % Closures (No Reason)
- % Incidents/Accidents
- % Obstructions/Hazards
- % Weather Related

Step 3.5

List the non-actionable conditions that are present within each segment by milepost if possible. Non-Actionable conditions are conditions that exist within the environment of each segment that cannot be improved through an engineered solution. Examples of Non-Actionable conditions can include border patrol check points and other closures/restrictions not controlled by ADOT. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Task 4.

Step 3.6

Input any programmed and planned projects or issues that have been identified from previous documents or studies that are relevant to the Final Need. Sources for this data include the current Highway Log, the 2015 Climbing and Passing Lane Prioritization Study, and ADOT's 5-year construction program.

Step 3.7

Considering all information in Steps 1-3, identify the contributing factors to the Final Need column. Potential contributing factors to freight performance needs include roadway vertical grade, number of lanes, traffic volume-to-capacity ratios, presence/lack of a climbing lanes, and road closures. Also identify higher than average percentages of one or more closure reasons on any given segment

Example Scales for Level of Need - Freight Index

Performance Thresholds	Performance Level	Initial Performance Level of Need	Description (Non-emphasis Area)
	Good	None	All levels of Good and the top third of Fair (>0.74)
	Good		
0.77	Good		
	Fair		
	Fair	Low	Middle third of Fair (0.70-0.74)
0.67	Fair	Medium	Lower third of Fair and top third of Poor (0.64-0.70)
	Poor		
	Poor	High	Lower two-thirds of Poor (<0.64)
	Poor		

Needs Scale

Measure	None >=	> Low <		> Medium <		High <=
Corridor Freight Index (Emphasis Area)	Dependent on weighted average of interrupted vs. uninterrupted segments					
Corridor Freight Index (Non-Emphasis Area)	Dependent on weighted average of interrupted vs. uninterrupted segments					
Freight Index (Segment)						
Measure	**None >=**	**> Low <**		**> Medium <**		**High <=**
Interrupted	0.28	0.28	0.22	0.22	0.12	0.12
Uninterrupted	0.74	0.74	0.70	0.70	0.64	0.64
Measure	**None <=**	**< Low >**		**< Medium >**		**High >=**
Directional TTI						
Interrupted	1.53	1.53	1.77	1.77	2.23	2.23
Uninterrupted	1.21	1.21	1.27	1.27	1.39	1.39
Directional PTI						
Interrupted	4.00	4.00	5.00	5.00	7.00	7.00
Uninterrupted	1.37	1.367	1.43	1.43	1.57	1.57
Closure Duration						
All Facility Operations	71.07	71.07	97.97	97.97	151.75	151.75
Measure	**None >=**	**> Low <**		**> Medium <**		**High <=**
Bridge Clearance (feet)						
All Bridges	16.33	16.33	16.17	16.17	15.83	15.83