FINAL REPORT

SR 347/SR 84 Corridor Profile Study Update

Junction I-8 to Junction I-10

PREPARED FOR ADOT APRIL 2023

ADOT WORK TASK NO.
MPD 0021-21

ADOT CONTRACT NO.
17-171963

PREPARED BY

Kimley»Horn

SR 347/SR 84 CORRIDOR PROFILE STUDY

SR 347: I-10 TO SR 84
SR 84: SR 347 TO I-8

ADOT WORK TASK NO. MPD0021-21 H80

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APRIL 2023

PREPARED FOR:

ARIZONA DEPARTMENT OF TRANSPORTATION

PREPARED BY:

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ACRONYMS & ABBREVIATIONS

AADT	Average Annual Daily Traffic
ADOT	Arizona Department of Transportation
ASLD	Arizona State Land Department
AZTDM	Arizona Travel Demand Model
BCA	Benefit-Cost Analysis
BLM	Bureau of Land Management
BQAZ	Building a Quality Arizona
CCTV	Closed Circuit Television
CDP	Census Designated Places
CR	Cracking Rating
CYMPO	Central Yavapai Metropolitan Planning Organization
DMS	Dynamic Message Sign
DCR	Design Concept Report
FMPO	Flagstaff Metropolitan Planning Organization
FY	Fiscal Year
HCRS	Highway Condition Reporting System
HPMS	Highway Performance Monitoring System
I-	Interstate
INRIX	Real-time traffic conditions database
IRI	International Roughness Index
ITS	Intelligent Transportation System
LCCA	Life-Cycle Cost Analysis
LOS	Level of Service
LOTTR	Level of Travel Time Reliability
LRTP	Long Range Transportation Plan
MAG	Maricopa Association of Governments
MAP 21	Moving Ahead for Progress in the 21st Century
MP	Milepost
MPD	Multimodal Planning Division
NACOG	Northern Arizona Council of Governments
NB	Northbound
NPV	Net Present Value
OP	Overpass
PES	Performance Effectiveness Score
P2P	Planning to Programming
PDI	Pavement Distress Index
PSR	Pavement Serviceability Rating
RTP	Regional Transportation Plan
SB	Southbound
STSP	Strategic Traffic Safety Plan
SR	State Route
TI	Traffic Interchange
TIP	Transportation Improvement Plan
TTTR	Truck Travel Time Reliability
UP	Underpass
USDOT	United States Department of Transportation
V/C	Volume to Capacity Ratio
VMT	Vehicle-Miles Traveled
WIM	Weigh-in-motion

Executive Summary

EXECUTIVE SUMMARY

INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of State Route 347 (SR 347) from Interstate 10 (I-10) to State Route 84 (SR 84) and SR 84 from SR 347 to Interstate 8 (I-8). Only the portion of SR 347 between Peters and Nall Road and SR 84 along with SR 84 from SR 347 to I-8 is the focus of this CPS update as the portion between I-10 and Peters and Nall Road was recently evaluated in the SR 347: I-10 to Peters and Nall Road Scoping Study prepared by the Maricopa Association of Governments (MAG) in 2022.

ADOT has completed 21 original CPS within four separate groupings or rounds. In 2020, ADOT separated the previously studied corridors into six groupings to be updated and reassessed: Northeast, Northcentral, Northwest, Southeast, Southcentral, and Southwest. The SR 347/SR 84 Corridor, depicted in **Figure ES-1** along with all CPS corridors, is one of the strategic statewide corridors identified and the subject of this CPS Update.

Corridor Study Purpose, Goals and Objectives

The purpose of the CPS 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 described below:

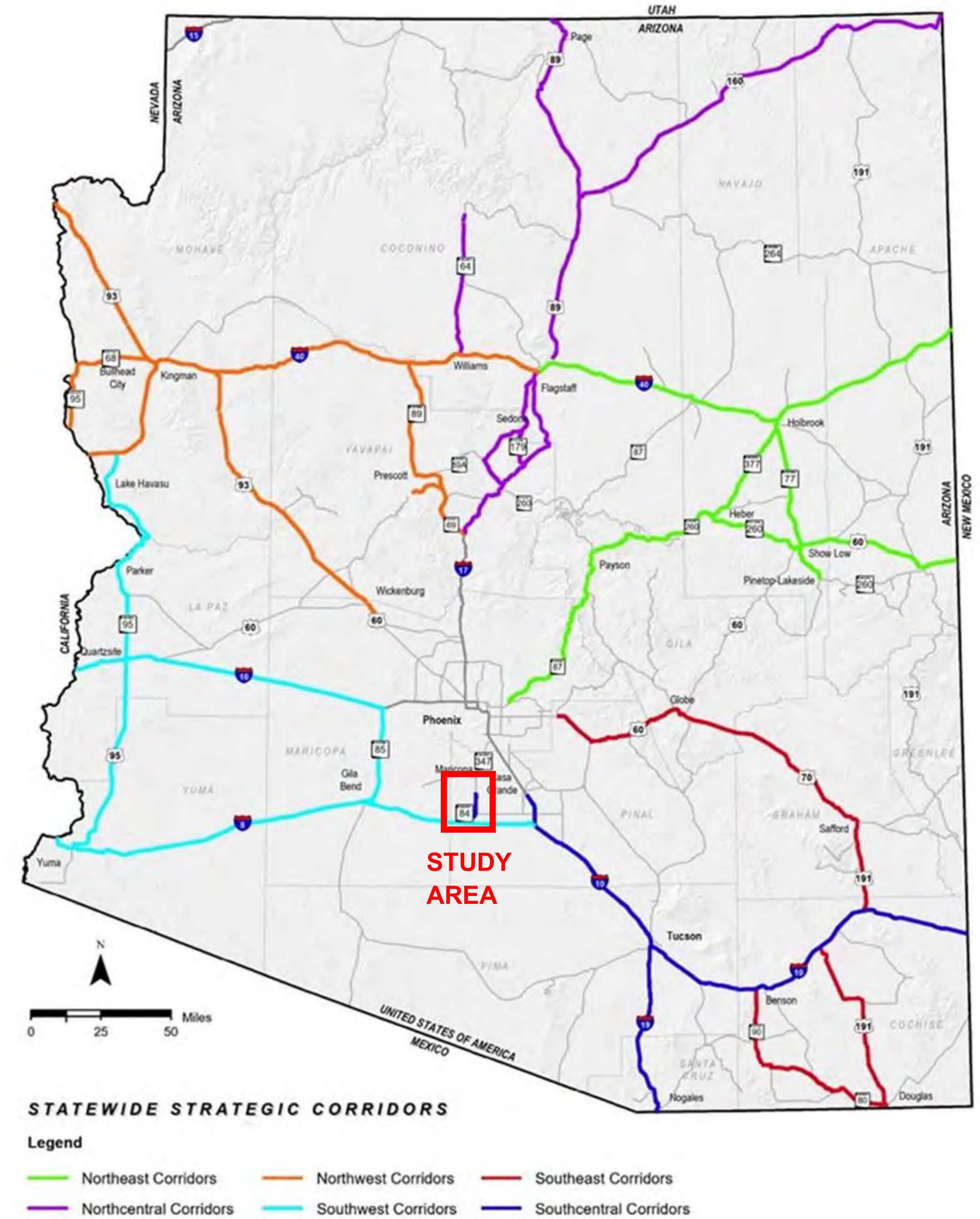
- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the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

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 347/SR 84 CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.

The following goals are 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

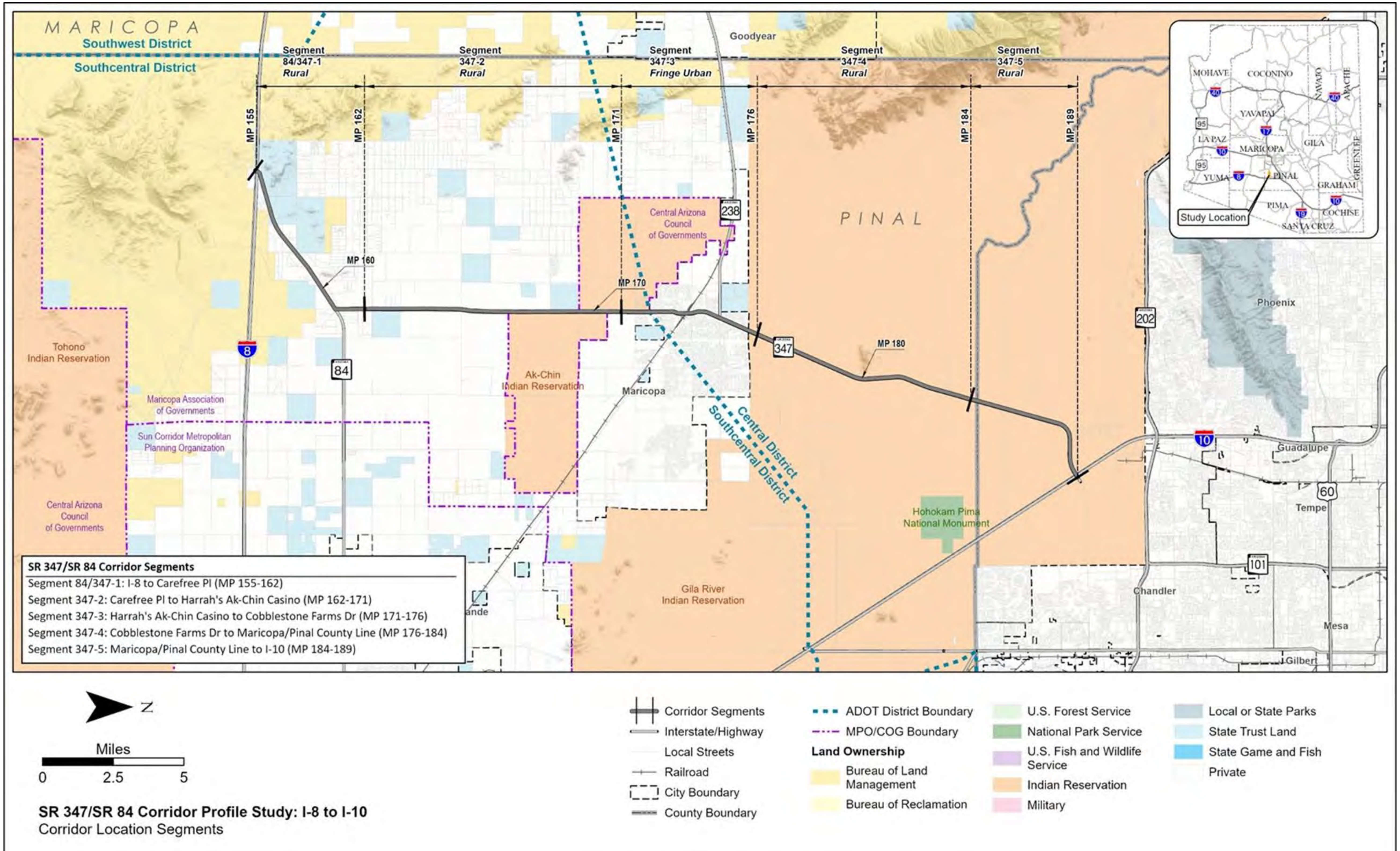
Figure ES-1: Corridor Study Area



Study Location and Corridor Segments

The SR 347/SR 84 Corridor is divided into 5 planning segments for analysis and evaluation. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are shown in **Figure ES- 2**.

Figure ES-2: Corridor Location and Segments



CORRIDOR PERFORMANCE

A series of performance measures is used to assess the SR 347/SR 84 Corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

Figure ES-3 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance.

Figure ES-3: Corridor Profile Performance Framework

The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance. **Table ES-1** provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table ES-1: Corridor Performance Measures

Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index, cracking, and rutting	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and suspected serious injury crashes	• Directional Safety Index • Strategic Traffic Safety Plan Emphasis Areas • Other Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck travel time reliability	• Travel Time Reliability • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

Each of the primary and secondary performance measures identified in the table above is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance – Rating is above the identified desirable/average range

Fair/Average Performance – Rating is within the identified desirable/average range

Poor/Below Average Performance – Rating is below the identified desirable/average range

The terms “good”, “fair”, and “poor” apply to the Pavement, Bridge, Mobility, and Freight performance measures, which have defined thresholds. The terms “above average”, “average”, and “below average” apply to the Safety performance measures, which have thresholds referenced to statewide averages.

Corridor Performance Summary

Table ES-2 shows a summary of corridor performance for all primary measures and secondary measure indicators for the SR 347/SR 84 Corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure. The following general observations were made related to the performance of the SR 347/ SR 84 Corridor:

- The Pavement performance measures generally show “poor” or “fair” performance; there are no bridges to evaluate within the corridor; the Mobility performance measures generally show “good” performance; the Safety performance measures show a mix of “above average” and “below average” performance; and the Freight performance measures had insufficient data to analyze the segments
- The weighted average of the Pavement Index shows “poor” overall performance for the SR 347/SR 84 Corridor; Segments 84/347-1 and 347-2 shows “poor” performance for % Area Failure and “good” performance for Directional PSR performance metrics
- There are no bridges on either Segment 84/347-1 or Segment 347-2
- The weighted average of the Mobility Index shows “good” overall performance for the SR 347/SR 84 Corridor; Segments 84/347-1 and 347-2 show “poor” performances for % Bicycle Accommodation
- The weighted average of the Safety Index shows “below average” overall performance for the SR 347/SR 84 Corridor; for the Directional Safety Index, Segment 84/347-1 shows “below average” performance in both directions
- The Freight Index has insufficient data to analyze the weighted average of the Freight Index
- Segments 84/347-1 and 347-2 show a mix of “good/above average”, “fair/average”, and “poor/below average” performance for the various performance measures

Table ES-2: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area				Bridge Performance Area			Mobility Performance Area									
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional LOTTR (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
			NB	SB							NB	SB	NB	SB	NB	SB		
84/347-1[2]	7	3.08	3.98	4.09	68.8%	No Bridges in Segment			0.18	0.24	0.08	0.09	0.17	0.03	No Data		12%	18.8%
347-2[2]	8	2.35	3.87	3.88	75.0%	No Bridges in Segment			0.12	0.18	0.04	0.05	0.18	0.05	No Data		14%	20.1%
Weighted Corridor Average		2.70	3.92	3.98	72.0%	N/A	N/A	N/A	0.15	0.21	0.06	0.17	0.17	0.04	No Data		13%	19.5%
SCALES																		
Performance Level		**Non-Interstate**				**All**			**Urban and Fringe Urban**				**All**		**All**		**All**	
Good/Above Average Performance		> 3.60	>3.50		< 5%	> 6.5	> 80	> 6	< 0.71				< 0.22		<1.15		> 90%	> 17%
Fair/Average Performance		2.80-3.60	2.90 - 3.50		5%- 20%	5.0 - 6.5	50 - 80	5 - 6	>0.71 - 0.89				0.22 - 0.62		1.15-1.50		60% - 90%	11% - 17%
Poor/Below Average Performance		< 2.80	< 2.90		> 20%	< 5.0	< 50	< 5	> 0.89				>0.62		>1.50		< 60%	< 11%
Performance Level		**Interstate**							**Rural**									
Good/Above Average Performance		> 3.75	>3.75		< 5%				< 0.56									
Fair/Average Performance		3.00-3.75	3.40 - 3.75		5%- 20%				>0.56 - 0.76									
Poor/Below Average Performance		< 3.00	< 3.40		> 20%				> 0.76									

[1]Urban Operating Environment
[2]Rural Operating Environment

Table ES-2: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area								Freight Performance Area					
		Safety Index	Directional Safety Index		% of Fatal + Suspected Serious Injury Crashes at Intersections	% of Fatal + Suspected Serious Injury Crashes Involving Lane Departures	% of Fatal + Suspected Serious Injury Crashes Involving Pedestrians	% of Segment Fatal + Suspected Serious Injury Crashes Involving Trucks	% of Segment Fatal + Suspected Serious Injury Crashes Involving Bicycles	Freight Index	Directional TTTR		Closure Duration (minutes/milepost/year)		Bridge Vertical Clearance (feet)
			NB	SB							NB	SB	NB	SB	
84/347-1 [a^]	7	3.24	2.26	4.22	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	No Data	No Data		26.85	6.86	No UP
347-2 [b*]	8	0.12	0.08	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	No Data	No Data		13.37	3.00	No UP
Weighted Corridor Average		1.62	1.13	2.11	0.00	0.00	0.00	0.00	0.00	N/A	N/A	N/A	19.83	19.83	4.85
SCALES		**SCALES**													
Performance Level		**2 or 3 or 4 Lane Divided Highway**								**Uninterrupted**			**All**		
Good/Above Average Performance		>0.81			<23.4%	<56.4%	<2.4%	<3.7%	<0.0%	< 1.15			< 44.18		> 16.5
Fair/Average Performance		0.81 - 1.19			23.4% - 29.3%	56.4% - 65.0%	2.4% - 3.6%	3.7% - 9.9%	0.0% - 2.2%	1.15 - 1.35			44.18-124.86		16.0 - 16.5
Poor/Below Average Performance		>1.19			>29.3%	>65.0%	>3.6%	>9.9%	>2.2%	> 1.35			> 124.86		< 16.0
Performance Level		**2 or 3 Lane Undivided Highway**								**Interrupted**					
Good/Above Average Performance		<0.92			<11.2%	<66.9%	<3.8%	<4.2%	<0.0%	<1.45					
Fair/Average Performance		0.92 - 1.08			11.2% - 15.6%	66.9% - 74.5%	3.8% -7.2%	4.2% -8.0%	0.0% - 3.3%	1.45-1.85					
Poor/Below Average Performance		>1.08			>15.6%	>74.5%	>7.2%	>8.0%	>3.3%	>1.85					

[a] 2 or 3 Lane Undivided Highway ^Uninterrupted Flow Facility

[b] 2 or 3 or 4 Lane Divided Highway *Interrupted Flow Facility

Note: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings

NEEDS ASSESSMENT

Corridor Description

The SR 347/SR 84 Corridor between I-10 and I-8 provides movement for agricultural, freight, commuting, recreation needs, and regional travel within Arizona. It provides a key link between the southern portion of the Phoenix metropolitan area and the southern region of the state and serves intrastate, interstate, and international commerce.

Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP) 2010-2035 goals and objectives that were updated in 2017. Statewide performance goals that are relevant to SR 347/SR 84 performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three "Emphasis Areas" were identified for the SR 347/SR 84 Corridor: Mobility, Safety, and Freight.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Addressing current and future congestion, thereby improving mobility on congested segments, will also help the corridor fulfill its potential as a significant contributor to the region's economy.

Needs Assessment Process

The performance-based needs assessment evaluates the difference between the baseline performance and the performance objectives for each of the five performance areas used to characterize the health of the corridor: Pavement, Bridge, Mobility, Safety, and Freight. The performance-based needs assessment process is illustrated in **Figure ES-4**.

The needs assessment compares baseline corridor performance with performance objectives to provide a starting point for the identification of 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 is shown in **Figure ES-5**.

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. A detailed review of available data helps identify contributing factors to the need and if there is a high level of historical investment.

Figure ES-4: Needs Assessment Process

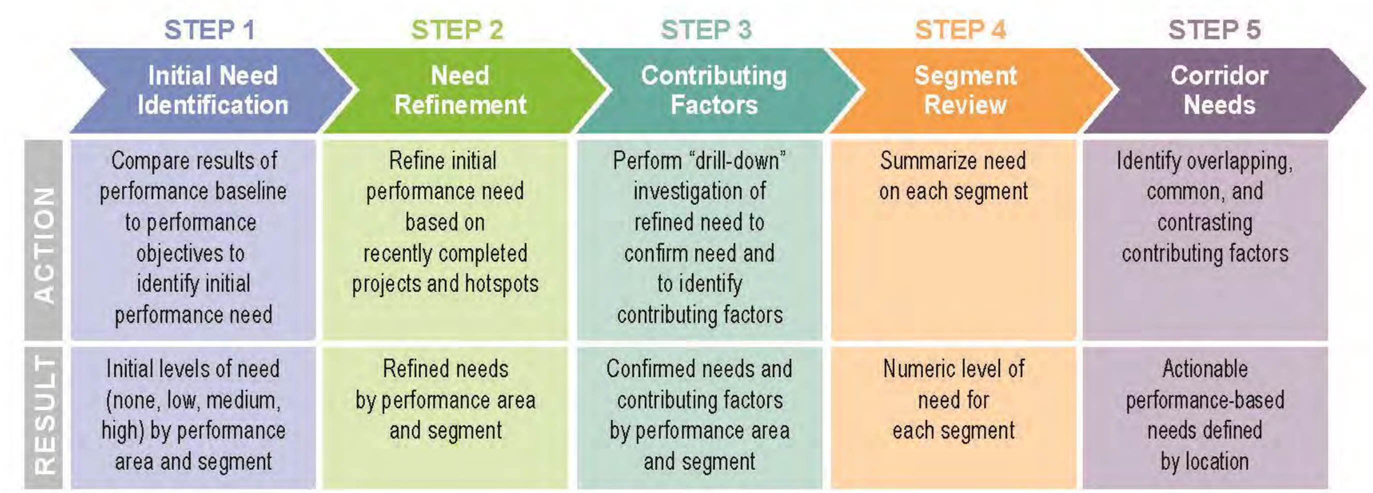


Figure ES-5: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

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

**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.*

Summary of Needs

Table ES-3 provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Mobility, Safety, and Freight for the SR 347/SR 84 Corridor). There is one segment with a Medium overall average need and one segment with a Low overall average need.

Pavement Needs

- Pavement hot spots were identified in Segments 84/347- 1 and 347-2
- Segment 84/347-1 shows a Medium level of need
- Segment 347-2 shows a High level of need

Bridge Needs

- There are no bridges and therefore no Bridge needs in Segments 84/347-1 and 347-2

Mobility Needs

- The Mobility performance area is an emphasis area for the SR 347/SR 84 Corridor
- Low Mobility needs were identified in Segments 84/347-1 and 347-2
- The identified needs are related to bicycle accommodations

Safety Needs

- The Safety performance area is an emphasis area for the SR 347/SR 84 Corridor
- A High Safety need was identified in Segment 84/347-1
- There were no Safety hot spots identified

Freight Needs

- The Freight performance area is an emphasis area for the SR 347/SR 84 Corridor
- Data was missing for the Freight Index and Directional TTTR but District input indicates there is no current Freight need in Segments 84/347-1 and 347-2
- There were no Freight hot spots identified
- There were no Freight needs that were identified in Segments 84/347-1 and 347-2

Overlapping Needs

This section identifies overlapping performance needs on the SR 347/SR 84 Corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to improve overall performance more effectively. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- Segment 84/347-1, which has the highest average need score of all the segments of the corridor, has elevated needs in the Safety and Pavement performance areas
- Segment 347-2 has elevated needs in the Pavement performance area

Table ES-3: Summary of Needs by Segment

Performance Area	Segment Number and Mileposts (MP)	
	84/347-1	347-2
	MP 155-162	MP 162-171
Pavement	Medium	High
Bridge	None	None
Mobility*	Low	Low
Safety*	High	None
Freight*	None	None
Average Need	**1.23**	**0.85**

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

* Identified as an Emphasis Area for the SR 347/SR 84 Corridor
# 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

STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need (i.e., Medium or High). Addressing areas of Medium or High need will have the greatest effect on corridor performance and are the focus of the strategic solutions. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The SR 347/SR 84 strategic investment areas (resulting from the elevated needs) are shown in **Figure ES-6**.

Screening Process

This section examines qualifying strategic needs and determines if the needs in those locations require action. In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures, including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment or rating issues; these hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need; this bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the SR 347/SR 84 Corridor will be considered along with other candidate projects in the ADOT statewide programming process.

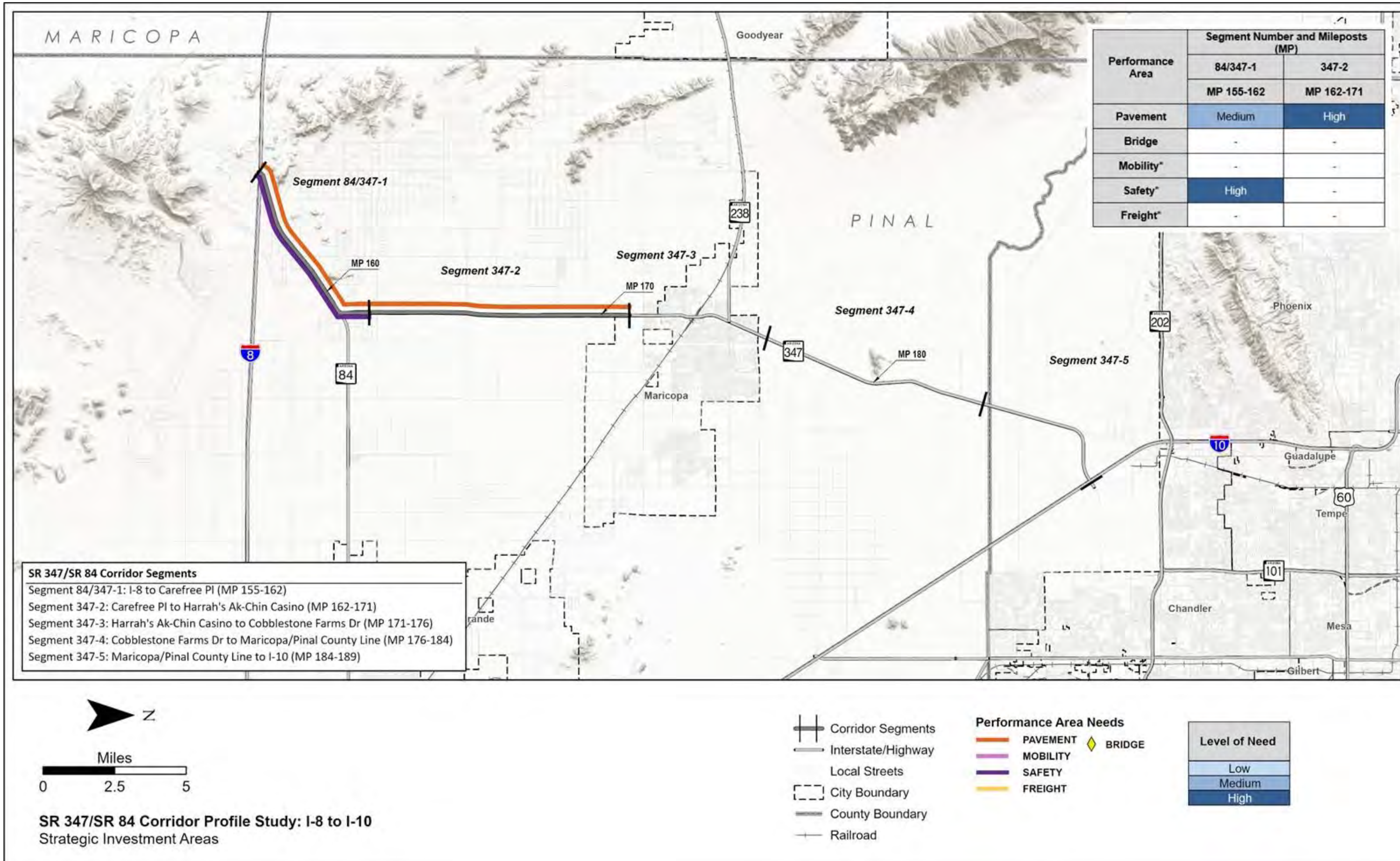
Candidate solutions should include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance area will include two options: rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

Figure ES-6: Strategic Investment Areas



Performance Area	Segment Number and Mileposts (MP)	
	84/347-1	347-2
	MP 155-162	MP 162-171
Pavement	Medium	High
Bridge	-	-
Mobility*	-	-
Safety*	High	-
Freight*	-	-

SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation are shown in **Figure ES-7** and described more fully below.

Life-Cycle Cost Analysis
All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

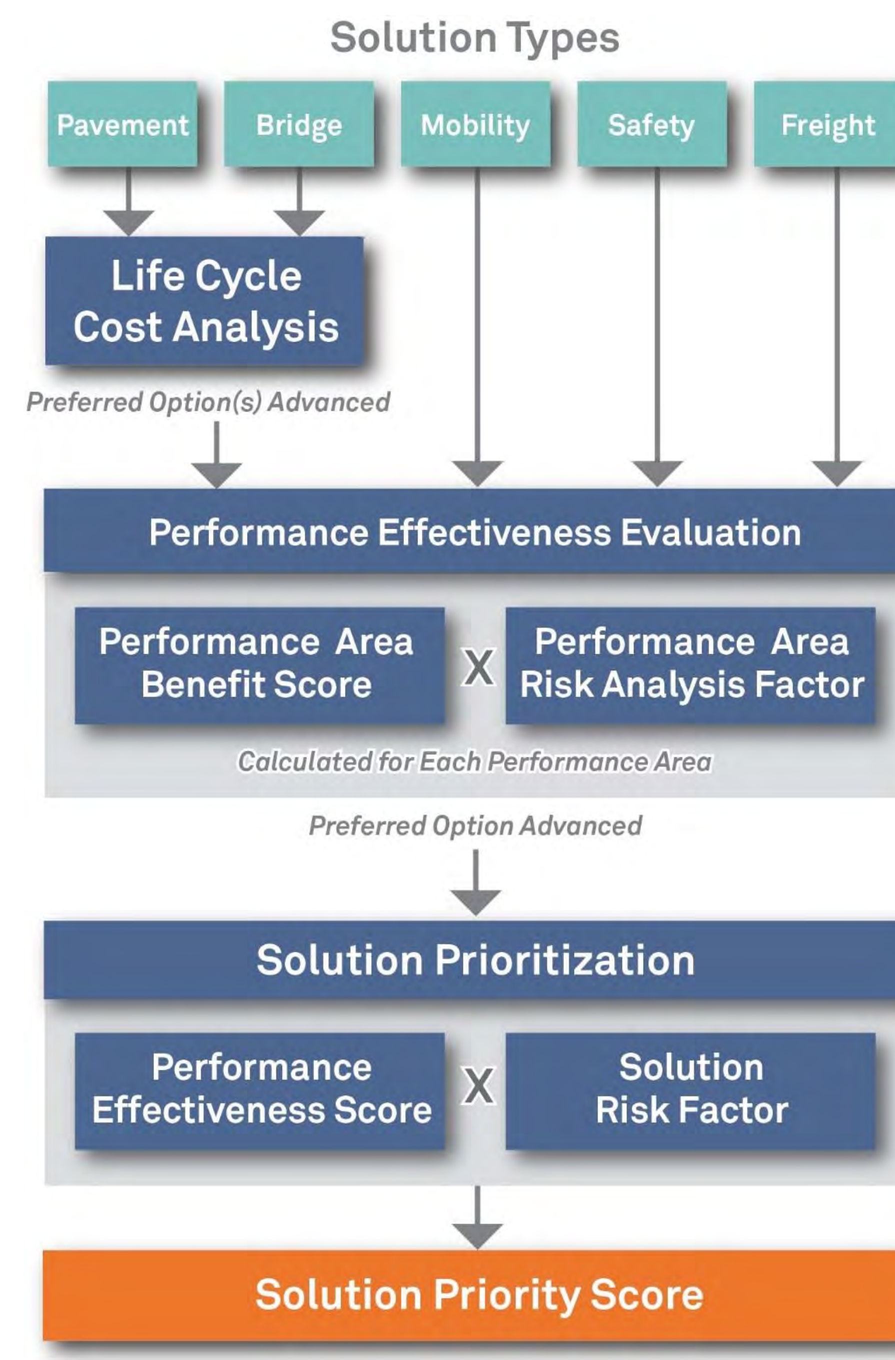
When multiple independent candidate solutions are developed for Mobility, Safety, or Freight strategic investment areas, these candidate solution options advance directly to the Performance Effectiveness Evaluation without an LCCA.

Performance Effectiveness Evaluation
After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

Solution Risk Analysis
All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of performance failure.

Candidate Solution Prioritization
The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure ES-7: Candidate Solution Evaluation Process



SUMMARY OF CORRIDOR RECOMMENDATIONS

Prioritized Candidate Solution Recommendations

Table ES-4 and **Figure ES-8** show the prioritized candidate solutions recommended for the SR 347/SR 84 Corridor in ranked order of priority. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Implementation of these solutions is anticipated to improve performance of the SR 347/SR 84 Corridor. The following observations were noted about the prioritized solutions:

- Most of the anticipated improvements in performance are in the Safety performance area

Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor-specific recommendations that are not related to construction or policy. The list below identifies other corridor recommendations for the SR 347/SR 84 Corridor:

- When recommending future projects along the SR 347/SR 84 Corridor, review historical ratings and levels of investment. According to data used for this study, no pavement and bridge locations have exhibited high historical investment (pavement) or rating fluctuation (bridge) issues within the limits of the study

Policy and Initiative Recommendations

In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through this process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on the SR 347/SR 84 Corridor, but across the entire state highway system where the conditions are applicable. The following list, which is in no particular order of priority, was derived from the initial four CPS rounds:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic message signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is required to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network
- At traffic interchanges with existing communication connectivity to the ADOT TOC, consideration should be given to adding thermal detection cameras for vehicle detection with the capability for wrong-way vehicle detection
- Improved vehicle detection systems, as recommended by ADOT Systems Technology group, should be deployed at traffic interchanges for improved traffic control

Next Steps

The candidate solutions recommended in this study are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the SR 347/SR 84 Corridor will be considered along with other candidate projects in the ADOT statewide programming process.

It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives.

These results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.

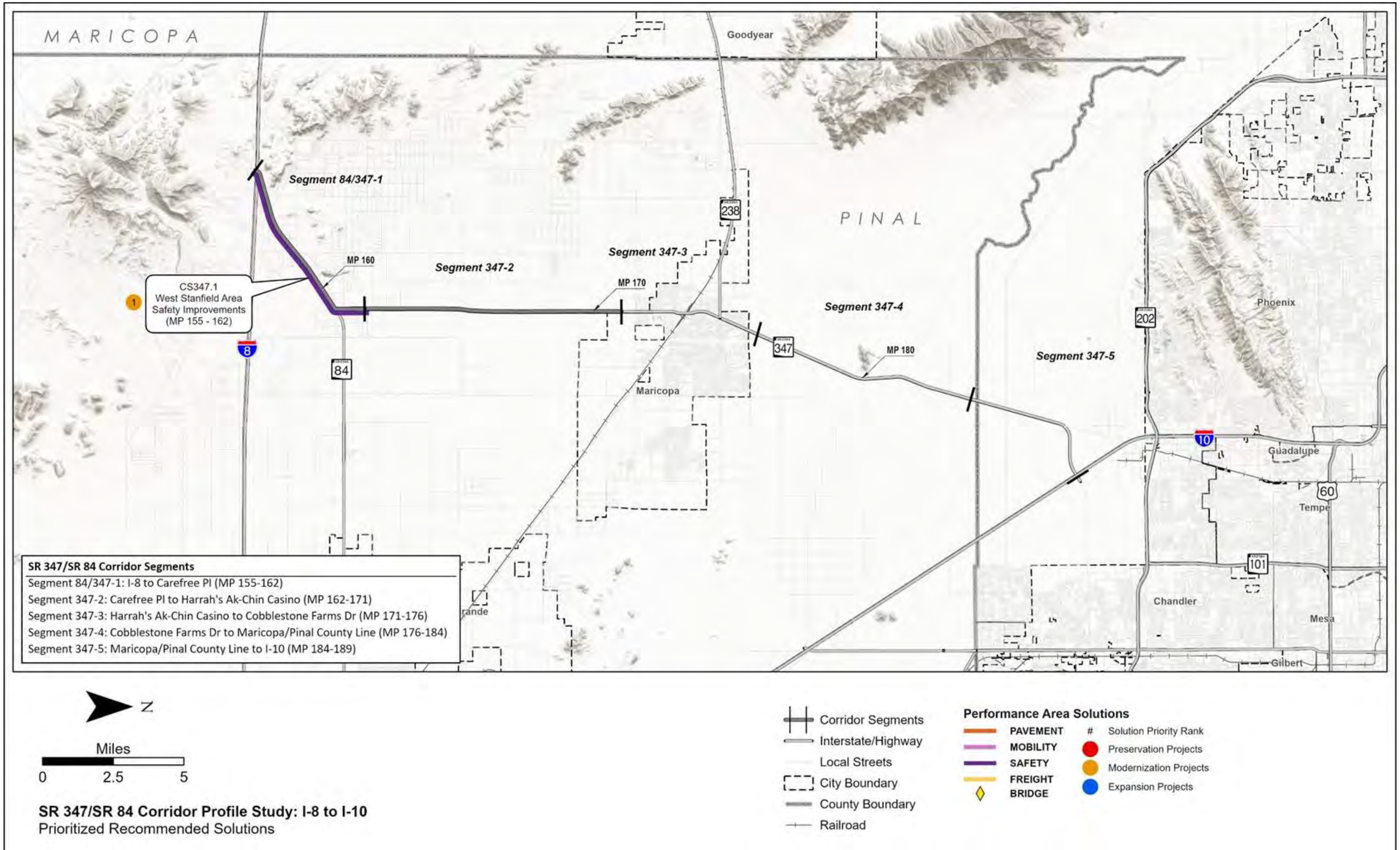
This CPS assessment is an update to the original CPS assessments conducted between 2017 and 2019. Due to changes in state and federal reporting standards as well as data availability, the original methodology has been adapted to produce comparable and relatable performance, need, and evaluation results. The methodology has changed as follows:

- Pavement performance now includes the addition of rutting as a component of the Pavement Distress measure
- Bridge performance no longer includes the % Functionally Obsolete secondary measure
- Safety performance includes updated secondary measure categories and is evaluated against updated statewide averages
- Mobility and Freight performance are evaluated using updated reliability measures based on Level of Travel Time Reliability and Truck Travel Time Reliability, which are new federal standard measures adapted from the previous Travel Time Index and Planning Time Index measures

Table ES-4: Prioritized Recommended Solutions

Rank	Candidate Solution #	Option	Solution Name and Location	Description / Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
1	CS347/84.1	-	West Stanfield Area Safety Improvements (MP 155-162)	-Rehabilitate shoulders in both directions (striping, delineators, RPMs, safety edge, and rumble strips for both shoulders)	$3.20	M	**271**

Figure ES-8: Prioritized Recommended Solutions



Final Report

Final Report

1 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of State Route 347 (SR 347) from Interstate 10 (I-10) to State Route 84 (SR 84) and SR 84 from SR 347 to Interstate 8 (I-8). Only the portion of SR 347 between Peters and Nall Road and SR 84 along with SR 84 from SR 347 to I-8 is the focus of this CPS update as the portion between I-10 and Peters and Nall Road was recently evaluated in the SR 347: I-10 to Peters and Nall Road Scoping Study prepared by the Maricopa Association of Governments (MAG) in 2022.

The CPS study examines key performance measures relative to the SR 347/SR 84 Corridor, and the results of this performance evaluation are used to identify potential strategic improvements.

The intent of the corridor profile program, and of ADOT's 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 has completed 21 original CPS within four separate groupings or rounds. In 2020, ADOT separated the previously studied corridors into six groupings to be updated and reassessed: Northeast, Northcentral, Northwest, Southeast, Southcentral, and Southwest. The 13 corridor studies within the three northern groupings were updated in Summer 2022. The 8 corridor studies within the three southern groupings began in Spring 2022 and include:

<u>Southeast</u>

- US 60: Meridian Road to US 70; US 70: US 60 to US 191; and US 191: US 70 to SR 80
- SR 90: I-10 to SR 80 and SR 80: SR 90 to US 191

<u>Southcentral</u>

- I-19: Nogales to I-10
- I-10: Casa Grande to the New Mexico State Line
- SR 347: Peters and Nall Road to SR 84 and SR 84: SR 347 to I-8

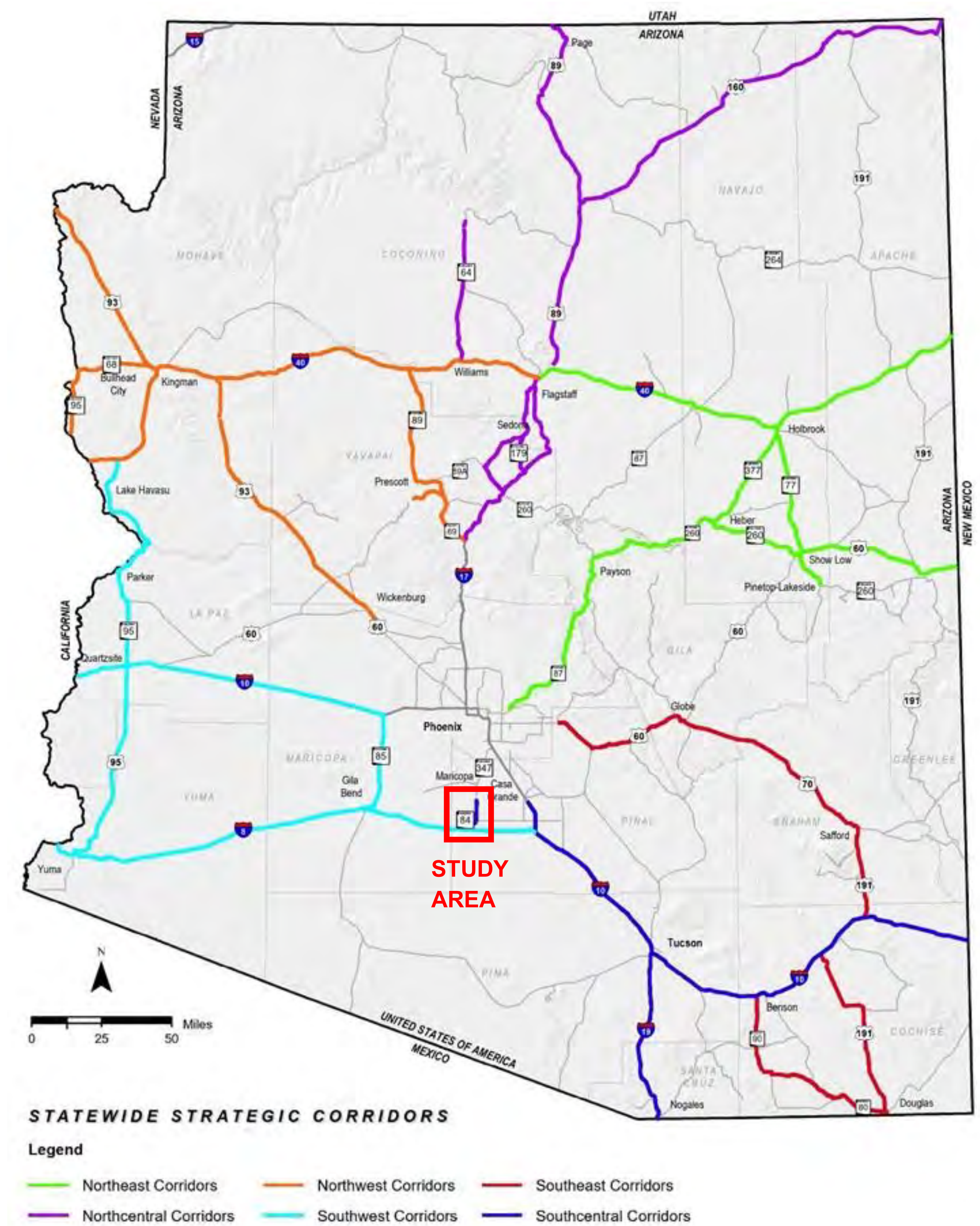
<u>Southwest</u>

- US/SR 95: I-8 to I-40
- I-10: California State Line to SR 85 and SR 85: I-10 to I-8
- I-8: California State Line to I-10

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

The SR 347/SR 84 Corridor, depicted in **Figure 1** along with all CPS corridors, is one of the strategic statewide corridors identified and the subject of this CPS Update.

Figure 1: Corridor Study Area



1.1 Corridor Study Purpose

The purpose of the CPS 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 described below:

- 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 solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

1.2 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 347/SR 84 CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance. Corridor benefits can be categorized by the following three investment types:

- Preservation: Activities that protect transportation infrastructure by sustaining asset condition or extending asset service life
- Modernization: Highway improvements that upgrade efficiency, functionality, and safety without adding capacity
- Expansion: Improvements that add transportation capacity through the addition of new facilities and/or services

This study identifies potential actions to improve the performance of the SR 347/SR 84 Corridor. Proposed actions are compared based on their likelihood of achieving desired performance levels, life-cycle costs, cost-effectiveness, and risk analysis to produce a prioritized list of solutions that help achieve corridor goals.

The following goals are 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 Corridor Overview and Location

The SR 347/SR 84 Corridor between I-10 and I-8 provides movement for agricultural, freight, commuting, recreation needs, and regional travel within Arizona. It provides a key link between the southern portion of the Phoenix metropolitan area and the southern region of the state and serves intrastate, interstate, and international commerce. The corridor connects the City of Maricopa, the Ak-Chin Indian Community, and the Gila River Indian Community (GRIC). This corridor also serves recreational areas within and near the Sonoran Desert National Monument via SR 238 and I-8. The SR 347/SR 84 Corridor includes all of SR 347 and a small portion of SR 84. The SR 347/SR 84 Corridor between I-10 and I-8 is approximately 34 miles in length.

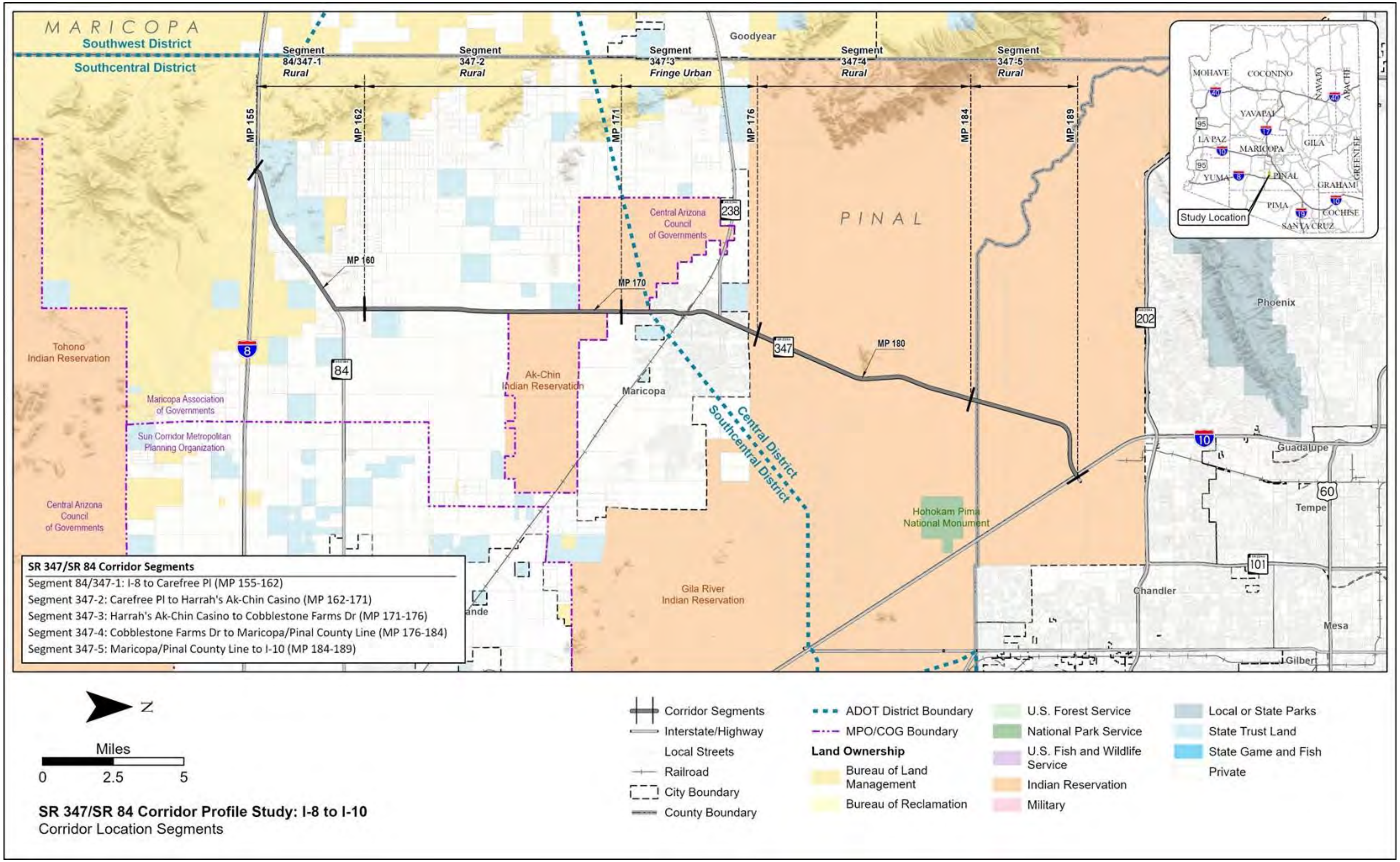
1.4 Corridor Segments

The SR 347/SR 84 Corridor is divided into 5 planning segments to allow for an appropriate level of detailed needs analysis, performance evaluation, and comparison between different segments of the corridor. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are described in **Table 1** and shown in **Figure 2**. Segments 347-3 through 347-5 are shown in this and all subsequent figures for context but omitted from this and all subsequent tables as they are not the focus of this CPS update.

Table 1: SR 347/SR 84 Corridor Segments

Segment #	Route	Begin	End	Approx. Begin Milepost	Approx. End Milepost	Approx. Length (miles)	Typical Through Lanes (NB/EB, SB/WB)	2020/2040 Average Annual Daily Traffic Volume (vpd)	Character Description
84/347-1	SR 84/ SR 347	I-8	Carefree Place	155	162	7	1,1	2,300 / 4,800	This rural segment has uninterrupted flow (except for the southbound SR 347 movement at SR 84), consistent topography, and is comprised of a two-lane undivided section.
347-2	SR 347	Carefree Place	Peters and Nall Road	162	170	8	2,2	4,600 / 11,900	This rural segment has uninterrupted flow, consistent topography, and is comprised of a four-lane divided section.

Figure 2: Corridor Location and Segments



1.5 Corridor Characteristics

The SR 347/SR 84 Corridor is an important travel corridor in the southcentral part of the state. The corridor functions as a route for agricultural, freight, recreational, commuting, and regional traffic and provides critical connections between the communities it serves and the rest of the regional and interstate network.

National Context

The SR 347/SR 84 corridor is a vital link across southcentral Arizona that connects the City of Maricopa, GRIC, and the Ak-Chin Indian Community to the Phoenix metropolitan area. It is a strategic transportation link across southcentral Arizona for freight and intercity travel.

Regional Connectivity

The SR 347/SR 84 Corridor between I-8 and I-10 provides movement for travel within southcentral Arizona. The corridor is located in two ADOT Districts (Central and Southcentral); two planning areas (MAG and Central Arizona Governments [CAG]); and two counties (Maricopa and Pinal). Within the corridor study limits, SR 347/SR 84 offers connections to several major roadways, including I-10, Riggs Road, SR 238, Maricopa-Casa Grande Highway, and I-8. This corridor serves the City of Maricopa as well as GRIC and the Ak-Chin Indian Community.

Commercial Truck Traffic

Communities along the SR 347/SR 84 corridor are dependent on the corridor to access the state economy through freight deliveries and travel to other locations. Freight traffic (trucks) comprise from 4% to 24% of the total traffic flow on the corridor, with the higher truck percentages within the southern portion of the corridor. The section of SR 347 between I-10 and SR 238 is frequently traveled by trucks hauling loads to the regional landfill on SR 238 west of SR 347. The corridor is also used as an oversized truck route.

Commuter Traffic

A majority of the commuter traffic along the SR 347/SR 84 Corridor occurs between the City of Maricopa and I-10. The SR 347/SR 84 Corridor is considered rural in character except within the City of Maricopa. According to the most recent traffic volume data maintained by ADOT, traffic volumes range from approximately 1,300 vehicles per day on SR 84 near the I-8 traffic interchange (TI) to over 55,000 vehicles per day north of the City of Maricopa on SR 347.

According to 2020 American Community Survey data from the US Census Bureau, 80 percent to 90 percent of the workforce in areas along the corridor relies on a private vehicle to get to work.

Recreation and Tourism

The SR 347/SR 84 corridor provides access to the Sonoran Desert National Monument via SR 238 or I-8.

Multi-Modal Uses

Freight Rail

The Union Pacific Railroad (UPRR) "Sunset Route" crosses the corridor within the City of Maricopa. The UPRR Sunset Route connects Los Angeles with El Paso and passes through Southern Arizona in an east-west direction through Yuma, Wellton, Gila Bend, Maricopa, Casa Grande, Eloy, Marana, Tucson, Benson and Willcox. The UPRR Sunset Route typically carries between 45 and 65 trains per day.

Passenger Rail

Amtrak's Sunset Limited (New Orleans to Los Angeles) and Texas Eagle (Chicago to Los Angeles) routes serve long-distance tourist travel with daily service. The Sunset Limited and Texas Eagle routes share track with the UPRR Sunset Route and are subject to delays caused by freight traffic. There is a passenger station in the City of Maricopa. Other passenger stations are located in Yuma, Tucson, and Benson.

Bicycles/Pedestrians

Opportunities for bicycle and pedestrian travel are somewhat limited on SR 347/SR 84. Bicycle traffic is permitted on the mainline outside shoulder in rural areas. Outside shoulder widths on the rural SR 347 portions of the corridor are around ten feet wide. Outside shoulder widths on the SR 84 portion are five feet wide. Sidewalks are provided along SR 347 through parts of the City of Maricopa but are not continuous.

Bus/Transit

The City of Maricopa provides several types of transit services through the City of Maricopa Express Transit (COMET) system. These transit types include local demand response, local limited demand response, route deviation services, regional demand response, and Valley Metro vanpool. These transit options typically require a reservation or run on a very limited basis. The route deviation services generally have stops at the Pinal County Public Health Clinic/Library, Legacy School, Central Arizona College, Copper Sky Recreation Center, Sun Life Medical, COPA Senior Center, and Sun Life Women's Center.

Aviation

There are two general aviation facilities in proximity to the SR 347/SR 84 Corridor. These include Stellar Airpark, owned and operated by the Stellar Runway Utilizers Association, and the Ak-Chin Regional Airport (formerly Phoenix Regional Airport), owned and operated by the Ak-Chin Indian Community. The northern portion of the corridor serves as a connection to numerous other airports located in the Phoenix metropolitan area via I-10 and the Loop 202

Land Ownership, Land Uses, and Jurisdictions

As shown previously in **Figure 2**, the SR 347/SR 84 Corridor traverses multiple jurisdictions and land owned or managed by various entities. The southern section of the corridor traverses privately held and State Trust land. A portion of the central segment of the corridor traverses the Ak-Chin Indian Community. The northern section of the corridor traverses GRIC. Land ownership in and surrounding the City of Maricopa is mainly private land.

Population Centers

Population centers of various sizes exist along the SR 347/SR 84 Corridor. **Table 2** provides a summary of the populations for communities along the two southern segments of the corridor. Significant population growth is projected between 2010 and 2040 in the City of Maricopa and in the corridor vicinity according to the Arizona State Demographer's Office.

Table 2: Current and Future Population

Community	2010 Population	2020 Population	2040 Population	% Change 2010-2040	Total Growth
Pinal County	376,369	466,175	820,877	118%	444,508
Maricopa	43,598	59,126	88,838	104%	45,240

Source: U.S. Census, Arizona Commerce Authority

Major Traffic Generators

The Phoenix metropolitan area, along with the City of Maricopa, are major traffic generators for the SR 347/SR 84 Corridor.

Tribes

Portions of the SR 347/SR 84 Corridor lie within GRIC and the Ak-Chin Indian Community.

Wildlife Linkages

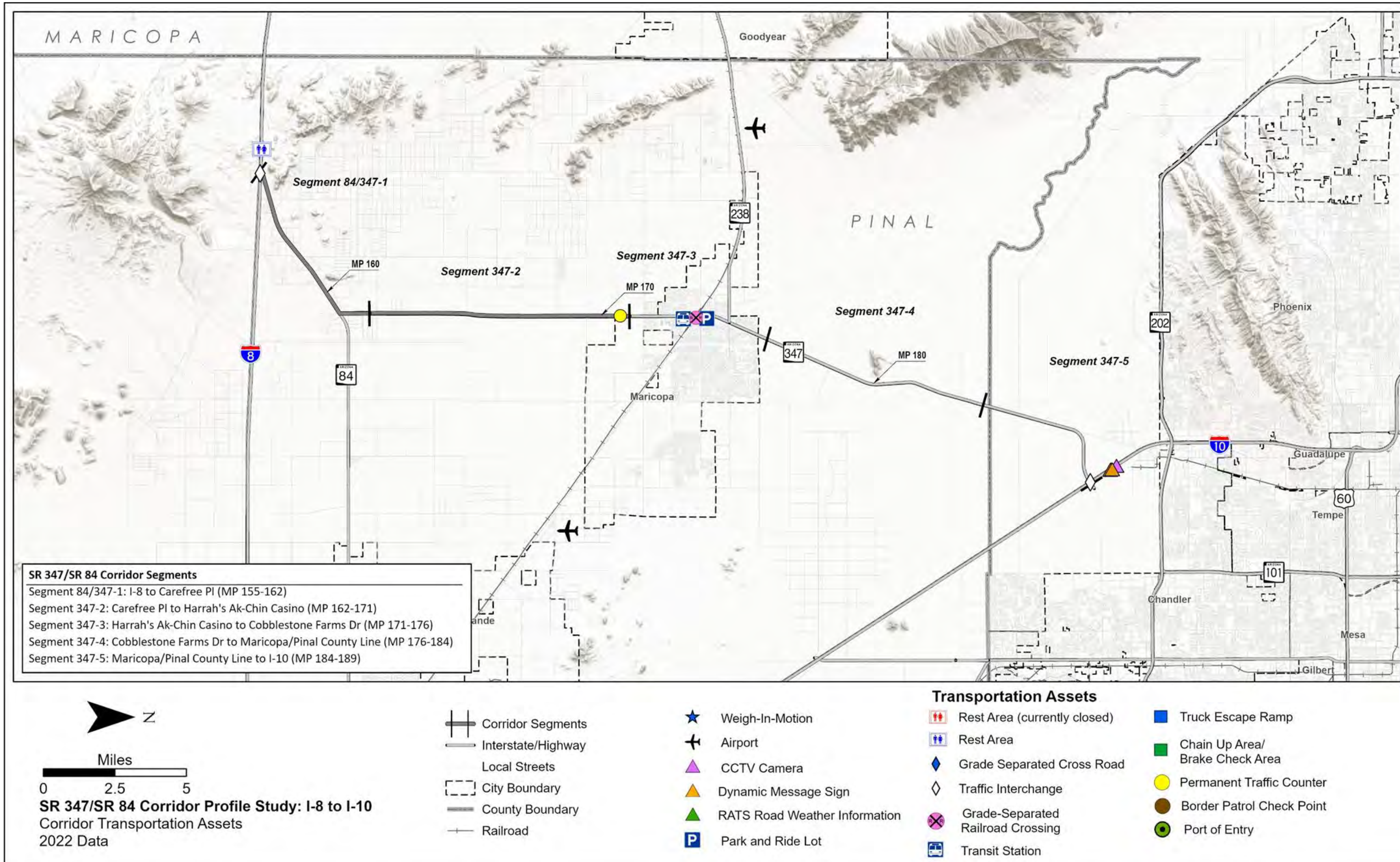
The Arizona State Wildlife Action Plan (SWAP) provides a 10-year vision for the entire state, identifying wildlife and habitats in need of conservation, insight regarding the stressors to those resources, and actions that can be taken to alleviate those stressors. Using the Habimap Tool that creates an interactive database of information included in the SWAP, the following were identified in relation to the SR 347/SR 84 Corridor:

- Arizona Game and Fish Department (AGFD) Wildlife Waters are located near the southern portion of the corridor, specifically in the areas to the north and south of the SR 84/I-8 TI
- The corridor travels through a few allotments controlled by the Arizona State Land Department (ASLD)
- Riparian areas include a few small areas adjacent to SR 347 near the City of Maricopa and on the east and west sides of SR 347 near the SR347/SR84 junction
- Arizona Wildlife Linkages: No missing or potential wildlife linkages are noted
- According to the Species and Habitat Conservation Guide (SHCG), sensitive habitats that have moderate to high conservation potential exist along the corridor; these areas are located primarily on the southern half of the corridor, with the highest conservation potential on the SR 84 section of the corridor
- Areas where Species of Greatest Conservation Need (SGCN) are high or moderately vulnerable are similar to the areas identified in the SHCG (see above), with those of highest conservation need located along the SR 84 section of the corridor
- Identified areas of moderate or high levels of Species of Economic and Recreational Importance (SERI) exist along the corridor; these are located primarily on the southern half of the corridor

Corridor Assets

- Corridor transportation assets are summarized in **Figure 3**.
- The corridor includes two grade-separated TIs: one at the northern terminus of the corridor involving SR 347 and I-10 and another at the southern terminus of the corridor involving SR 84 and I-8. There is a permanent traffic counter on SR 347 at MP 171.7. Within the corridor vicinity there are closed circuit television (CCTV) cameras and Dynamic Message Signs (DMS) on I-10, along with various small General Aviation or private airports. There is a park and ride facility near MP 173.5 in Maricopa.

Figure 3: Corridor Transportation Assets



1.6 Corridor Stakeholders and Input Process

A Technical Advisory Committee (TAC) was created that was comprised of representatives from key stakeholders. TAC meetings will be held at key milestones to present results and obtain feedback. In addition, several meetings will be conducted with key stakeholders to present the results and obtain feedback.

Key stakeholders identified for this study included:

- ADOT Central District
- ADOT Southcentral District
- ADOT Technical Groups
- MAG
- CAG
- AGFD
- ASLD
- Federal Highway Administration (FHWA)

Several Working Papers were developed during the course of the CPS. The Working Papers were provided to the TAC for review and comment.

1.7 Prior Studies and Recommendations

This study identified recommendations from previous studies, plans, and preliminary design documents. Studies, plans, and programs pertinent to the SR 347/SR 84 Corridor were reviewed to understand the full context of future planning and design efforts within and around the study area. These studies are organized below into four categories: Framework and Statewide Studies, Regional Planning Studies, Planning Assistance for Rural Areas (PARAs) and Small Area Transportation Studies (SATS), and Design Concept Reports (DCRs) and Project Assessments (PAs).

Framework and Statewide Studies

- ADOT Bicycle and Pedestrian Plan Update (2013)
- ADOT Pedestrian Safety Action Plan (2017)
- ADOT Five-Year Transportation Facilities Construction Program (2023 – 2027)
- ADOT Climbing and Passing Lane Prioritization Study (2015)
- ADOT Arizona Key Commerce Corridors (2014)
- ADOT Arizona Multimodal Freight Analysis Study (2009)
- ADOT Arizona Ports of Entry Study (2021)
- ADOT Arizona State Airport Systems Plan (2018)
- ADOT Arizona State Freight Plan (2017)
- ADOT Arizona State Rail Plan (2011)
- AGFD Arizona State Wildlife Action Plan (2012)
- AGFD Arizona Wildlife Linkages Assessment (2006)
- ADOT Arizona Statewide Dynamic Message Sign Master Plan (2011)
- ADOT Arizona Statewide Intelligent Transportation System (ITS) Architecture (2018)
- ADOT Arizona Statewide Rail Framework Study (2010)
- ADOT Arizona Statewide Rest Area Study (2011)
- ADOT Arizona Statewide Shoulders Study (2015)
- ADOT Arizona Strategic Traffic Safety Plan (2019)
- ADOT Arizona Roadway Departure Safety Implementation Plan (RDSIP) (2014)
- ADOT AASHTO U.S. Bicycle Route System (2015)
- ADOT Low Volume State Routes Study (2017)
- ADOT Statewide Stormwater & Erosion Control Study (2020)
- ADOT Statewide Transportation Planning Framework – Building a Quality Arizona (BQAZ) (2009)
- ADOT Transportation Asset Management Plan (2021)
- ADOT What Moves You Arizona? Long-Range Transportation Plan (2016-2040)

Regional Planning Studies

- I-11 Tier 1 Environmental Impact Statement
- MAG 2050 Momentum Regional Transportation Plan (2021)
- Interstates 8 and 10 Hidden Valley Transportation Framework Study (2009)
- Pinal County Regional Transportation Authority Proposed Projects (2017)
- MAG Regional Transit Framework (2010)
- CAG Regional Transportation Plan (2015)

Planning Assistance for Rural Areas (PARA) Studies

- Pinal County SATS (2006)
- City of Maricopa Area Transportation Plan (2015)
- Southern Maricopa/Northern Pinal County Area Transportation Study (2003)

Summary of Prior Recommendations

Various studies and plans, including several DCRs, have recommended improvements to the SR 347/SR 84 Corridor as shown in **Table 3** and **Figure 4**. They include, but are not limited to:

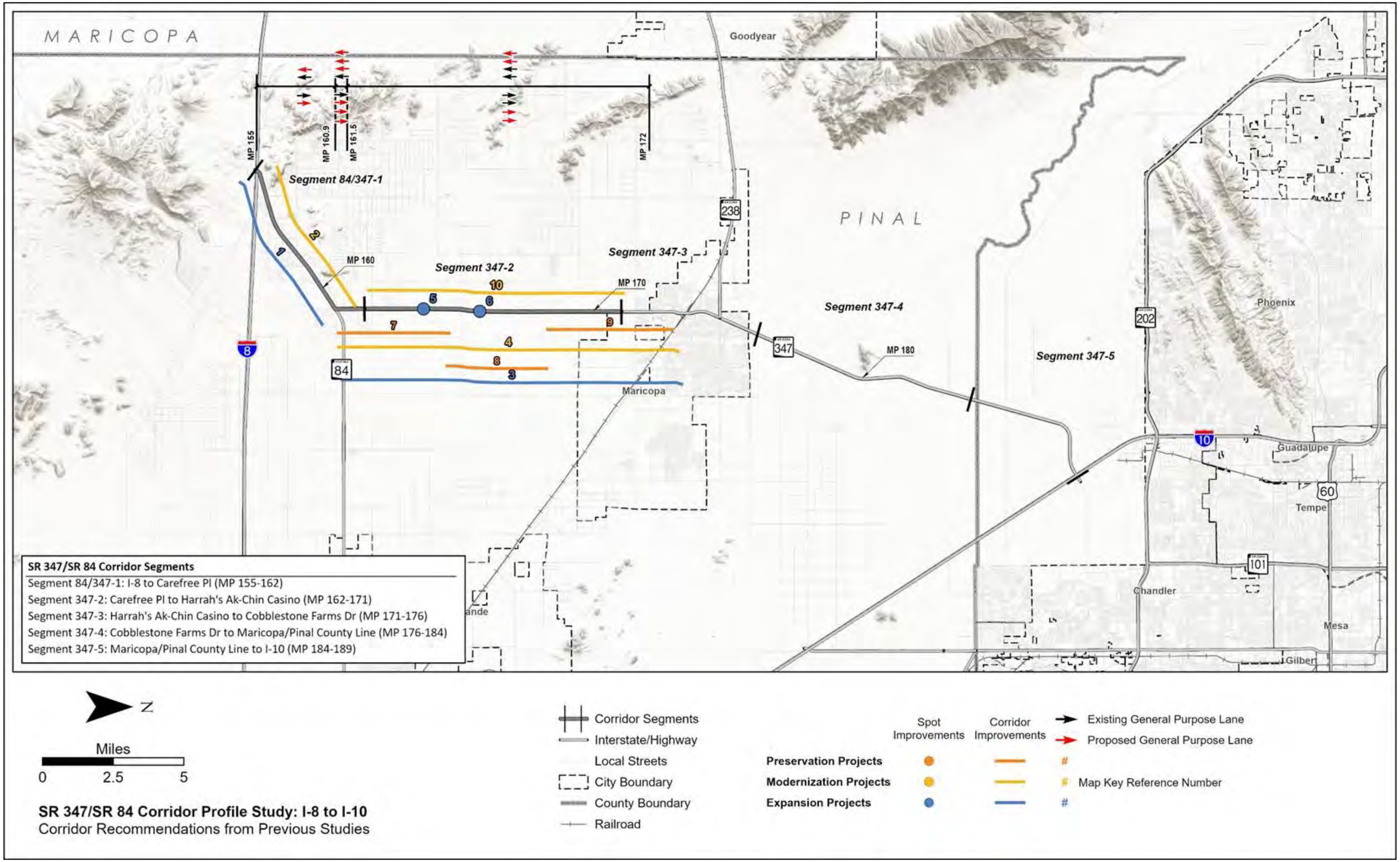
- Widening SR 84 to 4 lanes
- Widening SR 347 to 6 lanes or 8 lanes through the City of Maricopa
- New grade-separated TIs at the following locations:
  - With proposed West Pinal County Freeway
  - With proposed SR 238 Freeway
  - With Riggs Road
- New signalized intersections along SR 347 at the following locations:

  - With proposed Val Vista Parkway
  - With proposed East-West Corridor
  - SR 347/Maricopa Road intersection
- Constructing pedestrian safety improvements along SR 347 through the City of Maricopa including sidewalks and hybrid beacons
- Enhancing transit use along the corridor

Table 3: Corridor Recommendations from Previous Studies

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E]}			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
SR 84											
1	155	161	6	Widen SR 84 to 4 lanes and classify as an arterial or parkway			√	-	N/A	N	Pinal County Small Area Transportation Study (2006); Pinal County Regionally Significant Routes for Safety and Mobility (2008)
2	155.20	166.35	11.15	Pavement rehabilitation Jct I-18 to Hopi Drive RR 2.5"AC+FR	√			-	N/A	N	Final FY22-26 ADOT P2P Pavement List
SR 347											
3	161	173	12	Widen SR 347 to 6-lane arterial or 8-lane parkway and extend it down from SR 84 to I-8			√	-	NA	N	MAG Interstates 8 and 10 Hidden Valley Transportation Framework Study (2009); MAG Draft 2040 Regional Transportation Plan (2017); Pinal County Regionally Significant Routes for Safety and Mobility (2008); Pinal County Small Area Transportation Study (2006); CAG Regional Transportation Plan (2015); MAG SR 347 Scoping Study (2022)
4	161	173	12	Bus rapid transit with proposed park-and-ride near the SR 347/McCartney Road intersection		√		-	NA	N	MAG 2035 Regional Transportation Plan (2014); MAG Draft 2040 Regional Transportation Plan (2017)
5	164	164	-	New traffic interchange with proposed West Pinal County Freeway			√	-	NA	N	Proposed Pinal County Regional Transportation Authority Projects (2017); Pinal County East-West Corridor Study Final DCR (2015); MAG Interstates 8 and 10 Hidden Valley Transportation Framework Study (2009)
6	166	166	-	New signalized intersection with proposed Val Vista Parkway			√	-	NA	N	Pinal County East-West Corridor Study Final DCR (2015); Pinal County Regionally Significant Routes for Safety and Mobility (2008); MAG Interstates 8 and 10 Hidden Valley Transportation Framework Study (2009)
7	160.95	164.90	3.95	Pavement rehabilitation SR 84 to Miller Road RR 3"AC+FR	√			-	N/A	N	Final FY22-26 ADOT P2P Pavement List
8	164.90	168.42	3.52	Pavement rehabilitation Miller Rd to Papago Rd RR 3"AC+FR	√			-	N/A	N	Final FY22-26 ADOT P2P Pavement List
9	168.42	172.83	4.41	Pavement rehabilitation Papago Rd to Edison Rd RR 3"AC+FR	√			-	N/A	N	Final FY22-26 ADOT P2P Pavement List
10	162	171	9	Safety improvements Ak-Chin area		√		-	N/A	N	Final FY22-26 ADOT P2P Pavement List

Figure 4: Corridor Recommendations from Previous Studies



2 CORRIDOR PERFORMANCE

This chapter describes the evaluation of the existing performance of the SR 347/SR 84 Corridor. A series of performance measures is used to assess the corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

2.1 Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

Figure 5 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance. The primary measures in each of five performance areas are used to define the overall health of the corridor, while the secondary measures identify locations that warrant further diagnostic investigation to delineate needs. Needs are defined as the difference between baseline corridor performance and established performance objectives.

Figure 5: Corridor Profile Performance Framework

The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

These performance areas reflect national performance goals stated in *Moving Ahead for Progress in the 21st Century* (MAP-21):

- Safety: To achieve a significant reduction in traffic fatalities and serious injuries on all public roads
- Infrastructure Condition: To maintain the highway infrastructure asset system in a state of good repair
- Congestion Reduction: To achieve a significant reduction in congestion on the National Highway System
- System Reliability: To improve the efficiency of the surface transportation system
- Freight Movement and Economic Vitality: To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development
- Environmental Sustainability: To enhance the performance of the transportation system while protecting and enhancing the natural environment
- Reduced Project Delivery Delays: To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion

In 2015, the *Fixing America's Surface Transportation Act* (FAST Act) was passed. The FAST Act continued to emphasize the performance management approach identified in MAP-21 but included additional provisions for meeting established performance targets.

The MAP-21 and FAST Act performance areas were considered in the development of ADOT's P2P process, which integrates transportation planning with capital improvement programming and project delivery. Because the P2P program requires the preparation of annual transportation system performance reports using the five performance areas, consistency is achieved among various ADOT processes by using these same performance areas.

While these performance areas were established prior to the earlier rounds of the CPS program, several related federal and ADOT reporting measures and targets were not yet in place at that time. These measures and targets have since been established (subsequent to completion of the prior CPS rounds). As such, it became necessary to revisit and revise the CPS performance measures to be more consistent with the latest federal and ADOT reporting measures and targets.

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance.

Each of the primary and secondary performance measures is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance	– Rating is above the identified desirable/average range
Fair/Average Performance	– Rating is within the identified desirable/average range
Poor/Below Average Performance	– Rating is below the identified desirable/average range

Table 4 provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table 4: Corridor Performance Measures

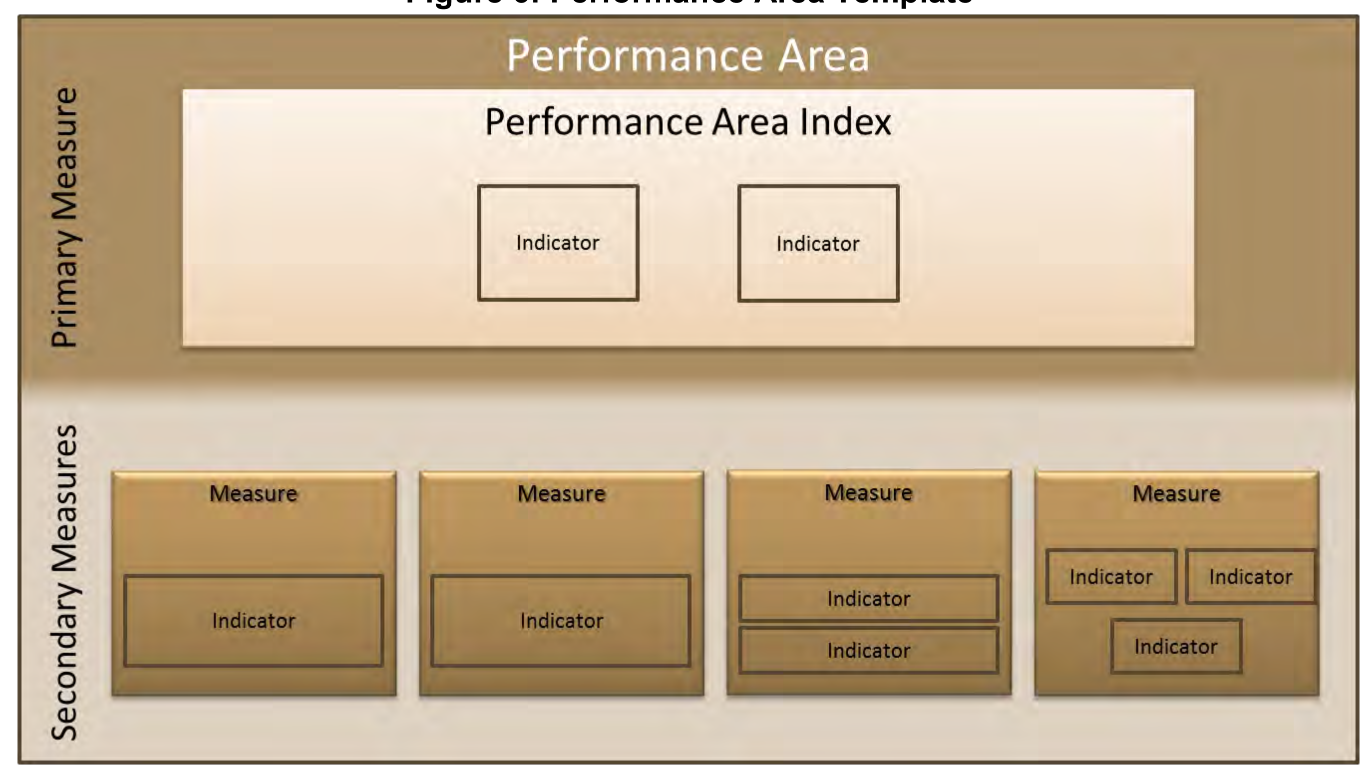
Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index, cracking, and rutting	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and suspected serious injury crashes	• Directional Safety Index • Strategic Traffic Safety Plan Emphasis Areas • Other Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck travel time reliability	• Travel Time Reliability • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

The general template for each performance area is illustrated in **Figure 6**.

The guidelines for performance measure development are:

- Indicators and performance measures for each performance area should be developed for relatively homogeneous corridor segments
- Performance measures for each performance area should be tiered, consisting of primary measure(s) and secondary measure(s)
- Primary and secondary measures should assist in identifying those corridor segments that warrant in-depth diagnostic analyses to identify performance-based needs and a range of corrective actions known as solution sets
- One or more primary performance measures should be used to develop a Performance Index to communicate the overall health of a corridor and its segments for each performance area; the Performance Index should be a single numerical index that is quantifiable, repeatable, scalable, and capable of being mapped; primary performance measures should be transformed into a Performance Index using mathematical or statistical methods to combine one or more data fields from an available ADOT database
- One or more secondary performance measure indicators should be used to provide additional details to define corridor locations that warrant further diagnostic analysis; secondary performance measures may include the individual indicators used to calculate the Performance Index and/or "hot spot" features

Figure 6: Performance Area Template

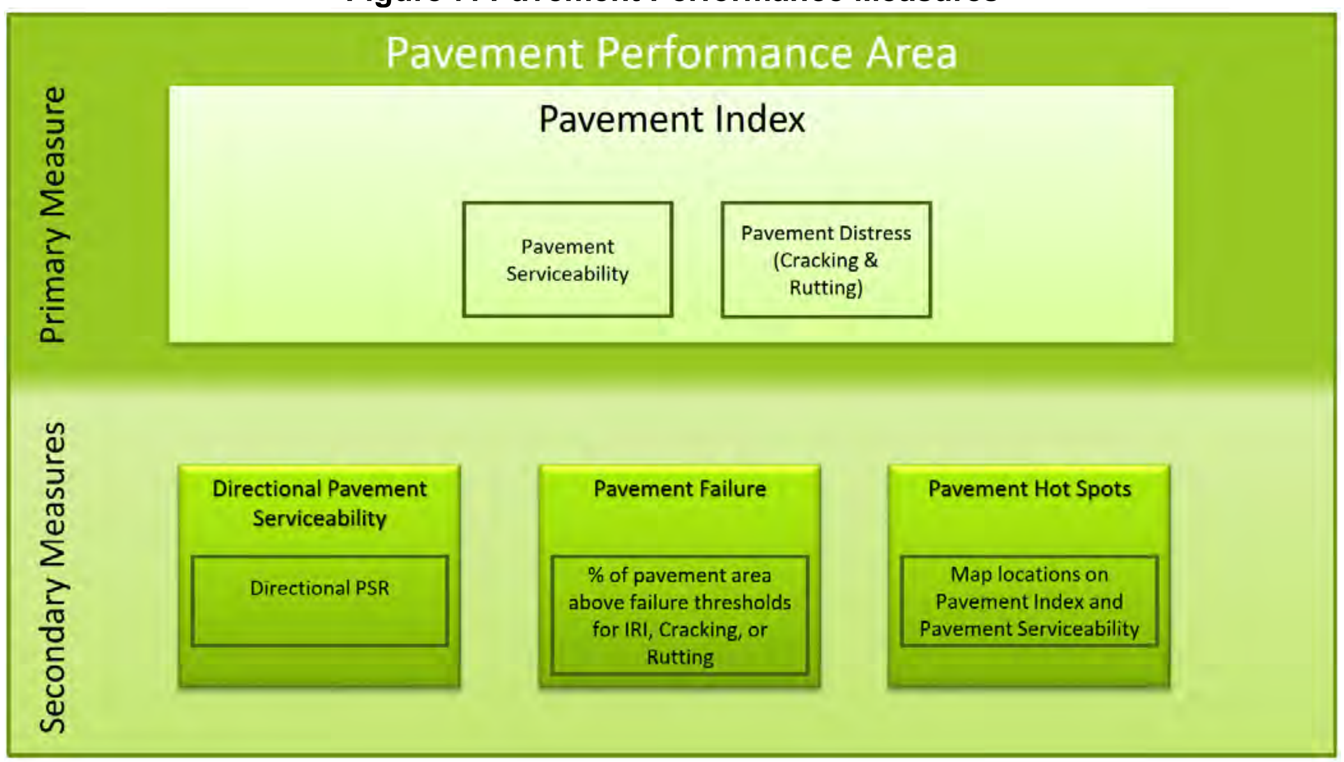


2.2 Pavement Performance Area

The Pavement Performance Area consists of a primary measure (Pavement Index) and three secondary measures, as shown in **Figure 7**. These measures assess the condition of the existing pavement along the SR 347/SR 84 Corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C.**

This CPS is an update to a previously completed report. The performance measures and performance thresholds have been revised from the previous version. For the Pavement performance area, the new methodology includes the use of Rutting data and the performance thresholds have been slightly modified.

Figure 7: Pavement Performance Measures



<u>*Primary Pavement Index*</u>

The Pavement Index is calculated using two pavement condition ratings: the Pavement Serviceability Rating (PSR) and the Pavement Distress Index (PDI).

The PSR is extracted from the International Roughness Index (IRI), a measurement of pavement roughness based on field-measured longitudinal roadway profiles. The PDI is extracted from the Cracking Rating (CR) and Rutting Rating, field-measured samples from each mile of highway.

Both the PSR and PDI use a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest. The Pavement Index for each segment is a weighted average of the directional ratings based on the number of travel lanes. Therefore, the condition of a section with more travel lanes will have a greater influence on the resulting segment Pavement Index than the condition of a section with fewer travel lanes.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Pavement performance area, the relevant operating environments are designated as interstate and non-interstate segments. For the SR 347/SR 84 Corridor, the following operating environments were identified:

- Non-interstate: all segments

<u>*Secondary Pavement Measures*</u>

Three secondary measures provide an in-depth evaluation of the different characteristics of pavement performance.

Directional Pavement Serviceability

- Weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel

Pavement Failure

- Percentage of pavement area rated above failure thresholds for IRI, Cracking, or Rutting

Pavement Hot Spots

- A Pavement "hot spot" exists where a given one-mile section of roadway rates as being in "poor" condition
- Highlights problem areas that may be under-represented in a segment average. This measure is recorded and mapped, but not included in the Pavement performance area rating calculations

<u>*Pavement Performance Results*</u>

The Pavement Index provides a high-level assessment of the pavement condition for the corridor and for each segment. The three secondary measures provide more detailed information to assess pavement performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Pavement Index shows "poor" overall performance for the SR 347/SR 84 Corridor
- According to the Pavement Index, Segment 347-2 is in "poor" condition
- Segments 84/347-1 and 347-2 and the weighted average for the corridor have "poor" % Area Failure ratings
- Pavement hot spots along the corridor include:
  - Segment 84/347-1, NB/EB MP 156-162 and SB/WB MP 158-159 and 160-162
  - Segment 347-2, MP 162-168

Table 5 summarizes the Pavement performance results for the SR 347/SR 84 Corridor. **Figure 8** illustrates the primary Pavement Index performance and locations of Pavement hot spots along the SR 347/SR 84 Corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 5: Pavement Performance

Segment	Segment Length (miles)	Pavement Index	Directional PSR		% Area Failure
			NB/EB	SB/WB	
84/347-1	6.9	3.08	3.98	4.09	68.8%
347-2	7.5	2.35	3.87	3.88	75.0%
Weighted Corridor Average		2.70	3.92	3.98	72.0%
SCALES					
Performance Level		Non-Interstate			
Good		> 3.60	> 3.50		< 5%
Fair		2.80 - 3.60	2.90 - 3.50		5% - 20%
Poor		< 2.80	< 2.90		> 20%

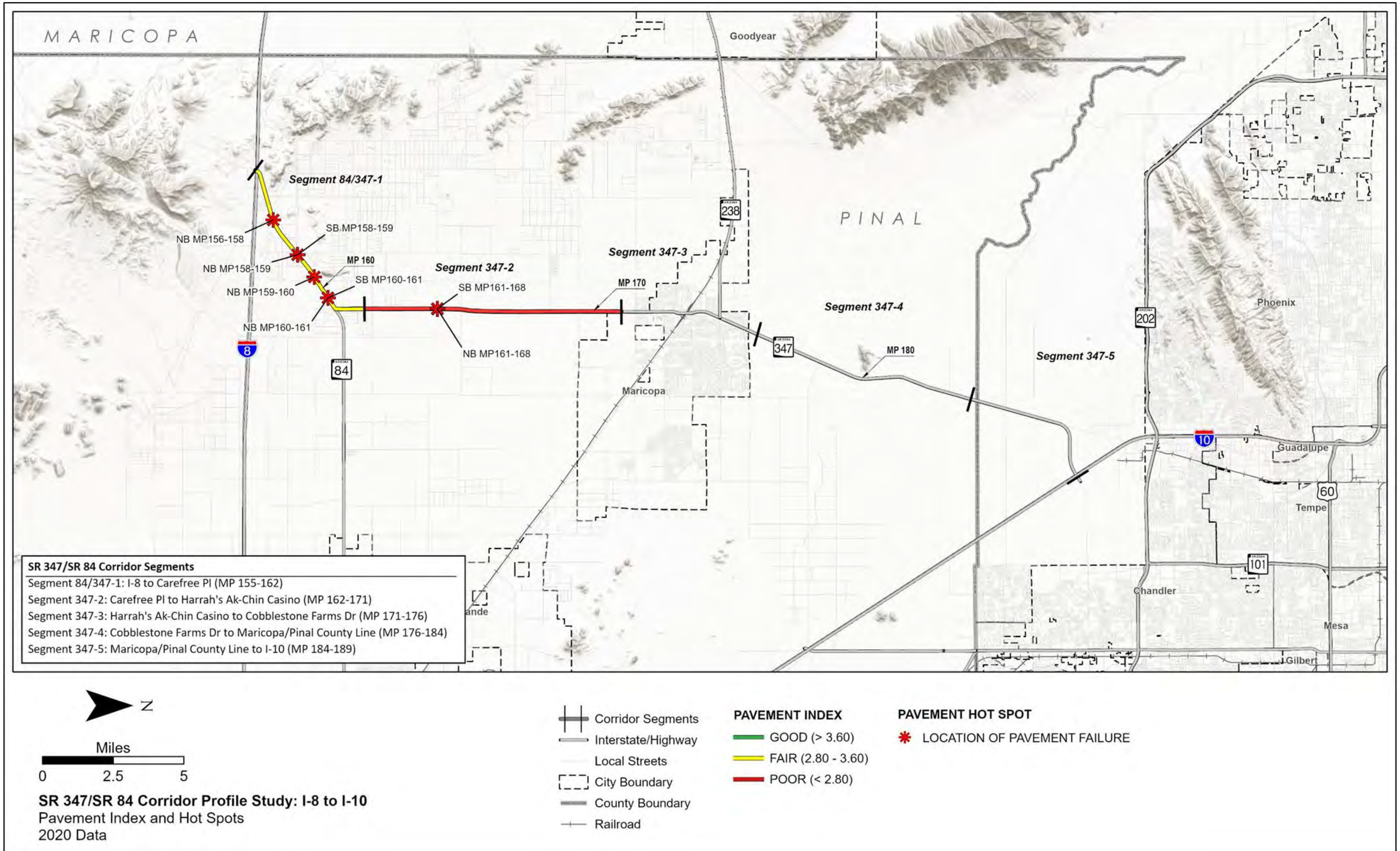
Statewide Transportation Asset Management Plan

Moving Ahead for Progress in the 21st Century Act of 2012 (MAP-21), identified national transportation system goals. The transportation asset management regulations associated with the infrastructure condition goals required the development of a Transportation Asset Management Plan (TAMP) covering National Highway System (NHS) bridges and pavements. As part of the statewide TAMP, ADOT developed pavement performance metrics and thresholds in compliance with federal tracking and reporting requirements, as shown in **Table 6**. The thresholds shown in **Table 6** are the basis for the TAMP and ADOT's federal reporting and are different than those used in this CPS, which are based on ADOT's Pavement Management System, as shown in **Table 5**. The TAMP reports asset condition information in the aggregate at the statewide level and applying the thresholds shown in **Table 6** would result in different segment-level performance than shown in **Table 5**.

Table 6: Statewide TAMP Metrics

Metric	Good	Fair	Poor
IRI (in./mile)	< 95	95-170	> 170
Cracking (%)	< 5	5-20 (asphalt) 5-15 (jointed concrete) 5-10 (cont. reinforced concrete)	> 20 > 15 > 10
Rutting (in.)	< 0.20	0.20–0.40	> 0.40
Faulting (in.)	<0.10	0.10-0.15	> 0.15

Figure 8: Pavement Performance

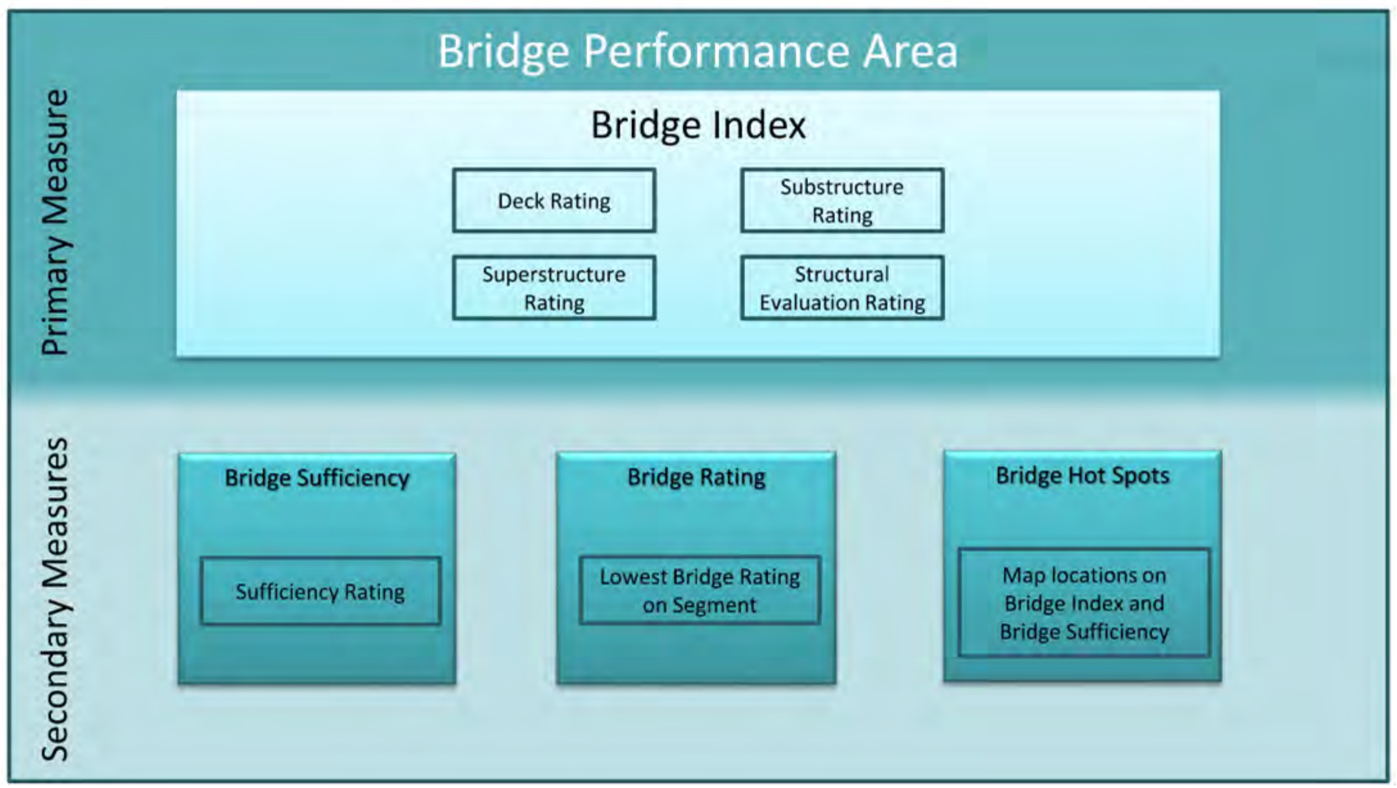


2.3 Bridge Performance Area

The Bridge Performance Area consists of a primary measure (Bridge Index) and three secondary measures, as shown in **Figure 9**. These measures assess the condition of the existing bridges along the SR 347/SR 84 Corridor. Only bridges that carry mainline traffic or bridges that cross the mainline are included in the calculation. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C.**

This CPS is an update to a previously completed report. The performance measures and performance thresholds have been revised from the previous version. For the Bridge performance area, the new methodology does not include the performance metric related to Functionally Obsolete bridges, which was used in the previous methodology.

Figure 9: Bridge Performance Measures



<u>*Primary Bridge Index*</u>

The Bridge Index is calculated based on the use of four different bridge condition ratings from the ADOT Bridge Database, also known as the Arizona Bridge Information and Storage System (ABISS). The four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating. These ratings are based on inspection reports and establish the structural adequacy of each bridge. The performance of each individual bridge is established by using the lowest of these four ratings. The use of these ratings, and the use of the lowest rating, is consistent with the approach used by the ADOT Bridge Group to assess the need for bridge rehabilitation. The Bridge Index is calculated as a weighted average for each segment based on deck area.

<u>*Secondary Bridge Measures*</u>

Three secondary measures provide an in-depth evaluation of the characteristics of each bridge:

Bridge Sufficiency

- Multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour
- Rates the structural and functional sufficiency of each bridge on a 100-point scale

Bridge Rating

- The lowest rating of the four bridge condition ratings (substructure, superstructure, deck, and structural evaluation) on each segment
- Identifies lowest performing evaluation factor on each bridge

Bridge Hot Spots

- A Bridge "hot spot" is identified where a given bridge has a bridge rating of 4 or lower or multiple ratings of 5 between the deck, superstructure, and substructure ratings
- Identifies particularly low-performing bridges or those that may decline to low performance in the immediate future

<u>*Bridge Performance Results*</u>

The Bridge Index provides a high-level assessment of the structural condition of bridges for the corridor and for each segment. The four secondary measures provide more detailed information to assess bridge performance.

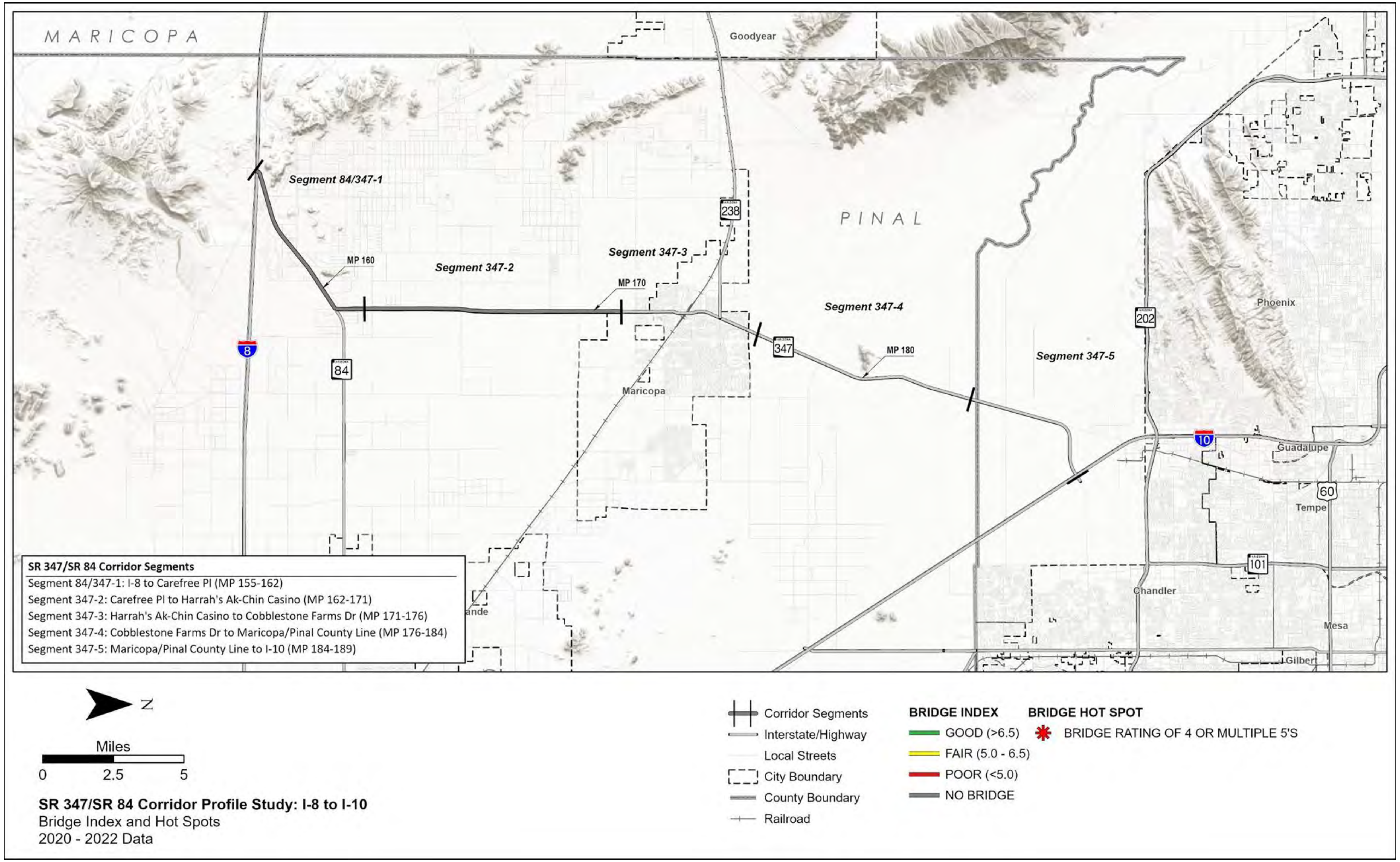
There are no bridges within Segments 84/347-1 or 347-2.

Table 7 summarizes the Bridge performance results for the SR 347/SR 84 Corridor. **Figure 10** illustrates the primary Bridge Index performance and locations of Bridge hot spots along the SR 347/SR 84 Corridor. Maps for each secondary measure can be found in **Appendix A.**

Table 7: Bridge Performance

Segment #	Segment Length (miles)	# of Bridges	Bridge Index	Sufficiency Rating	Lowest Bridge Rating
84/347-1	6.9	0	No Bridges		
347-2	7.5	0	No Bridges		
Weighted Corridor Average			-	-	-
SCALES					
Performance Level			**All**		
Good			> 6.50	> 80	> 6.0
Fair			5.0 – 6.50	50 – 80	5.0 – 6.0
Poor			< 5.0	< 50	< 5.0

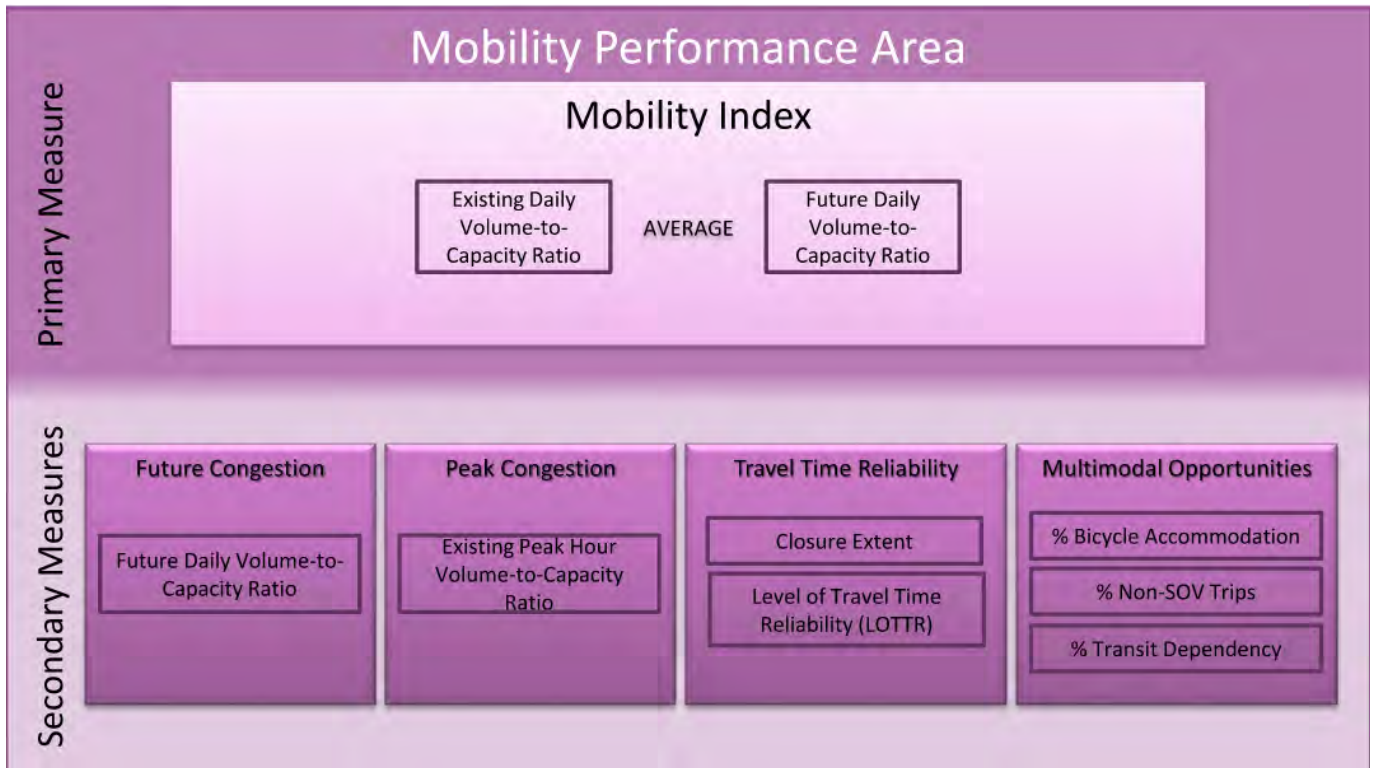
Figure 10: Bridge Performance



2.4 Mobility Performance Area

The Mobility performance area consists of a primary measure (Mobility Index) and four secondary measures, as shown in **Figure 11**. These measures assess the condition of existing mobility along the SR 347/SR 84 Corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 11: Mobility Performance Measures



<u>*Primary Mobility Index*</u>

The Mobility Index is an average of the existing (2020) daily volume-to-capacity (V/C) ratio and the future (2040 AZTDM) daily V/C ratio for each segment of the corridor. The V/C ratio is an indicator of the level of congestion. This measure compares the average annual daily traffic (AADT) volume to the capacity of the corridor segment as defined by the service volume for level of service (LOS) E. By using the average of the existing and future year daily volumes, this index measures the level of daily congestion projected to occur in approximately ten years (2030) if no capacity improvements are made to the corridor.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Mobility performance area, the relevant operating environments are urban vs. rural setting. For the SR 347/SR 84 Corridor, the following operating environments were identified:

- Rural Flow: Segments 84/347-1 and 347-2

<u>*Secondary Mobility Measures*</u>

Four secondary measures provide an in-depth evaluation of operational characteristics of the corridor:

Future Congestion – Future Daily V/C

- The future (2040 AZTDM) daily V/C ratio. This measure is the same value used in the calculation of the Mobility Index
- Provides a measure of future congestion if no capacity improvements are made to the corridor

Peak Congestion – Existing Peak Hour V/C

- The peak hour V/C ratio for each direction of travel
- Provides a measure of existing peak hour congestion during typical weekdays

Travel Time Reliability – Three separate travel time reliability indicators together provide a comprehensive picture of how much time may be required to travel within the corridor:

- Closure Extent:
  - The average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average was applied to each closure that takes into account the distance over which the closure occurs
  - Closures related to crashes, weather, or other incidents are a significant contributor to non-recurring delays; construction-related closures were excluded from the analysis
- Level of Travel Time Reliability (LOTTR):
  - The ratio of the 80th percentile travel time to average (50th percentile) travel time for a given corridor segment in a specific direction; as corridor segments were often comprised of multiple roadway sections for which LOTTR was reported, a weighted average was applied to each section based on the section length in order to arrive at the segment LOTTR
  - The LOTTR reflects how consistent or dependable the travel might be from day to day or during different times of day

Multimodal Opportunities – Three multimodal opportunity indicators reflect the characteristics of the corridor that promote alternate modes to the single occupancy vehicle (SOV) for trips along the corridor:

- % Bicycle Accommodation:
  - Percentage of the segment that accommodates bicycle travel; bicycle accommodation on the roadway or on shoulders varies depending on traffic volumes, speed limits, and surface type

- Encouraging bicycle travel has the potential to reduce automobile travel, especially on non-interstate highways
- % Non-SOV Trips:
  - The percentage of trips (less than 50 miles in length) by non-SOVs
  - The percentage of non-SOV trips in a corridor gives an indication of travel patterns along a section of roadway that could benefit from additional multimodal options
- % Transit Dependency:
  - The percentage of households that have zero or one automobile and households where the total income level is below the federally defined poverty level
  - Used to track the level of need among those who are considered transit dependent and more likely to utilize transit if it is available

Mobility Performance Results

The Mobility Index provides a high-level assessment of mobility conditions for the corridor and for each segment. The four secondary measures provide more detailed information to assess mobility performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Mobility Index shows “good” overall performance for the SR 347/SR 84 Corridor
- During the existing peak hour, traffic operations are “good” for all segments
- All segments are anticipated to have “good” performance in the future, according to the Future Daily V/C performance indicator
- All segments of SR 347/SR 84 show “good” performance in Closure Extent
- There is no LOTTR performance data available for Segments 84/347-1 and 347-2
- The SR 347/SR 84 Corridor shows “poor” performance in % Bicycle Accommodation, indicating narrow shoulders
- All segments of SR 347/SR 84 show “good” performance for Non-SOV Trips

Table 8 summarizes the Mobility performance results for the SR 347/SR 84 Corridor. **Figure 12** illustrates the primary Mobility Index performance along the SR 347/SR 84 Corridor. Maps for each secondary measure can be found in **Appendix A**.

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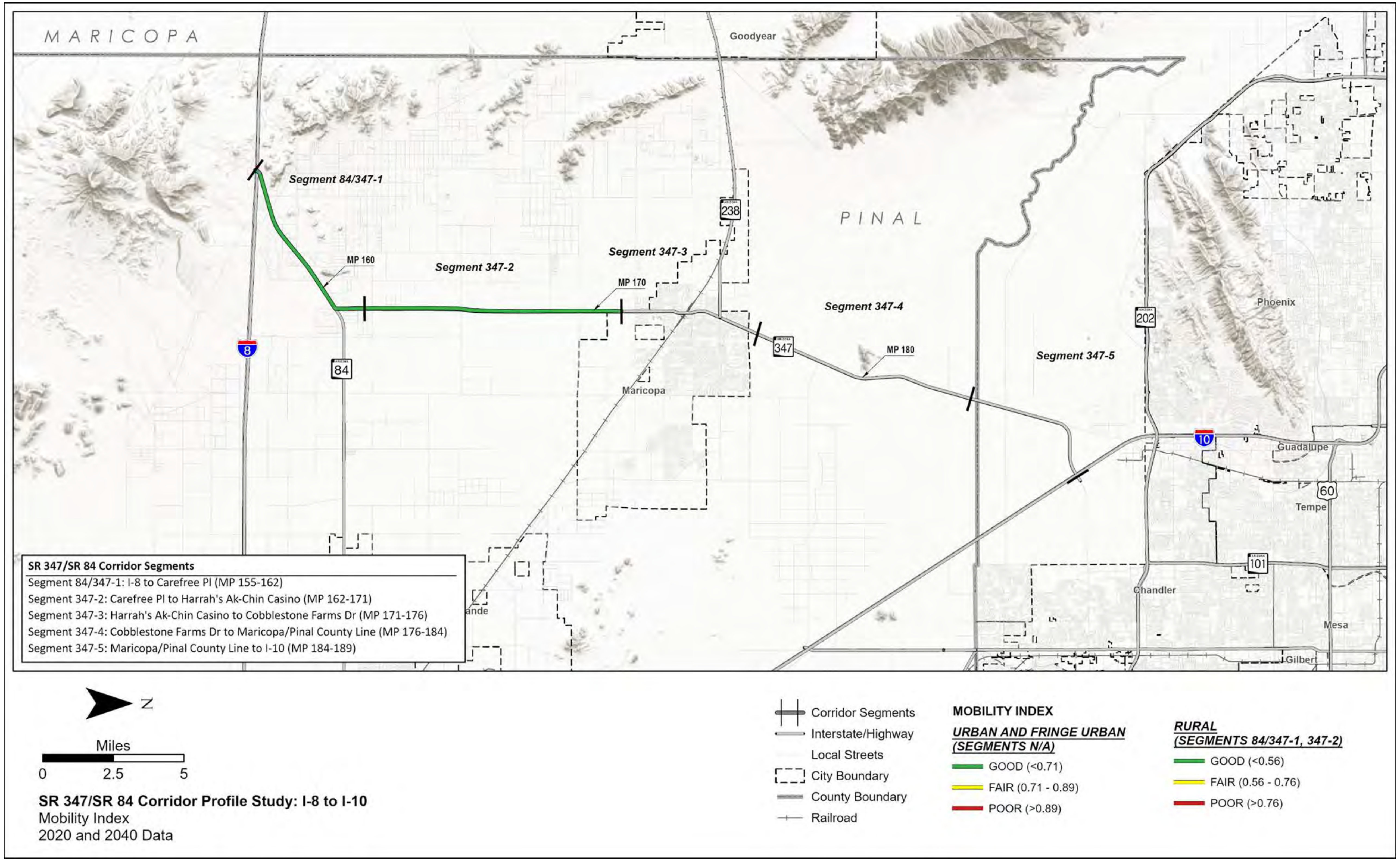
Table 8: Mobility Performance

Segment	Segment Length (miles)	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/milepost/ year/mile)		Directional LOTTR (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
				NB/EB	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB		
84/347-1[2]	6.9	0.18	0.24	0.08	0.09	0.17	0.03	No Data		12%	18.8%
347-2[2]	7.5	0.12	0.18	0.04	0.05	0.18	0.05	No Data		14%	20.1%
Weighted Corridor Average		0.15	0.21	0.06	0.07	0.17	0.04	No Data		13%	19.5%
SCALES											
Performance Level		**Rural**				**All**		**All**		**All**	**All**
Good		< 0.56				< 0.22		< 1.15		> 90%	> 17%
Fair		0.56 – 0.76				0.22 – 0.62		1.15 – 1.50		60% – 90%	11% – 17%
Poor		> 0.76				> 0.62		> 1.50		< 60%	< 11%

[1]Urban Operating Environment
[2]Rural Operating Environment

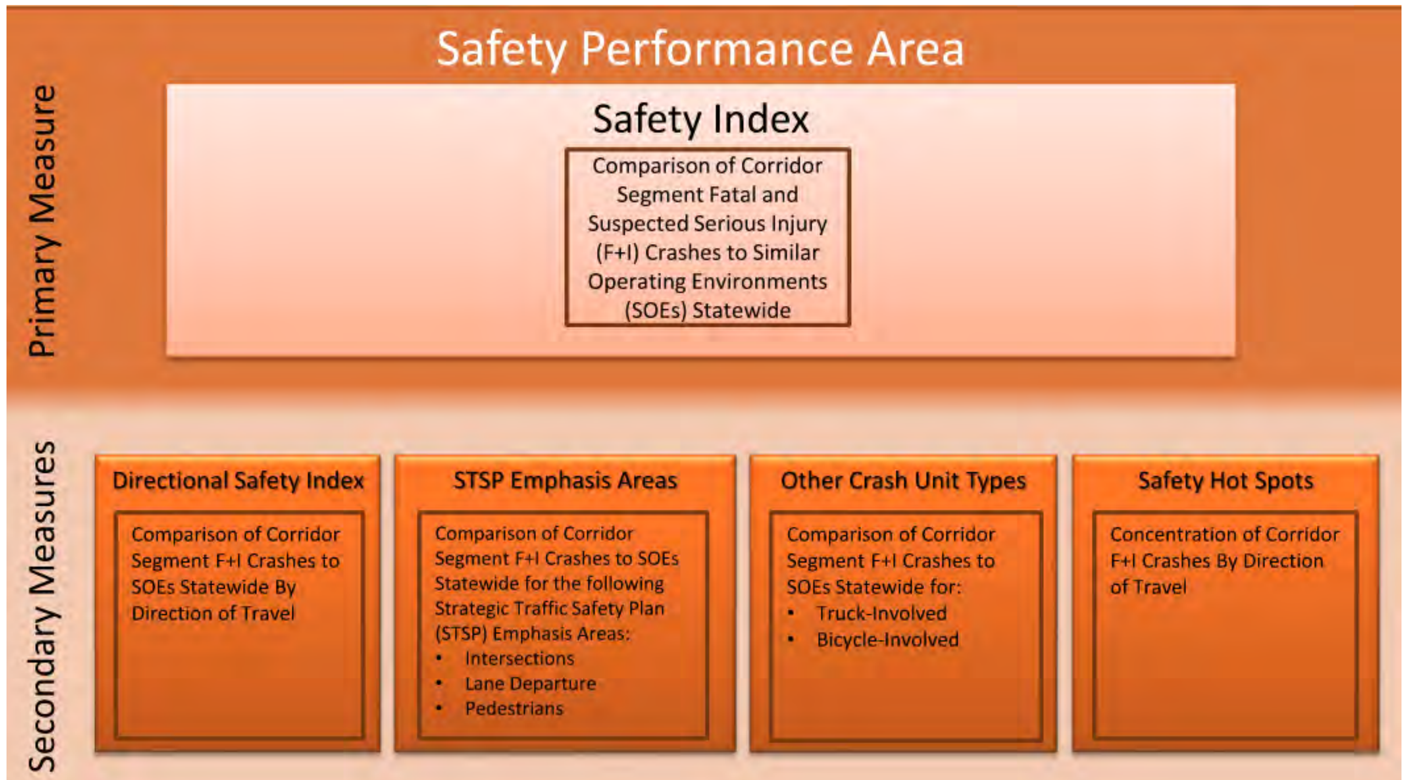
Figure 12: Mobility Performance



2.5 Safety Performance Area

The Safety performance area consists of a primary measure (Safety Index) and four secondary measures, as illustrated in **Figure 13**. All measures relate to crashes that result in fatal and suspected serious injuries, as these types of crashes are the emphasis of the ADOT Strategic Traffic Safety Plan (STSP), FHWA, and MAP-21. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C.**

Figure 13: Safety Performance Measures



Primary Safety Index

The Safety Index is based on the bi-directional frequency and rate of fatal and suspected serious injury crashes, the relative cost of those types of crashes, and crash occurrences on similar roadways in Arizona. According to ADOT's 2018 Highway Safety Improvement Program Application, fatal crashes have an estimated cost that is 17.3 times the estimated cost of suspected serious injury crashes ($9.5 million compared to $555,000).

Each corridor segment is rated on a scale by comparing the segment score with the average statewide score for similar operating environments. Because crash frequencies and rates vary depending on the operating environment of a particular roadway, statewide values were developed for similar operating environments defined by functional classification, urban vs. rural setting, number of travel lanes, and traffic volumes. For the SR 347/SR 84 Corridor, the following operating environments were identified:

- 2 or 3 Lane Undivided Highway: Segment 84/347-1
- 2 or 3 or 4 Lane Divided Highway: Segment 347-2

Secondary Safety Measures

Four secondary measures provide an in-depth evaluation of the different characteristics of safety performance:

Directional Safety Index

- This measure is based on the directional frequency and rate of fatal and suspected serious injury crashes

STSP Emphasis Areas

ADOT's 2019 STSP identified several emphasis areas for reducing fatal and suspected serious injury crashes. This measure compared rates of crashes in three STSP emphasis areas to other corridors with a similar operating environment. The three STSP emphasis areas related to crashes involving:

- Intersections
- Lane departures
- Pedestrians

Other Crash Unit Types

- The percentage of total fatal and suspected serious injury crashes that involves crash unit types of trucks and bicycles is compared to the statewide average on roads with similar operating environments

Safety Hot Spots

- The hot spot analysis identifies abnormally high concentrations of fatal and suspected serious injury crashes along the study corridor by direction of travel

For the Safety Index and the secondary safety measures, any segment that has too small of a sample size to generate statistically reliable performance ratings for a particular performance measure is considered to have "insufficient data" and is excluded from the safety performance evaluation for that particular performance measure.

Safety Performance Results

The Safety Index provides a high-level assessment of safety performance for the corridor and for each segment. The four secondary measures provide more detailed information to assess safety performance.

Based on the results of this analysis, the following observations were made:

- A total of 7 fatal and suspected serious injury crashes occurred along the SR 347/SR 84 Corridor in 2016-2020; of these crashes, 3 were fatal and 4 involved suspected serious injuries
- The crash unit type performance measures for crashes at intersections, lane departures and for crashes involving pedestrians, trucks, and bicyclists have insufficient data to generate reliable performance ratings for the SR 347/SR 84 Corridor
- The weighted average of the Safety Index shows “below average” performance for the SR 347/SR 84 Corridor compared to other segments statewide that have similar operating environments, meaning the corridor generally has more crashes than is typical statewide
- The Directional Safety Index value for Segment 84/347-1 is “below average” in both directions and for Segment 347-2 is “above average” in both directions
- There was insufficient data to determine crash hot spots for the SR 347/SR 84 Corridor

Table 9 summarizes the Safety performance results for the SR 347/SR 84 Corridor. **Figure 14** illustrates the primary Safety Index performance and locations of Safety hot spots along the SR 347/SR 84 Corridor. Maps for each secondary measure can be found in **Appendix A**.

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Table 9: Safety Performance

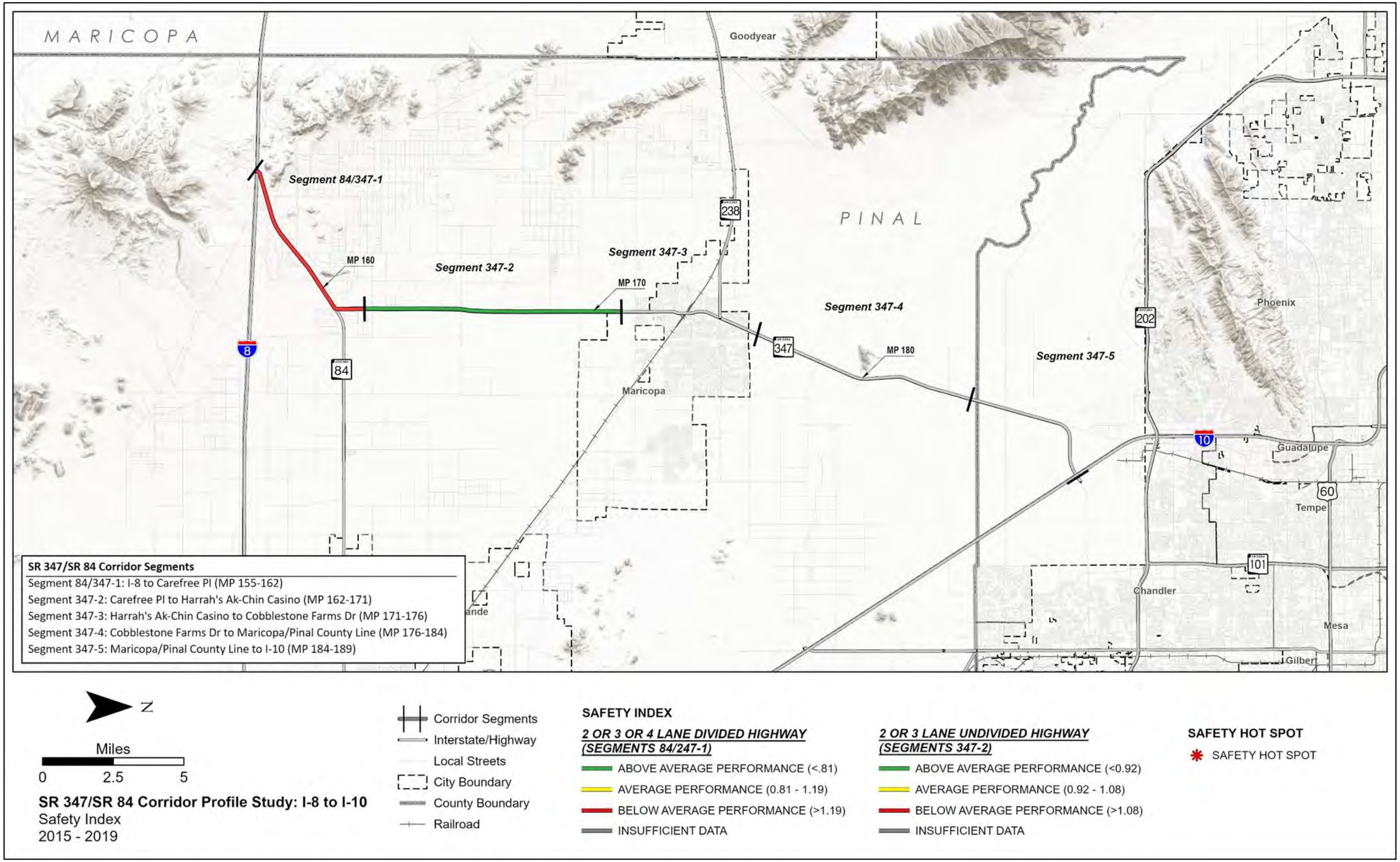
Segment	Segment Length (miles)	Safety Index	Directional Safety Index		% of Fatal + Suspected Serious Injury Crashes at Intersections	% of Fatal + Suspected Serious Injury Crashes Involving Lane Departures	% of Fatal + Suspected Serious Injury Crashes Involving Pedestrians	% of Fatal + Suspected Serious Injury Crashes Involving Trucks	% of Fatal + Suspected Serious Injury Crashes Involving Bicycles
			NB/EB	SB/WB					
84/347-1[a]	6.9	3.24	2.26	4.22	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
347-2[b]	7.5	0.12	0.08	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
Weighted Corridor Average		1.62	1.13	2.11	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
SCALES									
Performance Level		**2 or 3 or 4 Lane Divided Highway**							
Above Average		>0.81			<23.4%	<56.4%	<2.4%	<3.7%	<0.0%
Average		0.81 - 1.19			23.4% - 29.3%	56.4% - 65.0%	2.4% - 3.6%	3.7% - 9.9%	0.0% - 2.2%
Below Average		>1.19			>29.3%	>65.0%	>3.6%	>9.9%	>2.2%
Performance Level		**2 or 3 Lane Undivided Highway**							
Above Average		< 0.84			< 0%	< 72.8%	< 1.0%	< 19.0%	< 0.0%
Average		0.84 – 1.16			0% – 0%	72.8% – 76.4%	1.0% – 3.3%	19.0% – 22.5%	0.0% – 0.9%
Below Average		> 1.16			> 0%	> 76.4%	> 3.3%	> 22.5%	> 0.9%

[a] 2 or 3 Lane Undivided Highway

[b] 2 or 3 or 4 Lane Divided Highway

Note: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings

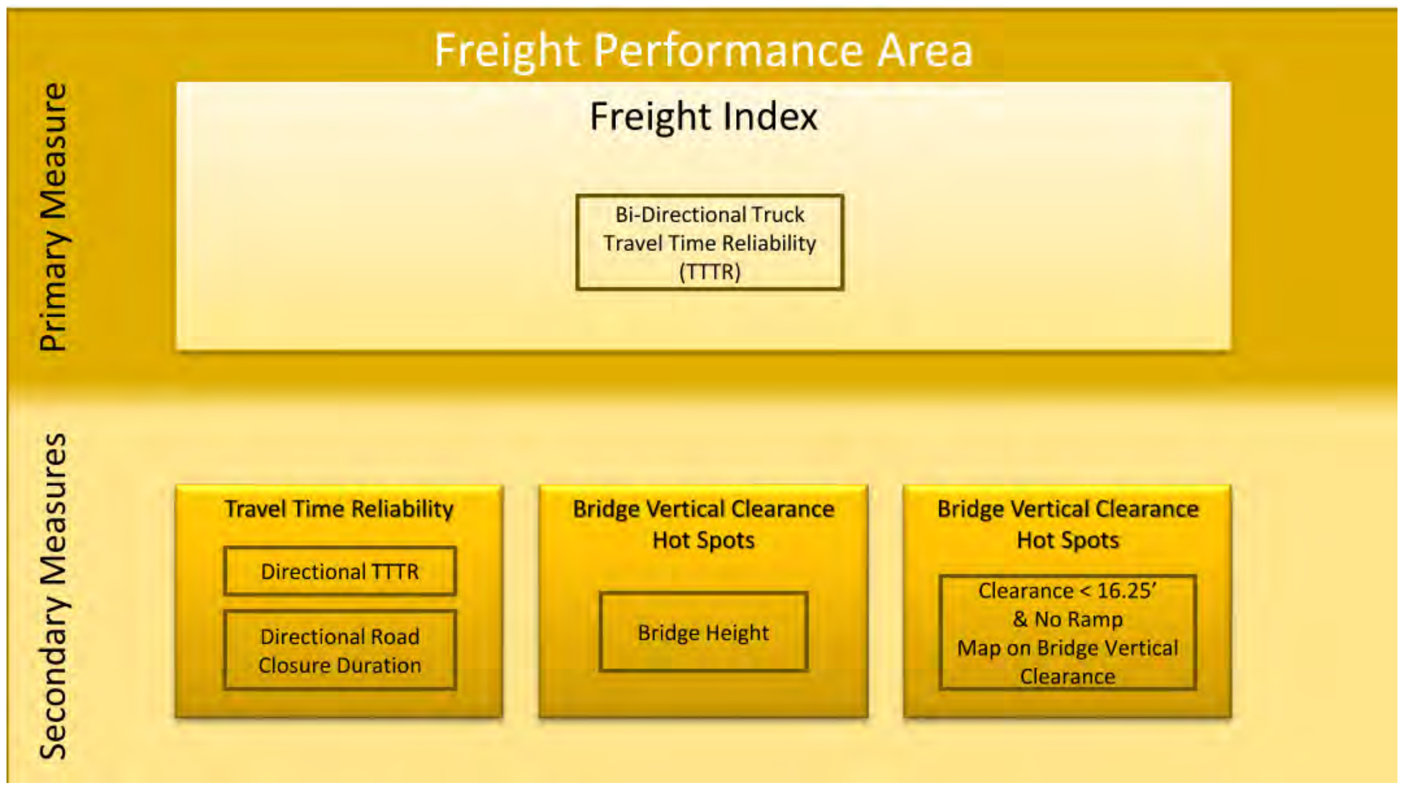
Figure 14: Safety Performance



2.6 Freight Performance Area

The Freight performance area consists of a single primary measure (Freight Index) and three secondary measures, as illustrated in **Figure 15**. All measures related to the reliability of truck travel are measured by observed truck travel time speed and delays to truck travel from road closures or physical restrictions to truck travel. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 15: Freight Performance Measures



Primary Freight Index

The Freight Index is a reliability performance measure based on the travel time reliability for truck travel. The Truck Travel Time Reliability (TTTR) is the ratio of the 95th percentile truck travel time to average (50th percentile) truck travel time. The TTTR reflects the extra buffer time needed for on-time delivery while accounting for delay resulting from circumstances such as recurring congestion, crashes, inclement weather, and construction activities.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Freight performance area, the relevant operating environments are interrupted flow (e.g., signalized at-grade intersections are present) and uninterrupted flow (e.g., controlled access grade-separated conditions such as a freeway or interstate highway).

For the SR 347/SR 84 Corridor, the following operating environments were identified:

- Interrupted Flow: Segment 84/347-1
- Uninterrupted Flow: Segment 347-2

Secondary Freight Measures

The Freight performance area includes three secondary measures that provide an in-depth evaluation of the different characteristics of freight performance:

Travel Time Reliability – Two separate travel time reliability indicators together provide a comprehensive picture of how much time may be required to travel within the corridor:

- Directional Truck Travel Time Reliability (TTTR):
  - The ratio of the 95th percentile truck travel time to average (50th percentile) truck travel time for a given corridor segment in a specific direction; as corridor segments were often comprised of multiple roadway sections for which TTTR was reported, a weighted average was applied to each section based on the section length in order to arrive at the segment TTTR
- Directional Closure Duration
  - The average time (in minutes) a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average is applied to each closure that takes into account the distance over which the closure occurs

Bridge Vertical Clearance

- The minimum vertical clearance (in feet) over the travel lanes for underpass structures on each segment

Bridge Vertical Clearance Hot Spots

- A Bridge vertical clearance "hot spot" exists where the underpass vertical clearance over the mainline travel lanes is less than 16.25 feet and no exit/entrance ramps exist to allow vehicles to bypass the low clearance location
- If a location with a vertical clearance less than 16.25 feet can be avoided by using immediately adjacent exit/entrance ramps rather than the mainline, it is not considered a hot spot

Freight Performance Results

The Freight Index provides a high-level assessment of freight mobility for the corridor and for each segment. The three secondary measures provide more detailed information to assess freight performance.

Based on the results of this analysis, the following observations were made:

- There is no data for Freight Index or Directional TTTR for the SR 347/SR 84 Corridor
- Both segments show “good” overall performance for Closure Duration
- No bridge vertical clearance hot spots exist along the SR 347/SR 84 Corridor

Table 10 summarizes the Freight performance results for the SR 347/SR 84 Corridor. **Figure 16** illustrates the primary Freight Index performance and locations of freight hot spots along the SR 347/SR 84 Corridor. Maps for each secondary measure can be found in **Appendix A**.

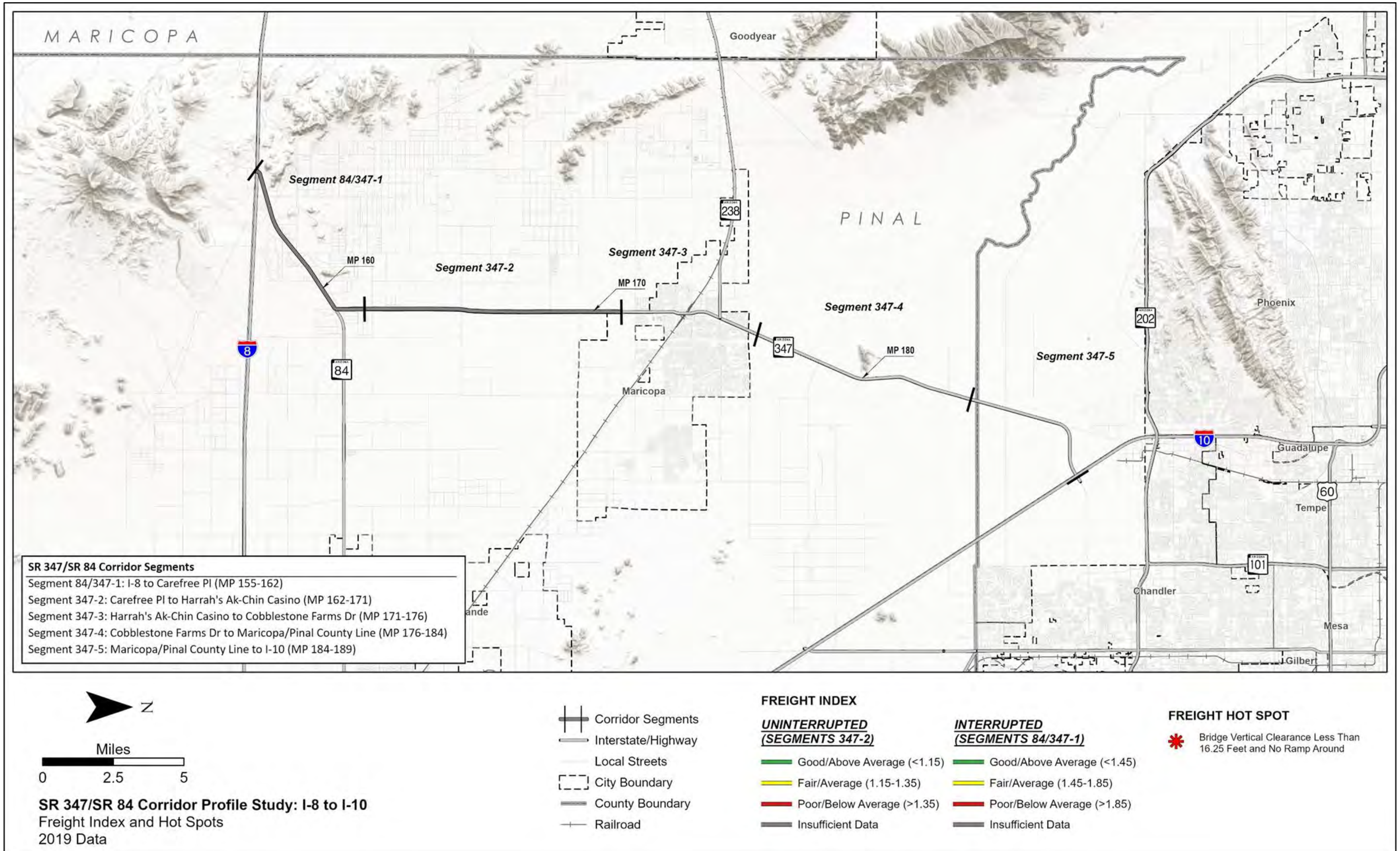
Table 10: Freight Performance

Segment	Segment Length (miles)	Freight Index	Directional TTTR		Closure Duration (minutes/milepost /year/mile)		Bridge Vertical Clearance (feet)
			NB/EB	SB/WB	NB/EB	SB/WB	
84/347-1*	6.9	No Data	No Data	No Data	26.85	6.86	No UP
347-2^	7.5	No Data	No Data	No Data	13.37	3.00	No UP
Weighted Corridor Average		-	-	-	19.83	13.37	No UP
SCALES							
Performance Level		Uninterrupted			All		All
Good		< 1.15			< 44.18		> 16.5
Fair		1.15 – 1.35			44.18 – 124.86		16.0 – 16.5
Poor		> 1.35			> 124.86		< 16.0
Performance Level		Interrupted					
Good		< 1.45					
Fair		1.45 – 1.85					
Poor		> 1.85					

^Uninterrupted Flow Facility

*Interrupted Flow Facility

Figure 16: Freight Performance



2.7 Corridor Performance Summary

Based on the results presented in the preceding sections, the following general observations were made related to the performance of the SR 347/SR 84 Corridor:

- The Pavement performance measures generally show “poor” or “fair” performance; there are no bridges to evaluate within the corridor; the Mobility performance measures generally show “good” performance; the Safety performance measures show a mix of “above average” and “below average” performance; and the Freight performance measures had insufficient data to analyze the segments
- The weighted average of the Pavement Index shows “poor” overall performance for the SR 347/SR 84 Corridor; Segments 84/347-1 and 347-2 shows “poor” performance for % Area Failure and “good” performance for Directional PSR performance metrics
- There are no bridges on either Segment 84/347-1 or Segment 347-2
- The weighted average of the Mobility Index shows “good” overall performance for the SR 347/SR 84 Corridor; Segments 84/347-1 and 347-2 show “poor” performances for % Bicycle Accommodation
- The weighted average of the Safety Index shows “below average” overall performance for the SR 347/SR 84 Corridor; for the Directional Safety Index, Segment 84/347-1 shows “below average” performance in both directions
- The Freight Index has insufficient data to analyze the weighted average of the Freight Index
- Segments 84/347-1 and 347-2 show a mix of “good/above average”, “fair/average”, and “poor/below average” performance for the various performance measures

Figure 17 shows the percentage of the SR 347/SR 84 Corridor that rates as “good/above average” performance, “fair/average” performance, or “poor/below average” performance for each primary measure. Mobility is the highest performing area along the SR 347/SR 84 Corridor, with 100% of the corridor in “good” condition as it relates to the primary measure. Pavement and Safety both show “poor/below average” performance for approximately half of the corridor length.

Table 11 shows a summary of corridor performance for all primary measures and secondary measure indicators for the SR 347/SR 84 Corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure. The weighted average ratings are summarized in **Figure 18**, which also provides a brief description of each performance measure. **Figure 18** represents the average for the entire corridor and any given segment or location could have a higher or lower rating than the corridor average.

Figure 17: Performance Summary by Primary Measure

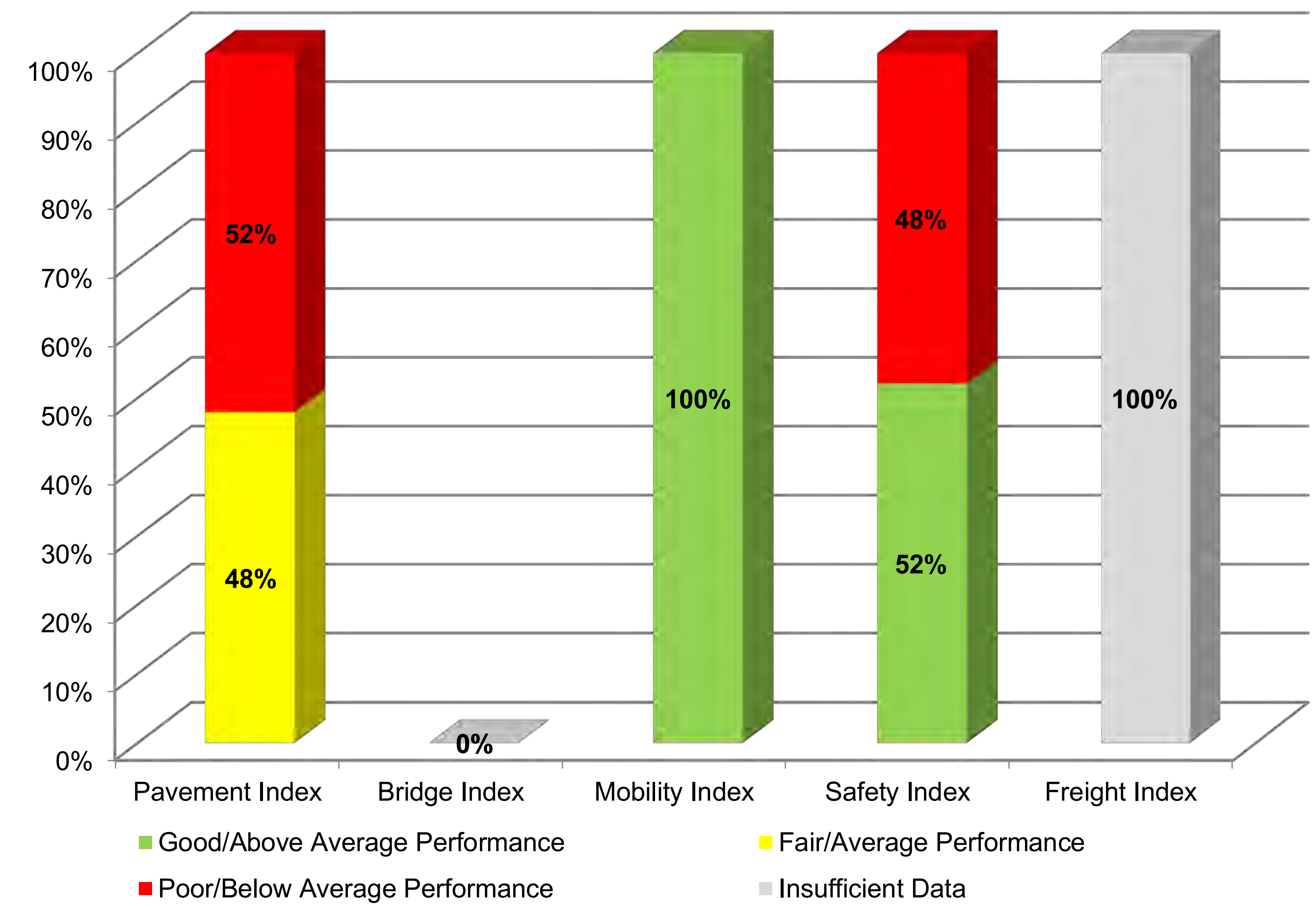


Figure 18: Corridor Performance Summary by Performance Measure

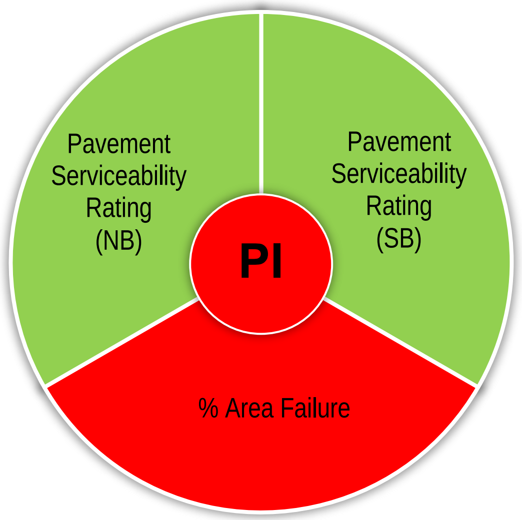
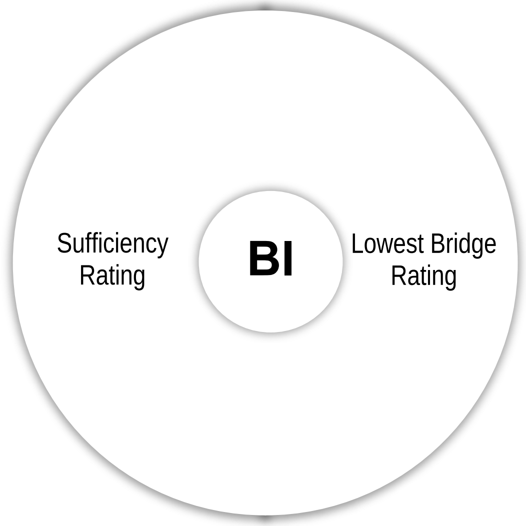
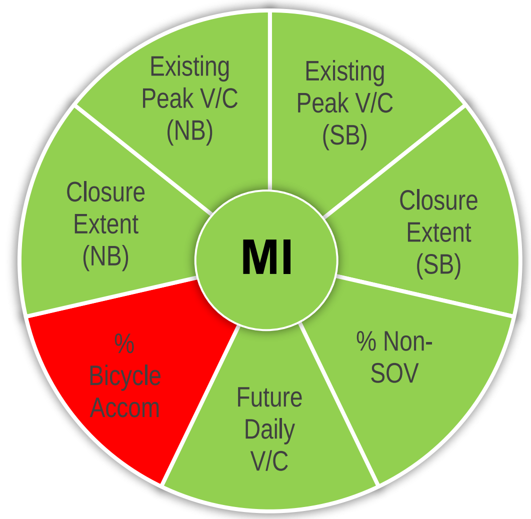
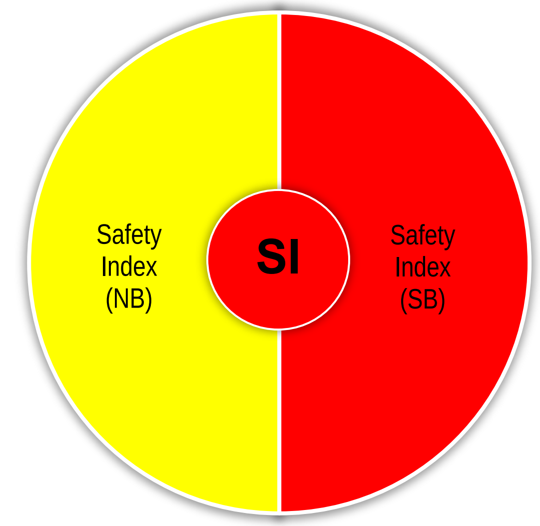
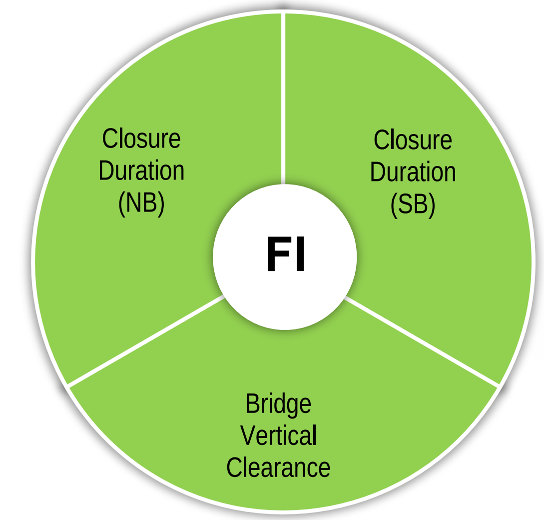
Pavement	Bridge	Mobility	Safety	Freight
				
Pavement Index (PI): based on three pavement condition ratings from the ADOT Pavement Database; the three ratings are the International Roughness Index (IRI), the Cracking Rating, and the Rutting Rating	**Bridge Index (BI):** based on four bridge condition ratings from the ADOT Bridge Database; the four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating	**Mobility Index (MI):** an average of the existing daily volume-to-capacity (V/C) ratio and the projected long-term future daily V/C ratio	**Safety Index (SI):** combines the bi-directional frequency and rate of fatal and suspected serious injury crashes, compared to crash occurrences on roads with similar operating environments in Arizona	**Freight Index (FI):** a reliability performance measure based on the bi-directional Truck Travel Time Reliability (TTTR) for truck travel
➢ **Directional Pavement Serviceability Rating (PSR)** – the weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel ➢ **% Area Failure** – the percentage of pavement area rated above failure thresholds for IRI, Cracking, or Rutting	➢ **Sufficiency Rating** – multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour ➢ **Lowest Bridge Rating** – the lowest rating of the four bridge condition ratings on each segment	➢ **Future Daily V/C** – the future daily V/C ratio provides a measure of future congestion if no capacity improvements are made to the corridor ➢ **Existing Peak Hour V/C** – the existing peak hour V/C ratio for each direction of travel provides a measure of existing peak hour congestion during typical weekdays ➢ **Closure Extent** – the average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel ➢ **Directional Level of Travel Time Reliability (LOTTR)** – the ratio of the 80th percentile peak period travel time to the 50th percentile peak period travel time for all vehicles ➢ **% Bicycle Accommodation** – the percentage of a segment that accommodates bicycle travel ➢ **% Non-Single Occupancy Vehicle (Non-SOV) Trips** –the percentage of trips that are taken by vehicles carrying more than one occupant	➢ **Directional Safety Index** – the combination of the directional frequency and rate of fatal and suspected serious injury crashes, compared to crash occurrences on roads with similar operating environments in Arizona ➢ environments	➢ **Directional TTTR** – the ratio of the 95th percentile peak period travel time to the 50th percentile peak period travel time for trucks ➢ **Closure Duration** – the average time a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel ➢ **Bridge Vertical Clearance** – the minimum vertical clearance over the travel lanes for underpass structures on each segment.

Table 11: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area				Bridge Performance Area			Mobility Performance Area									
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional LOTTR (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
			NB	SB							NB	SB	NB	SB	NB	SB		
84/347-1[2]	7	3.08	3.98	4.09	68.8%	No Bridges in Segment			0.18	0.24	0.08	0.09	0.17	0.03	No Data		12%	18.8%
347-2[2]	8	2.35	3.87	3.88	75.0%	No Bridges in Segment			0.12	0.18	0.04	0.05	0.18	0.05	No Data		14%	20.1%
Weighted Corridor Average		2.70	3.92	3.98	72.0%	N/A	N/A	N/A	0.15	0.21	0.06	0.17	0.17	0.04	No Data		13%	19.5%
SCALES																		
Performance Level		**Non-Interstate**				**All**			**Urban and Fringe Urban**				**All**		**All**		**All**	
Good/Above Average Performance		> 3.60	>3.50	< 5%	> 6.5	> 80	> 6	< 0.71					< 0.22		<1.15		> 90%	> 17%
Fair/Average Performance		2.80-3.60	2.90 - 3.50	5%- 20%	5.0 - 6.5	50 - 80	5 - 6	>0.71 - 0.89					0.22 - 0.62		1.15-1.50		60% - 90%	11% - 17%
Poor/Below Average Performance		< 2.80	< 2.90	> 20%	< 5.0	< 50	< 5	> 0.89					>0.62		>1.50		< 60%	< 11%
Performance Level		**Interstate**							**Rural**									
Good/Above Average Performance		> 3.75	>3.75	< 5%				< 0.56										
Fair/Average Performance		3.00-3.75	3.40 - 3.75	5%- 20%				>0.56 - 0.76										
Poor/Below Average Performance		< 3.00	< 3.40	> 20%				> 0.76										

[1]Urban Operating Environment
[2]Rural Operating Environment

Table 11: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area								Freight Performance Area					
		Safety Index	Directional Safety Index		% of Fatal + Suspected Serious Injury Crashes at Intersections	% of Fatal + Suspected Serious Injury Crashes Involving Lane Departures	% of Fatal + Suspected Serious Injury Crashes Involving Pedestrians	% of Segment Fatal + Suspected Serious Injury Crashes Involving Trucks	% of Segment Fatal + Suspected Serious Injury Crashes Involving Bicycles	Freight Index	Directional TTTR		Closure Duration (minutes/milepost/year)		Bridge Vertical Clearance (feet)
			NB	SB							NB	SB	NB	SB	
84/347-1 [a^]	7	3.24	2.26	4.22	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	No Data	No Data		26.85	6.86	No UP
347-2 [b*]	8	0.12	0.08	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	No Data	No Data		13.37	3.00	No UP
Weighted Corridor Average		1.62	1.13	2.11	0.00	0.00	0.00	0.00	0.00	N/A	N/A	N/A	19.83	19.83	4.85
SCALES		**SCALES**													
Performance Level		**2 or 3 or 4 Lane Divided Highway**								**Uninterrupted**			**All**		
Good/Above Average Performance		>0.81			<23.4%	<56.4%	<2.4%	<3.7%	<0.0%	< 1.15			< 44.18		> 16.5
Fair/Average Performance		0.81 - 1.19			23.4% - 29.3%	56.4% - 65.0%	2.4% - 3.6%	3.7% - 9.9%	0.0% - 2.2%	1.15 - 1.35			44.18-124.86		16.0 - 16.5
Poor/Below Average Performance		>1.19			>29.3%	>65.0%	>3.6%	>9.9%	>2.2%	> 1.35			> 124.86		< 16.0
Performance Level		**2 or 3 Lane Undivided Highway**								**Interrupted**					
Good/Above Average Performance		<0.92			<11.2%	<66.9%	<3.8%	<4.2%	<0.0%	<1.45					
Fair/Average Performance		0.92 - 1.08			11.2% - 15.6%	66.9% - 74.5%	3.8% -7.2%	4.2% -8.0%	0.0% - 3.3%	1.45-1.85					
Poor/Below Average Performance		>1.08			>15.6%	>74.5%	>7.2%	>8.0%	>3.3%	>1.85					

[a] 2 or 3 Lane Undivided Highway
[b] 2 or 3 or 4 Lane Divided Highway
^Uninterrupted Flow Facility
*Interrupted Flow Facility

Note: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings

3 NEEDS ASSESSMENT

3.1 Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP) 2010-2035 goals and objectives that were updated in 2017. Statewide performance goals that are relevant to SR 347/SR 84 performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three "Emphasis Areas" were identified for the SR 347/SR 84 Corridor: Mobility, Safety, and Freight.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas. **Table 12** shows the SR 347/SR 84 Corridor goals, corridor objectives, and performance objectives, and how they align with the statewide goals.

It is not reasonable within a financially constrained environment to expect that every performance measure will always be at the highest levels on every corridor segment. Therefore, individual corridor segment objectives have been set as "fair/average" or better and should not fall below that standard.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Addressing current and future congestion, thereby improving mobility on congested segments, will also help the corridor fulfill its potential as a significant contributor to the region's economy.

Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

Goal achievement will improve or reduce current and future congestion, increase travel time reliability, and reduce fatalities and suspected serious injuries resulting from vehicle crashes. Where performance is currently rated "good", the goal is always to maintain that standard, regardless of whether or not the performance is in an emphasis area.

Table 12: Corridor Performance Goals and Objectives

ADOT Statewide LRTP Goals	SR 347/SR 84 Corridor Goals	SR 347/SR 84 Corridor Objectives	Performance Area	Performance Measure / Secondary Measure Indicators	Performance Objective: Corridor Average	Performance Objective: Segment
Preserve & Maintain the State Transportation System	Maintain, preserve, extend service life, and modernize State Transportation System infrastructure	Improve pavement ride quality for all corridor users Reduce long-term pavement maintenance costs	Pavement	Pavement Index	Fair or better	Fair or better
				Directional Pavement Serviceability Rating		
				% Area Failure		
		Maintain structural integrity of bridges	Bridge	Bridge Index	Fair or better	Fair or better
				Sufficiency Rating		
				Lowest Bridge Rating		
Improve Mobility, Reliability, and Accessibility **Make Cost-Effective Investment Decisions and Support Economic Vitality**	Improve mobility through additional capacity and improved roadway geometry Provide a safe and reliable route for recreational and tourist travel Provide safe, reliable and efficient connection to all communities along the corridor to permit efficient regional travel Implement critical/cost-effective investments to improve access to multimodal transportation	Reduce current congestion and plan to facilitate future congestion that accounts for anticipated growth, particularly from the City of Maricopa and the nearby Phoenix metropolitan area Reduce delays from recurring and non-recurring events to improve reliability Better accommodate bicycle and pedestrian use on the state system Emphasize the deployment of technology to optimize existing system capacity and performance	Mobility *(Emphasis Area)*	Mobility Index	Good	Fair or better
				Future Daily V/C		
				Existing Peak Hour V/C		
				Closure Extent		
				Directional Level of Travel Time Reliability		
				% Bicycle Accommodation		
				% Non-SOV Trips		
Enhance Safety	Provide a safe, reliable, and efficient connection for the communities along the corridor Improve transportation system safety for all modes	Reduce the number and rate of fatal and suspected serious injury crashes for all roadway users	Safety *(Emphasis Area)*	Safety Index	Above Average	Average or better
				Directional Safety Index		
				% of Fatal + Suspected Serious Injury Crashes at Intersections		
				% of Fatal + Suspected Serious Injury Crashes Involving Lane Departures		
				% of Fatal + Suspected Serious Injury Crashes Involving Pedestrians		
				% of Fatal + Suspected Serious Injury Crashes Involving Trucks		
				% of Fatal + Suspected Serious Injury Crashes Involving Bicycles		
Improve Mobility, Reliability, and Accessibility **Make Cost-Effective Investment Decisions and Support Economic Vitality**	Provide a safe, reliable and efficient freight route	Implement the most cost-effective transportation solutions Reduce delays and restrictions to freight movement to improve reliability Improve travel time reliability (including impacts to motorists due to freight traffic)	Freight *(Emphasis Area)*	Freight Index	Good	Fair or better
				Truck Travel Time Reliability		
				Closure Duration		
				Bridge Vertical Clearance		

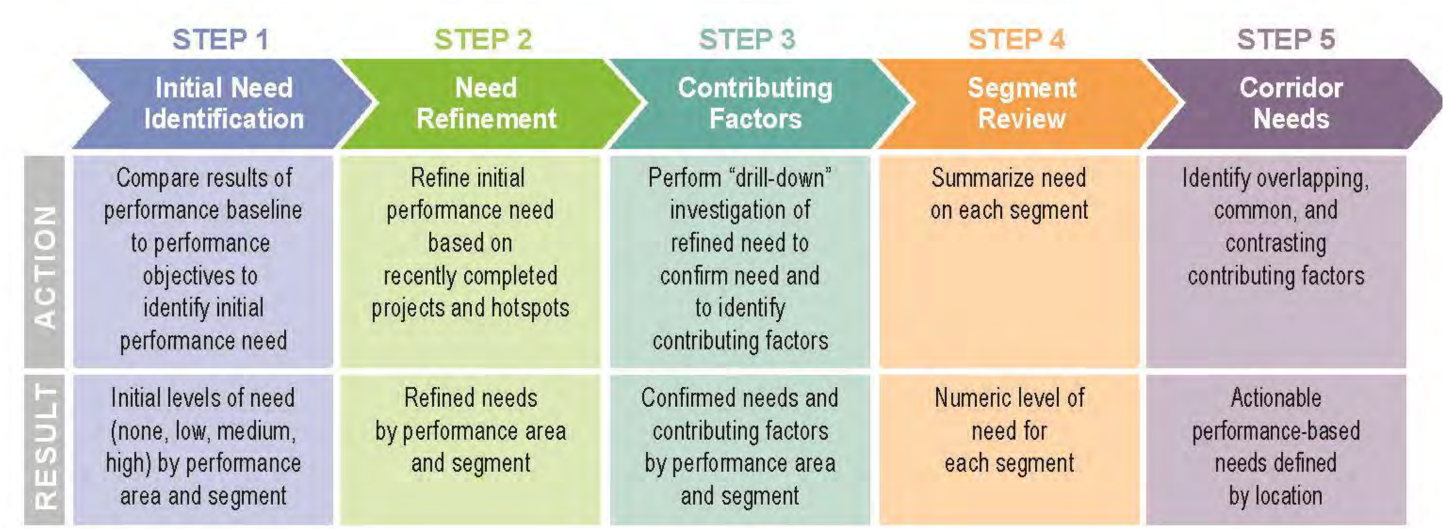
3.2 Needs Assessment Process

The following guiding principles were used as an initial step in developing a framework for the performance-based needs assessment process:

- Corridor needs are defined as the difference between the corridor performance and the performance objectives
- The needs assessment process should be systematic, progressive, and repeatable, but also allow for engineering judgment where needed
- 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 MP 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 19** and described in the following sections.

Figure 19: Needs Assessment Process



Step 1: Initial Needs Identification

The first step in the needs assessment process links baseline (existing) corridor performance with performance objectives. In this step, the baseline corridor performance is compared to the performance objectives to provide a starting point for the identification of 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 is shown in **Figure 20**.

Figure 20: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
	Good	None*	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
6.5	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		

**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.*

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final 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.

Step 2: Need Refinement

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

- For segments with an initial need of None that contain hot spots, the level of need should be increased from None to Low
- For segments with an initial level of need where recently completed projects or projects under construction are anticipated to partially or fully address the identified need, the level of need should be reduced or eliminated as appropriate
- Programmed projects that are expected to partially or fully address an identified need are not justification to lower the initial need because the programmed projects 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 needs are carried forward for further evaluation in Step 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 used to develop the baseline performance serve as the principal sources for the more detailed analysis. However, other supplemental databases may also be useful sources of information. The databases used for diagnostic analysis are listed below:

Pavement Performance Area

- Pavement Rating Database

Bridge Performance Area

- ABISS

Mobility Performance Area

- Highway Performance Monitoring System (HPMS) Database
- AZTDM
- Real-time traffic conditions data produced by INRIX Database
- Highway Conditions Reporting System (HCRS) Database

Safety Performance Area

- Crash Database

Freight Performance Area

- INRIX Database
- HCRS Database

In addition, other sources considered helpful in identifying contributing factors are:

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

Step 3 results in the identification of performance-based needs and contributing factors by segment (and MP locations, if appropriate) that can be addressed through investments in preservation, modernization, and expansion projects to improve corridor performance. See **Appendix D** for more information.

Step 4: Segment Review

In this step, the needs identified in Step 1 and refined in Step 2 are quantified for each segment to numerically estimate the level of need for each segment. Values of 0 to 3 are assigned to the final need levels (from Step 3) of None, Low, Medium, and High, respectively. A weighting factor is applied to the performance areas identified as emphasis areas and a weighted average need is calculated for each segment. The resulting average need score can be used to compare levels of need between segments within a corridor and between segments in different corridors.

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 solution sets 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.

3.3 Corridor Needs Assessment

This section documents the results of the needs assessment process described in the prior section. The needs in each performance area were classified as either None, Low, Medium, or High based on how well each segment performed in the existing performance analysis. The needs for each segment were numerically combined to estimate the average level of need for each segment of the corridor

The final needs assessments for each performance measure, along with the scales used in analysis, are shown in **Table 13** through **Table 17**.

Pavement Needs

- Pavement hot spots were identified in Segments 84/347-1 and 347-2
- Segment 84/347-1 shows a Medium level of need
- Segment 347-2 shows a High level of need
- See **Appendix D** for detailed information on contributing factors

Table 13: Final Pavement Needs

Segment #	Performance Score and Level of Need				Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Pavement Index	Directional PSR		% Area Failure				
		NB	SB					
84/347-1	3.08	3.98	4.09	69%	1.60	MP 156-162	None	Medium
347-2	2.35	3.87	3.88	75%	3.60	MP 162-168	None	High

Level of Need (Score)	Performance Score Need Scale			Segment Level Need Scale
None* (0)	> 3.33	> 3.30	< 10%	0
Low (1)	3.07 - 3.33	3.30 - 3.10	10% - 15%	< 1.5
Medium (2)	2.53 - 3.07	3.10 - 2.70	15% - 25%	1.5 - 2.5
High (3)	< 2.53	< 2.70	> 25%	> 2.5

Bridge Needs

- There are no bridges and therefore no Bridge needs in Segments 84/347-1 and 347-2
- See **Appendix D** for detailed information on contributing factors

Table 14: Final Bridge Needs

Segment #	Performance Score and Level of Need			Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Bridge Index	Sufficiency Rating	Lowest Bridge Rating				
84/347-1	No Bridges	No Bridges	No Bridges	None	None	None	None
347-2	No Bridges	No Bridges	No Bridges	None	None	None	None

Level of Need (Score)	Performance Score Need Scale			Segment Level Need Scale
None* (0)	≥ 6.0	≥ 70	> 5	0
Low (1)	5.5 - 6.0	60 - 70	5	< 1.5
Medium (2)	4.5 - 5.5	40 - 60	4	1.5 - 2.5
High (3)	≤ 4.5	≤ 40	< 4	> 2.5

**A segment need rating of ‘None’ does not indicate a lack of needed improvements; rather, it indicated 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.*

Mobility Needs

- The Mobility performance area is an emphasis area for the SR 347/SR 84 Corridor
- Low Mobility needs were identified in Segments 84/347-1 and 347-2
- The identified needs are related to bicycle accommodations
- See **Appendix D** for detailed information on contributing factors

Table 15: Final Mobility Needs

Segment #	Performance Score and Level of Need									Initial Segment Need	Recently Completed Projects	Final Segment Need
	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent		Directional LOTTR		% Bicycle Accommodation			
			NB/WB	SB/EB	NB/WB	SB/EB	NB/WB	SB/EB				
84/347-1[2b]	0.18	0.25	0.08	0.09	0.17	0.03	No Data	No Data	12%	0.6	None	Low
347-2[2a]	0.13	0.19	0.04	0.05	0.18	0.05	No Data	No Data	14%	0.8	None	Low
Level of Need (Score)	**Performance Score Need Scale**									**Segment Level Need Scale**		
None* (0)	≤ 0.77 (Urban)				< 0.35		< 1.27[a]		> 80%	0		
	≤ 0.63 (Rural)						< 1.27[b]					
Low (1)	0.77 - 0.83 (Urban)				0.35 - 0.49		1.27 - 1.38[a]		70% - 80%	< 1.5		
	0.63 - 0.69 (Rural)						1.27 - 1.38[b]					
Medium (2)	0.83 - 0.95 (Urban)				0.49 - 0.75		1.38 - 1.62[a]		50% - 70%	1.5 - 2.5		
	0.69 - 0.83 (Rural)						1.38 - 1.62[b]					
High (3)	≥ 0.95 (Urban)				> 0.75		> 1.62[a]		< 50%	> 2.5		
	≥ 0.83 (Rural)						> 1.62[b]					

1: Urban or Fringe Urban
2: Rural

a: Uninterrupted Flow Facility
b: Interrupted Flow Facility

** 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.*

<u>Safety Needs</u>

- The Safety performance area is an emphasis area for the SR 347/SR 84 Corridor
- A High Safety need was identified in Segment 84/347-1
- There were no Safety hot spots identified
- See **Appendix D** for detailed information on contributing factors

Table 16: Final Safety Needs

Segment #	Performance Score and Level of Need								Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Safety Index	Directional Safety Index		% of Fatal + Suspected Serious Injury Crashes at Intersections	% of Fatal + Suspected Serious Injury Crashes Involving Lane Departures	% of Fatal + Suspected Serious Injury Crashes Involving Pedestrians	% of Fatal + Suspected Serious Injury Crashes Involving Trucks	% of Fatal + Suspected Serious Injury Crashes Involving Bicycles				
		NB/EB	SB/WB									
84/347-1[a]	3.24	2.26	4.22	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	3.6	None	None	High
347-2[b]	0.12	0.08	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.0	None	None	None

Level of Need (Score)		Performance Score Needs Scale						Segment Level Need Scale
None* (0)	a	≤ 0.97	≤ 13%	≤ 69%	≤ 5%	≤ 5%	≤ 1%	0
	b	≤ 0.94	≤ 25%	≤ 59%	≤ 3%	≤ 6%	≤ 1%	
Low (1)	a	0.98 - 1.02	14%	70% -72%	6%	6%	2%	≤ 1.5
	b	0.95 - 1.07	26-27%	60% -62%	3%	7%-8%	2%	
Medium (2)	a	1.03 - 1.12	15% -16%	73% -76%	7%	7% -8%	3%	1.5 - 2.5
	b	1.08- 1.31	28% -30%	63% -67%	3%	9%-11%	3%	
High (3)	a	≥ 1.13	≥ 17%	≥ 77%	≥ 8%	≥ 9%	≥ 4%	≥ 2.5
	b	≥ 1.32	≥ 31%	≥ 68%	≥ 4%	≥ 12%	≥ 4%	

a: 2 or 3 Lane Undivided Highway
b: 2 or 3 or 4 Lane Divided Highway

** 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.*

Freight Needs

- The Freight performance area is an emphasis area for the SR 347/SR 84 Corridor
- Data was missing for the Freight Index and Directional TTTR but District input indicates there is no current Freight need in Segments 84/347-1 and 347-2
- There were no Freight hot spots identified
- There were no Freight needs that were identified in Segments 84/347-1 and 347-2
- See **Appendix D** for detailed information on contributing factors

Table 17: Final Freight Needs

Segment #	Performance Score and Level of Need						Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Freight Index	Directional TTTR		Closure Duration		Bridge Vertical Clearance				
		NB	SB	NB	SB					
84/347-1[b]	No Data	No Data	No Data	26.85	6.86	No UP	N/A	None	None	None
347-2[a]	No Data	No Data	No Data	13.37	3.00	No UP	N/A	None	None	None

Level of Need (Score)			Performance Score Need Scale			Segment Level Need Scale
None* (0)	a	≤ 1.22	≤ 1.22	≤ 71.07	≥ 16.33	0
	b	≤ 1.58	≤ 1.58			
Low (1)	a	1.22-1.28	1.22-1.28	71.07 - 97.97	16.17 - 16.33	≤ 1.5
	b	1.58-1.72	1.58-1.72			
Medium (2)	a	1.28-1.42	1.28-1.42	97.97 - 151.75	15.83 - 16.17	1.5 - 2.5
	b	1.72-1.98	1.72-1.98			
High (3)	a	≥ 1.42	≥ 1.42	≥ 151.75	≤ 15.83	≥ 2.5
	b	≥ 1.98	≥ 1.98			
	b	≥ 1.98	≥ 1.98			

a: Uninterrupted Flow Facility
b: Interrupted Flow Facility

** 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.*

Segment Review

The needs for each segment were combined to numerically estimate the average level of need for each segment of the corridor. **Table 18** provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Mobility, Safety, and Freight for the SR 347/SR 84 Corridor). There is one segment with a Medium overall average need and one segment with a Low overall average need.

Table 18: Summary of Needs by Segment

Performance Area	Segment Number and Mileposts (MP)	
	84/347-1	347-2
	MP 155-162	MP 162-171
Pavement	Medium	High
Bridge	None	None
Mobility*	Low	Low
Safety*	High	None
Freight*	None	None
Average Need	1.23	0.85

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

* Identified as an Emphasis Area for the SR 347/SR 84 Corridor
# 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

Summary of Corridor Needs

The needs in each performance area are shown in **Figure 21** and summarized below:

Pavement Needs

- Pavement hot spots were identified in Segments 84/347- 1 and 347-2
- Segment 84/347-1 shows a Medium level of need
- Segment 347-2 shows a High level of need

Bridge Needs

- There are no bridges and therefore no Bridge needs in Segments 84/347-1 and 347-2

Mobility Needs

- The Mobility performance area is an emphasis area for the SR 347/SR 84 Corridor
- Low Mobility needs were identified in Segments 84/347-1 and 347-2
- The identified needs are related to bicycle accommodations

Safety Needs

- The Safety performance area is an emphasis area for the SR 347/SR 84 Corridor
- A High Safety need was identified in Segment 84/347-1
- There were no Safety hot spots identified

Freight Needs

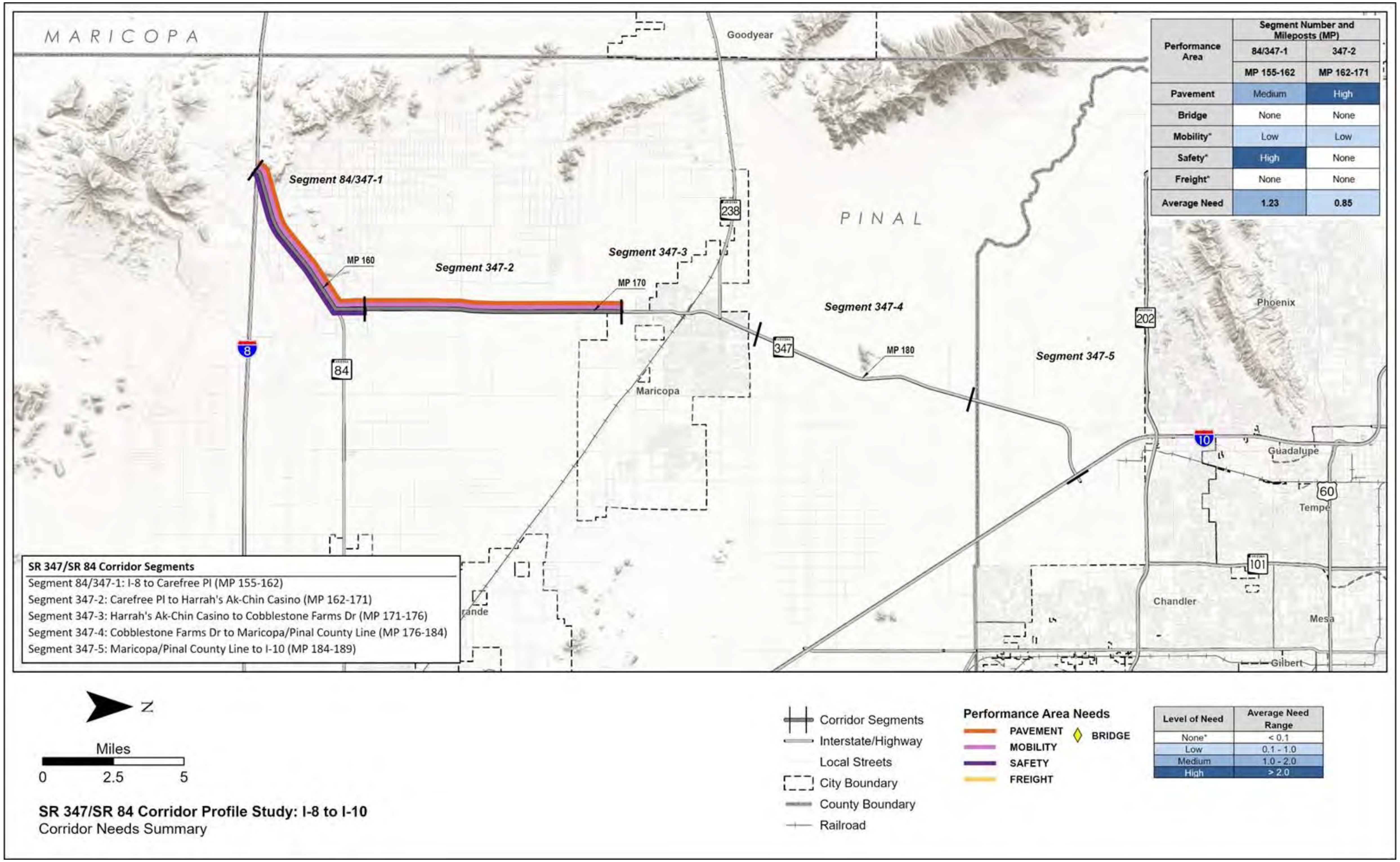
- The Freight performance area is an emphasis area for the SR 347/SR 84 Corridor
- Data was missing for the Freight Index and Directional TTTR but District input indicates there is no current Freight need in Segments 84/347-1 and 347-2
- There were no Freight hot spots identified
- There were no Freight needs that were identified in Segments 84/347-1 and 347-2

Overlapping Needs

This section identifies overlapping performance needs on the SR 347/SR 84 Corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to improve overall performance more effectively. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- Segment 84/347-1, which has the highest average need score of all the segments of the corridor, has elevated needs in the Safety and Pavement performance areas
- Segment 347-2 has elevated needs in the Pavement performance area

Figure 21: Corridor Needs Summary



*Identified as an Emphasis Area

*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.

4 STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need (i.e., Medium or High). Addressing areas of Medium or High need will have the greatest effect on corridor performance and are the focus of the strategic solutions. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The SR 347/SR 84 strategic investment areas (resulting from the elevated needs) are shown in **Figure 22**.

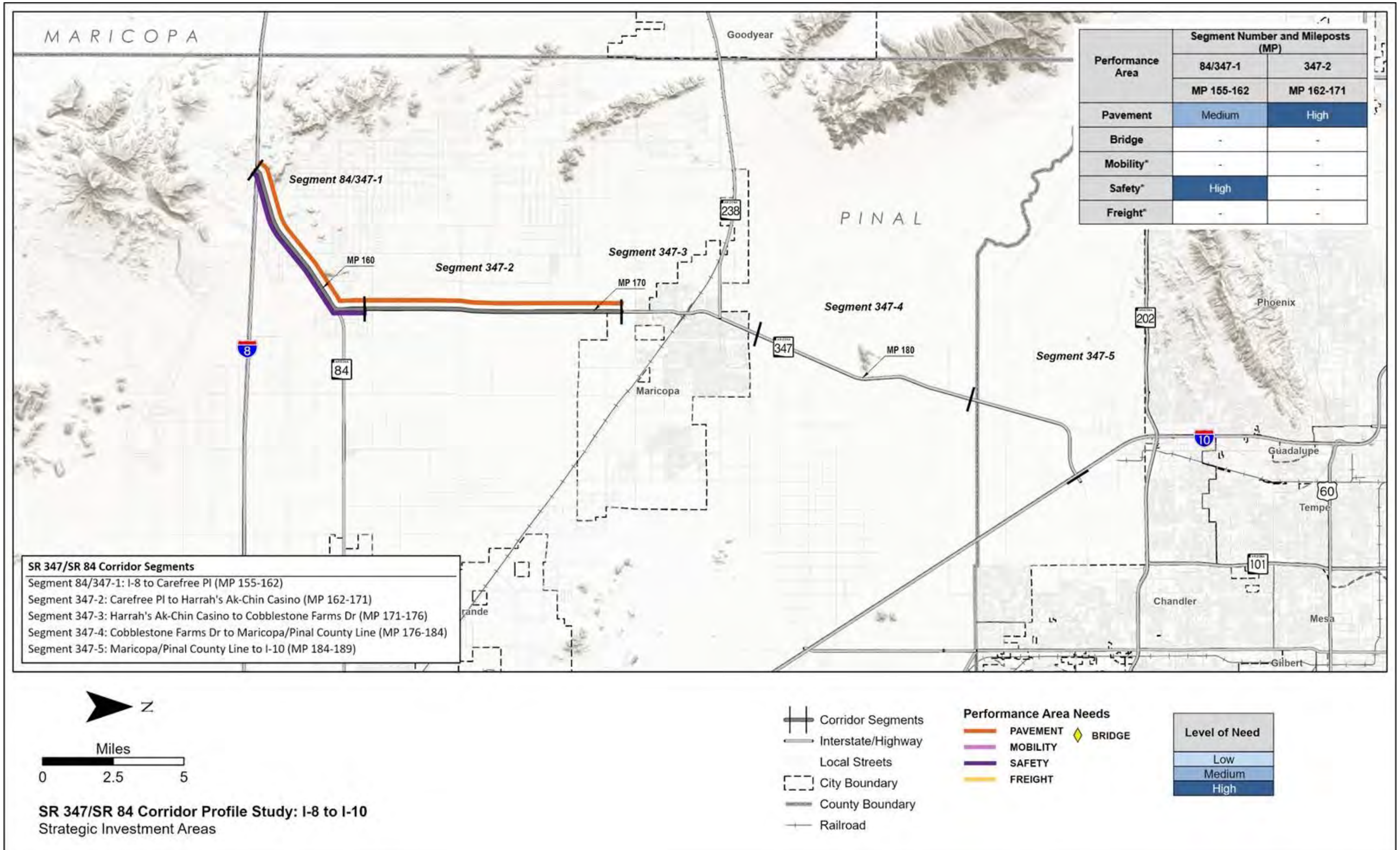
4.1 Screening Process

This section examines qualifying strategic needs and determines if the needs in those locations require action. In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures, including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment or rating issues; these hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need; this bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

Table 19 notes if each potential strategic need advanced to solution development, and if not, the reason for screening the potential strategic need out of the process. Locations advancing to solutions development are marked with Yes (Y); locations not advancing are marked with No (N) and highlighted. This screening table provides specific information about the needs in each segment that will be considered for strategic investment. The table identifies the level of need – either Medium or High segment needs, or segments without Medium or High level of need that have a hot spot. Each area of need is assigned a location number in the screening table to help document and track locations considered for strategic investment.

Figure 22: Strategic Investment Areas



Performance Area	Segment Number and Mileposts (MP)	
	84/347-1	347-2
	MP 155-162	MP 162-171
Pavement	Medium	High
Bridge	-	-
Mobility*	-	-
Safety*	High	-
Freight*	-	-

*Identified as an Emphasis Area

Table 19: Strategic Investment Area Screening

Segment # and MP	Level of Strategic Need: Pavement	Bridge	Mobility	Safety	Freight	Location #	Type	Need Description	Advance (Y/N)	Screening Description
84/347-1 (MP 155-162)	Medium	-	-	High	-	L1	Pavement	MP 155-162 has a Medium level of need based on the % Area Failure and has a hot spot MP 156-162	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes
						L2	Safety	MP 155-162 has an overall Safety Index and both Directional Safety Indexes above the statewide average 3 fatal crashes and 1 suspected serious injury crash in segment; crash data analysis indicates 50% involve overturning, 50% involve being under the under the influence of drugs or alcohol, and 50% occur in wet surface conditions	Y	No programmed project to address Safety need
347-2 (MP 162-169.5)	High	-	-	-	-	L3	Pavement	MP 162-169.5 has a High level of need based on the overall Pavement Index, % Area Failure, and a hot spot MP 162-168	N	No high historical investment so not considered a strategic investment, will likely be addressed by current ADOT processes

Legend: [shaded] Strategic investment area screened out from further consideration.

4.2 Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the SR 347/SR 84 Corridor will be considered along with other candidate projects in the ADOT statewide programming process.

Characteristics of Strategic Solutions

Candidate solutions should include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate Solutions

One candidate solution is proposed to address the identified needs on the SR 347/SR 84 Corridor.

Table 20 identifies each strategic location that has been assigned a candidate solution with a number (e.g., CS347.1, CS347.2, etc.). Each candidate solution is comprised of one or more components to address the identified needs. The assigned candidate solution numbers are linked to the location number and provide tracking capability through the rest of the process. The locations of proposed solutions are shown on the map in **Figure 23**.

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance area will include two options: rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

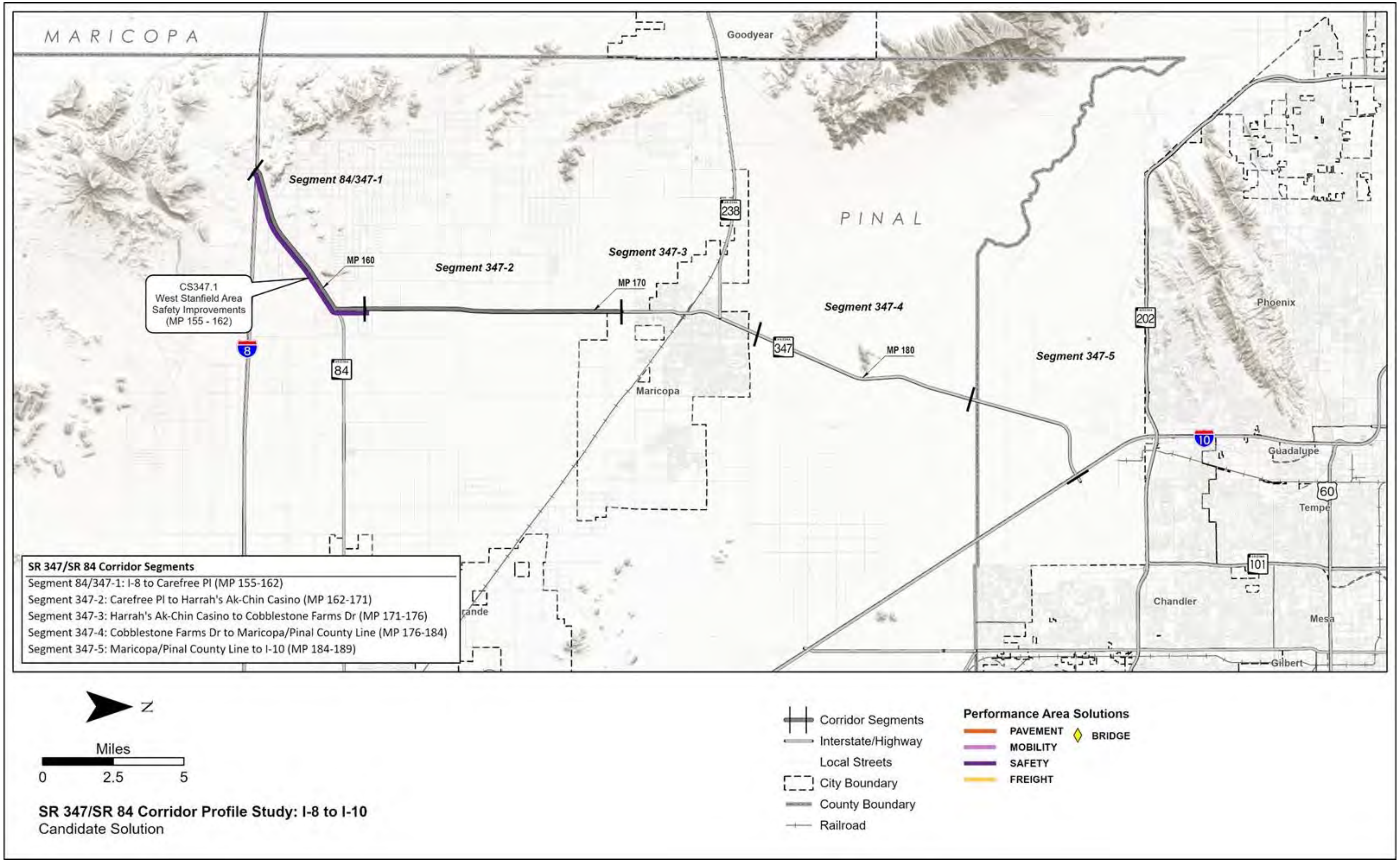
Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

Table 20: Candidate Solutions

Candidate Solution #	Segment #	Location #	Beginning Milepost	Ending Milepost	Candidate Solution Name	Option*	Candidate Solution Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS347.1	84/347-1	L2	155	162	West Stanfield Area Safety Improvements	-	-Rehabilitate shoulders in both directions (striping, delineators, RPMs, safety edge, and rumble strips for both shoulders)	M

* '-': Indicates only one solution is being proposed and no options are being considered

Figure 23: Candidate Solutions



5 SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation are shown in **Figure 24** and described more fully below.

Life-Cycle Cost Analysis

All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

When multiple independent candidate solutions are developed for Mobility, Safety, or Freight strategic investment areas, these candidate solution options advance directly to the Performance Effectiveness Evaluation without an LCCA.

Performance Effectiveness Evaluation

After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

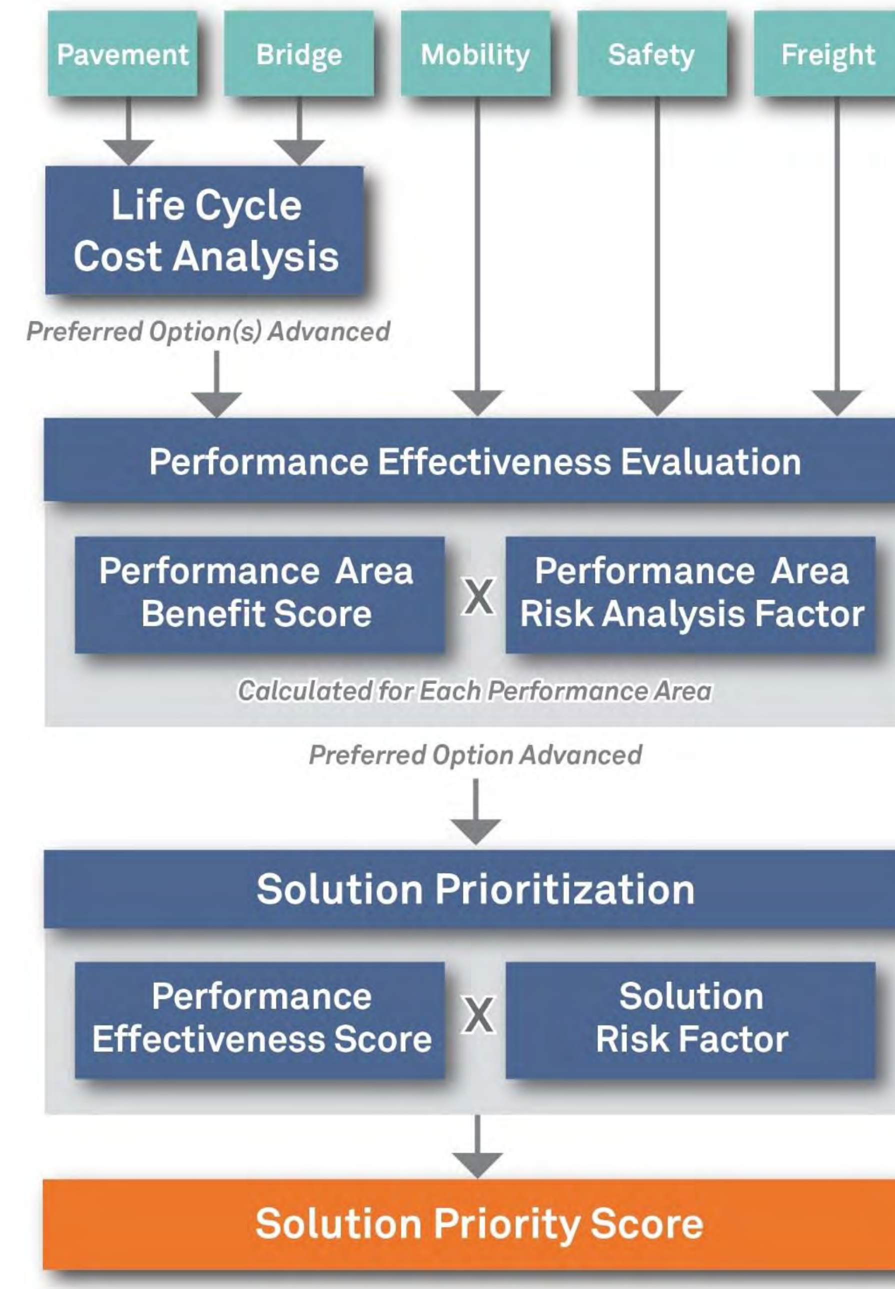
Solution Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of performance failure.

Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure 24: Candidate Solution Evaluation Process



5.1 Life-Cycle Cost Analysis

LCCA is conducted for any candidate solution that is developed as a result of a need in the Pavement or Bridge Performance Area. The intent of the LCCA is to determine which options warrant further investigation and eliminate options that would not be considered strategic.

LCCA is an economic analysis that compares cost streams over time and presents the results in a common measure, the present value of all future costs. The cost stream occurs over an analysis period that is long enough to provide a reasonably fair comparison among alternatives that may differ significantly in scale of improvement actions over shorter time periods. For both bridge and pavement LCCA, the costs are focused on agency (ADOT) costs for corrective actions to meet the objective of keeping the bridge or pavement serviceable over a long period of time.

LCCA is performed to provide a more complete holistic perspective on asset performance and agency costs over the life of an investment stream. This approach helps ADOT look beyond initial and short-term costs, which often dominate the considerations in transportation investment decision making and programming.

Bridge LCCA

For the bridge LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected bridges, as described below:

- Bridge replacement (large upfront cost but small ongoing costs afterwards)
- Bridge rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- On-going repairs until replacement (low upfront and ongoing costs until replacement)

The bridge LCCA model developed for the CPS reviews the characteristics of the candidate bridges including bridge ratings and deterioration rates to develop the three improvement strategies (full replacement, rehabilitation until replacement, and repair until replacement). Each strategy consists of a set of corrective actions that contribute to keeping the bridge serviceable over the analysis period. Cost and effect of these improvement actions on the bridge condition are essential parts of the model. Other considerations in the model include bridge age, elevation, pier height, length-to-span ratio, skew angle, and substandard characteristics such as shoulders and vehicle clearance. The following assumptions are included in the bridge LCCA model:

- The bridge LCCA only addresses the structural condition of the bridge and does not address other issues or costs
- The bridge will require replacement at the end of its 75-year service life regardless of current condition
- The bridge elevation, pier height, skew angle, and length-to-span ratio can affect the replacement and rehabilitation costs
- The current and historical ratings are used to estimate a rate of deterioration for each candidate bridge
- Following bridge replacement, repairs will be needed every 20 years
- Different bridge repair and rehabilitation strategies have different costs, expected service life, and benefit to the bridge rating
- The net present value of future costs is discounted at 3% and all dollar amounts are in 2022 dollars
- If the LCCA evaluation recommends rehabilitation or repair, the solution is not considered strategic and the rehabilitation or repair will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% should be considered equally; in such a case, the solution should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed

Based on the candidate solutions presented in **Table 20**, LCCA was not conducted for any bridges on the SR 347/SR 84 Corridor, as noted in **Table 21**. Additional information regarding the bridge LCCA is included in **Appendix E**.

Pavement LCCA

The LCCA approach to pavement is very similar to the process used for bridges. For the pavement LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected pavement, as described below:

- Pavement replacement (large upfront cost but small ongoing costs afterwards – could be replacement with asphalt or concrete pavement)
- Pavement major rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- Pavement minor rehabilitation until replacement (low upfront and ongoing costs until replacement)

The pavement LCCA model developed for the CPS reviews the characteristics of the candidate paving locations including the historical rehabilitation frequency to develop potential improvement strategies (full replacement, major rehabilitation until replacement, and minor rehabilitation until replacement, for either concrete or asphalt, as applicable). Each strategy consists of a set of corrective actions that contribute to keeping the pavement serviceable over the analysis period. The following assumptions are included in the pavement LCCA model:

- The pavement LCCA only addresses the condition of the pavement and does not address other issues or costs

- The historical pavement rehabilitation frequencies at each location are used to estimate future rehabilitation frequencies
- Different pavement replacement and rehabilitation strategies have different costs and expected service life
- The net present value of future costs is discounted at 3% and all dollar amounts are in 2022 dollars
- If the LCCA evaluation recommends rehabilitation or repair, the solution is not considered strategic and the rehabilitation will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% should be considered equally; in such a case, the solution should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed

Based on the candidate solutions presented in **Table 20**, LCCA was not conducted for pavement on the SR 347/SR 84 Corridor, as noted in **Table 22**. Additional information regarding the pavement LCCA is contained in **Appendix E**.

Table 21: Bridge Life-Cycle Cost Analysis Results

Candidate Solution	Present Value at 3% Discount Rate ($)			Ratio of Present Value Compared to Lowest Present Value			Other Needs	Results
	Replace	Rehab	Repair	Replace	Rehab	Repair		
No LCCA conducted for any bridges on the SR 347/SR 84 Corridor.								

Table 22: Pavement Life-Cycle Cost Analysis Results

Candidate Solution	Present Value at 3% Discount Rate ($)				Ratio of Present Value Compared to Lowest Present Value				Other Needs	Results
	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation		
No LCCA conducted for pavement on the SR 347/SR 84 Corridor.										

5.2 Performance Effectiveness Evaluation

The results of the Performance Effectiveness Evaluation are combined with the results of a Performance Area Risk Analysis to determine a PES as defined in Section 5.0. The objectives of the Performance Effectiveness Evaluation include:

- Measure the benefit to the performance system versus the cost of the solution
- Include risk factors to help differentiate between similar solutions
- Apply to each performance area that is affected by the candidate solution
- Account for emphasis areas identified for the corridor

The Performance Effectiveness Evaluation includes the following steps:

- Estimate the post-solution performance for each of the five performance areas (Pavement, Bridge, Mobility, Safety, and Freight)
- Use the post-solution performance scores to calculate a post-solution level of need for each of the five performance areas
- Compare the pre-solution level of need to the post-solution level of need to determine the reduction in level of need (potential solution benefit) for each of the five performance areas
- Calculate performance area risk weighting factors for each of the five performance areas
- Use the reduction in level of need (benefit) and risk weighting factors to calculate the PES

Post-Solution Performance Estimation

For each performance area, a slightly different approach is used to estimate the post-solution performance. This process is based on the following assumptions:

- Pavement:
  - The IRI rating would decrease (to 30 for replacement or 45 for rehabilitation)
  - The Cracking rating would decrease (to 0 for replacement or rehabilitation)
  - The Rutting rating would decrease (to 0 for replacement or rehabilitation)
- Bridge:
  - The structural ratings would increase (+1 for repair, +2 for rehabilitation, or increase to 8 for replacement)
  - The Sufficiency Rating would increase (+10 for repair, +20 for rehabilitation, or increase to 98 for replacement)
- Mobility:
  - Additional lanes would increase the capacity and therefore affect the Mobility Index and associated secondary measures
  - Other improvements (e.g., ramp metering, parallel ramps, variable speed limits) would also increase the capacity (to a lesser extent than additional lanes) and therefore would affect the Mobility Index and associated secondary measures
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the LOTTR secondary measure
  - Changes in the Safety Index (due to crash reductions) would have a direct effect on the Closure Extent secondary measure
- Safety:
  - Crash modification factors were developed that would be applied to estimate the reduction in crashes (for additional information see **Appendix F**)
- Freight:
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the Freight Index and the TTTR secondary measure
  - Changes in the Safety Index (due to crash reductions) would have a direct effect on the Closure Duration secondary measure

Performance Area Risk Analysis

The Performance Area Risk Analysis is intended to develop a numeric risk weighting factor for each of the five performance areas (Pavement, Bridge, Mobility, Safety, and Freight). This risk analysis addresses other considerations for each performance area that are not directly included in the performance system. A risk weighting factor is calculated for each candidate solution based on the specific characteristics at the solution location. For example, the Pavement Risk Factor is based on factors such as the elevation, daily traffic volumes, and amount of truck traffic. Additional information regarding the Performance Area Risk Factors is included in **Appendix G**.

Following the calculation of the reduction in level of need (benefit) and the Performance Area Risk Factors, these values are used to calculate the PES. In addition, the reduction in level of need in each emphasis area is also included in the PES.

Net Present Value Factor

The benefit (reduction in need) is measured as a one-time benefit. However, different types of solutions will have varying service lives during which the benefits will be obtained. For example, a preservation solution would likely have a shorter stream of benefits over time when compared to a modernization or expansion solution. To address the varying lengths of benefit streams, each solution is classified as a 10-year, 20-year, 30-year, or 75-year benefit stream, or the net present value (NPV) factor (F_{NPV}). A 3% discount rate is used to calculate F_{NPV} for each classification of solution. The service lives and respective factors are described below:

- A 10-year service life is generally reflective of preservation solutions such as pavement and bridge preservation; these solutions would likely have a 10-year stream of benefits; for these solutions, a F_{NPV} of 8.8 is used in the PES calculation
- A 20-year service life is generally reflective of modernization solutions that do not include new infrastructure; these solutions would likely have a 20-year stream of benefits; for these solutions, a F_{NPV} of 15.3 is used in the PES calculation

- A 30-year service life is generally reflective of expansion solutions or modernization solutions that include new infrastructure; these solutions would likely have a 30-year stream of benefits; for these solutions, a F_{NPV} of 20.2 is used in the PES calculation
- A 75-year service life is used for bridge replacement solutions; these solutions would likely have a 75-year stream of benefits; for these solutions, a F_{NPV} of 30.6 is used in the PES calculation

Vehicle-Miles Travelled Factor

Another factor in assessing benefits is the number of travelers who would benefit from the implementation of the candidate solution. This factor varies between candidate solutions depending on the length of the solution and the magnitude of daily traffic volumes. Multiplying the solution length by the daily traffic volume results in vehicle-miles travelled (VMT), which provides a measure of the amount of traffic exposure that would receive the benefit of the proposed solution. The VMT is converted to a VMT factor (known as F_{VMT}), which is on a scale between 0 and 5, using the equation below:

$$F_{VMT} = 5 - (5 \times e^{VMT \times -0.0000139})$$

Performance Effectiveness Score

The PES is calculated using the following equation:

PES = (Sum of all Risk Factored Benefit Scores + Sum of all Risk Factored Emphasis Area Scores) / Cost) x F_{VMT} x F_{NPV}

Where:

Risk Factored Benefit Score = Reduction in Segment-Level Need (benefit) x Performance Area Risk Weighting Factor (calculated for each performance area)

Risk Factored Emphasis Area Score = Reduction in Corridor-Level Need x Performance Area Risk Factors x Emphasis Area Factor (calculated for each emphasis area)

*Cost = estimated cost of candidate solution in millions of dollars (see **Appendix H**)*

F_{VMT} = Factor between 0 and 5 to account for VMT at location of candidate solution based on existing daily volume and length of solution

F_{NPV} = Factor (ranging from 8.8 to 30.6 as previously described) to address anticipated longevity of service life (and duration of benefits) for each candidate solution

The resulting PES values are shown in **Table 23**. Additional information regarding the calculation of the PES is contained in **Appendix I**.

For candidate solutions with multiple options to address Mobility, Safety, or Freight needs, the PES should be compared to help identify the best performing option. If one option clearly performs better than the other options (e.g., more than twice the PES value and a difference in magnitude of at least 20 points), the other options can be eliminated from further consideration. If multiple options have similar PES values, or there are other factors not accounted for in the performance system that could significantly influence the ultimate selection of an option (e.g., potential environmental concerns, potential adverse economic impacts), those options should all be advanced to the prioritization process. On the SR 347/SR 84 Corridor, no candidate solutions have options to address needs.

Table 23: Performance Effectiveness Scores

Candidate Solution #	Segment #	Option	Candidate Solution Name	Milepost Location	Estimated Cost* (in millions)	Risk Factored Benefit Score					Risk Factored Emphasis Area Scores			Total Factored Benefit Score	F_{VMT}	F_{NPV}	Performance Effectiveness Score
						Pavement	Bridge	Mobility	Safety	Freight	Mobility	Safety	Freight				
CS347/84.1	347/84-1	-	West Stanfield Area Safety Improvements	155-162	$3.20	0.00	0.00	0.00	16.17	0.00	0.00	9.94	0.00	26.12	0.99	15.3	123.6

*: See **Table 25** for total construction costs

5.3 Solution Risk Analysis

Following the calculation of the PES, an additional step is taken to develop the prioritized list of solutions. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of performance failure. **Figure 25** shows the risk matrix used to develop the risk weighting factors.

Figure 25: Risk Matrix

		Severity/Consequence				
		Insignificant	Minor	Significant	Major	Catastrophic
Frequency/Likelihood	Very Rare	Low	Low	Low	Moderate	Major
	Rare	Low	Low	Moderate	Major	Major
	Seldom	Low	Moderate	Moderate	Major	Severe
	Common	Moderate	Moderate	Major	Severe	Severe
	Frequent	Moderate	Major	Severe	Severe	Severe

Using the risk matrix in **Figure 25**, numeric values were assigned to each category of frequency and severity. The higher the risk, the higher the numeric factor assigned. The risk weight for each area of the matrix was calculated by multiplying the severity factor times the frequency factor. These numeric factors are shown in **Figure 26**.

Figure 26: Numeric Risk Matrix

			Severity/Consequence				
			Insignificant	Minor	Significant	Major	Catastrophic
		Weight	1.00	1.10	1.20	1.30	1.40
Frequency/Likelihood	Very Rare	1.00	1.00	1.10	1.20	1.30	1.40
	Rare	1.10	1.10	1.21	1.32	1.43	1.54
	Seldom	1.20	1.20	1.32	1.44	1.56	1.68
	Common	1.30	1.30	1.43	1.56	1.69	1.82
	Frequent	1.40	1.40	1.54	1.68	1.82	1.96

Using the values in **Figure 26**, risk weighting factors were calculated for each of the four risk categories (low, moderate, major, and severe). These values are simply the average of the values in **Figure 26** that fall within each category. The resulting average risk weighting factors are:

Low	Moderate	Major	Severe
1.14	1.36	1.51	1.78

The risk weighting factors listed above are assigned to the five performance areas as follows:

- Safety = 1.78
  - The Safety performance area quantifies the likelihood of fatal or incapacitating injury crashes; therefore, it is assigned the Severe (1.78) risk weighting factor
- Bridge = 1.51
  - The Bridge performance area focuses on the structural adequacy of bridges; a bridge failure may result in crashes or traffic being detoured for long periods of time resulting in significant travel time increases; therefore, it is assigned the Major (1.51) risk weighting factor
- Mobility and Freight = 1.36
  - The Mobility and Freight performance areas focus on capacity and congestion; failure in either of these performance areas would result in increased travel times but would not have significant effect on safety (crashes) that would not already be addressed in the Safety performance area; therefore, they are assigned the Moderate (1.36) risk weighing factor
- Pavement = 1.14
  - The Pavement performance area focuses on the ride quality of the pavement; failure in this performance area would likely be a spot location that would not dramatically affect drivers beyond what is already captured in the Safety performance area; therefore, it is assigned the Low (1.14) risk weighting factor

The benefit in each performance area is calculated for each candidate solution as part of the Performance Effectiveness Evaluation. Using this information on benefits and the risk factors listed above, a weighted (based on benefit) solution-level numeric risk factor is calculated for each candidate solution. For example, a solution that has 50% of its benefit in Safety and 50% of its benefit in Mobility has a weighted risk factor of 1.57 (0.50 x 1.36 + 0.50 x 1.78 = 1.57).

5.4 Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score as follows:

Prioritization Score = PES x Weighted Risk Factor x Segment Average Need Score

Where:

PES = Performance Effectiveness Score as shown in ***Table 23***

Weighted Risk Factor = Weighted factor to address risk of not implementing a solution based on the likelihood and severity of the performance failure

Segment Average Need Score = Segment level need score as shown in ***Table 18***

Table 24 shows the prioritization scores for the candidate solutions subjected to the solution evaluation and prioritization process. Solutions that address multiple performance areas tend to score higher in this process. The prioritized list of candidate solutions is provided in the subsequent section. See **Appendix J** for additional information on the prioritization process.

Table 24: Prioritization Scores

Candidate Solution #	Segment #	Option	Candidate Solution Name	Milepost Location	Estimated Cost (in millions)	Performance Effectiveness Score	Weighted Risk Factor	Segment Average Need Score	Prioritization Score	Percentage by which Solution Reduces Performance Area Segment Needs				
										Pavement	Bridge	Mobility	Safety	Freight
CS347/84.1	347/84-1	-	West Stanfield Area Safety Improvements	155-162	$3.20	123.6	1.78	1.23	**271**	0%	-	0%	32%	-

6 SUMMARY OF CORRIDOR RECOMENDATIONS

6.1 Prioritized Candidate Solution Recommendations

Table 25 and **Figure 27** show the prioritized candidate solutions recommended for the SR 347/SR 84 Corridor in ranked order of priority. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Implementation of these solutions is anticipated to improve performance of the SR 347/SR 84 Corridor. The following observations were noted about the prioritized solutions:

- Most of the anticipated improvements in performance are in the Safety performance area

6.2 Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor-specific recommendations that are not related to construction or policy. The list below identifies other corridor recommendations for the SR 347/SR 84 Corridor:

- When recommending future projects along the SR 347/SR 84 Corridor, review historical ratings and levels of investment. According to data used for this study, no pavement and bridge locations have exhibited high historical investment (pavement) or rating fluctuation (bridge) issues within the limits of the study

6.3 Policy and Initiative Recommendations

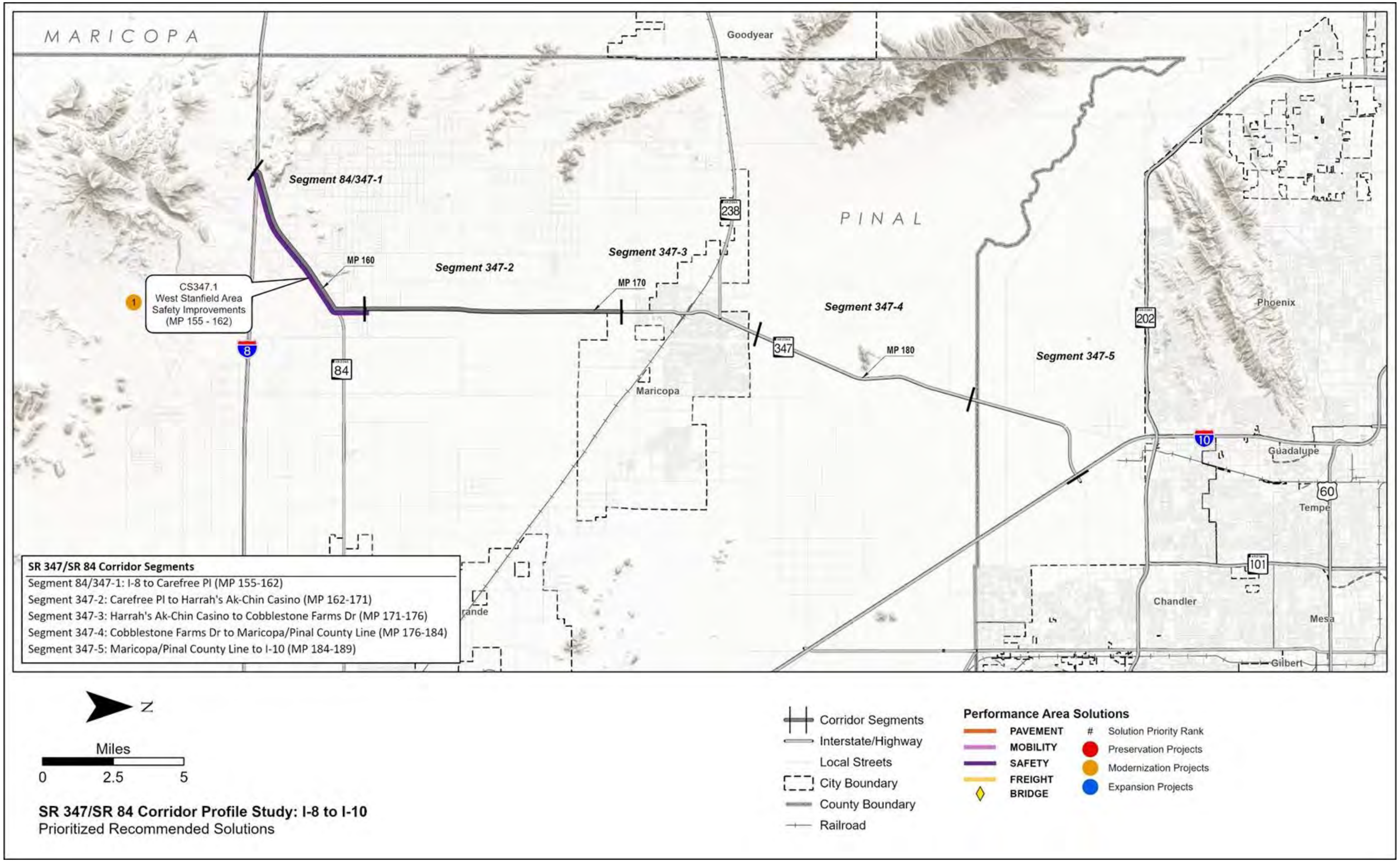
In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through this process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on the SR 347/SR 84 Corridor, but across the entire state highway system where the conditions are applicable. The following list, which is in no particular order of priority, was derived from the initial four CPS rounds:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic message signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is required to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network
- At traffic interchanges with existing communication connectivity to the ADOT TOC, consideration should be given to adding thermal detection cameras for vehicle detection with the capability for wrong-way vehicle detection
- Improved vehicle detection systems, as recommended by ADOT Systems Technology group, should be deployed at traffic interchanges for improved traffic control

Table 25: Prioritized Recommended Solutions

Rank	Candidate Solution #	Option	Solution Name and Location	Description / Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
1	CS347/84.1	-	West Stanfield Area Safety Improvements (MP 155-162)	-Rehabilitate shoulders in both directions (striping, delineators, RPMs, safety edge, and rumble strips for both shoulders)	$3.20	M	**271**

Figure 27: Prioritized Recommended Solutions



6.4 Next Steps

The candidate solutions recommended in this study are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the SR 347/SR 84 Corridor will be considered along with other candidate projects in the ADOT statewide programming process.

It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives.

These results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.

This CPS assessment is an update to the original CPS assessments conducted between 2017 and 2019. Due to changes in state and federal reporting standards as well as data availability, the original methodology has been adapted to produce comparable and relatable performance, need, and evaluation results. The methodology has changed as follows:

- Pavement performance now includes the addition of rutting as a component of the Pavement Distress measure
- Bridge performance no longer includes the % Functionally Obsolete secondary measure
- Safety performance includes updated secondary measure categories and is evaluated against updated statewide averages
- Mobility and Freight performance are evaluated using updated reliability measures based on Level of Travel Time Reliability and Truck Travel Time Reliability, which are new federal standard measures adapted from the previous Travel Time Index and Planning Time Index measures

Appendices

Appendix A: Corridor Performance Maps

This appendix contains maps of each primary and secondary measure associated with the five performance areas for the SR 347/SR 84 corridor. The following are the areas and maps included:

Pavement Performance Area:

- Pavement Index and Hot Spots
- Pavement Serviceability and Hot Spots (directional)
- Percentage of Pavement Area Failure

Bridge Performance Area:

- Bridge Index and Hot Spots
- Bridge Sufficiency
- Lowest Bridge Rating

Mobility Performance Area:

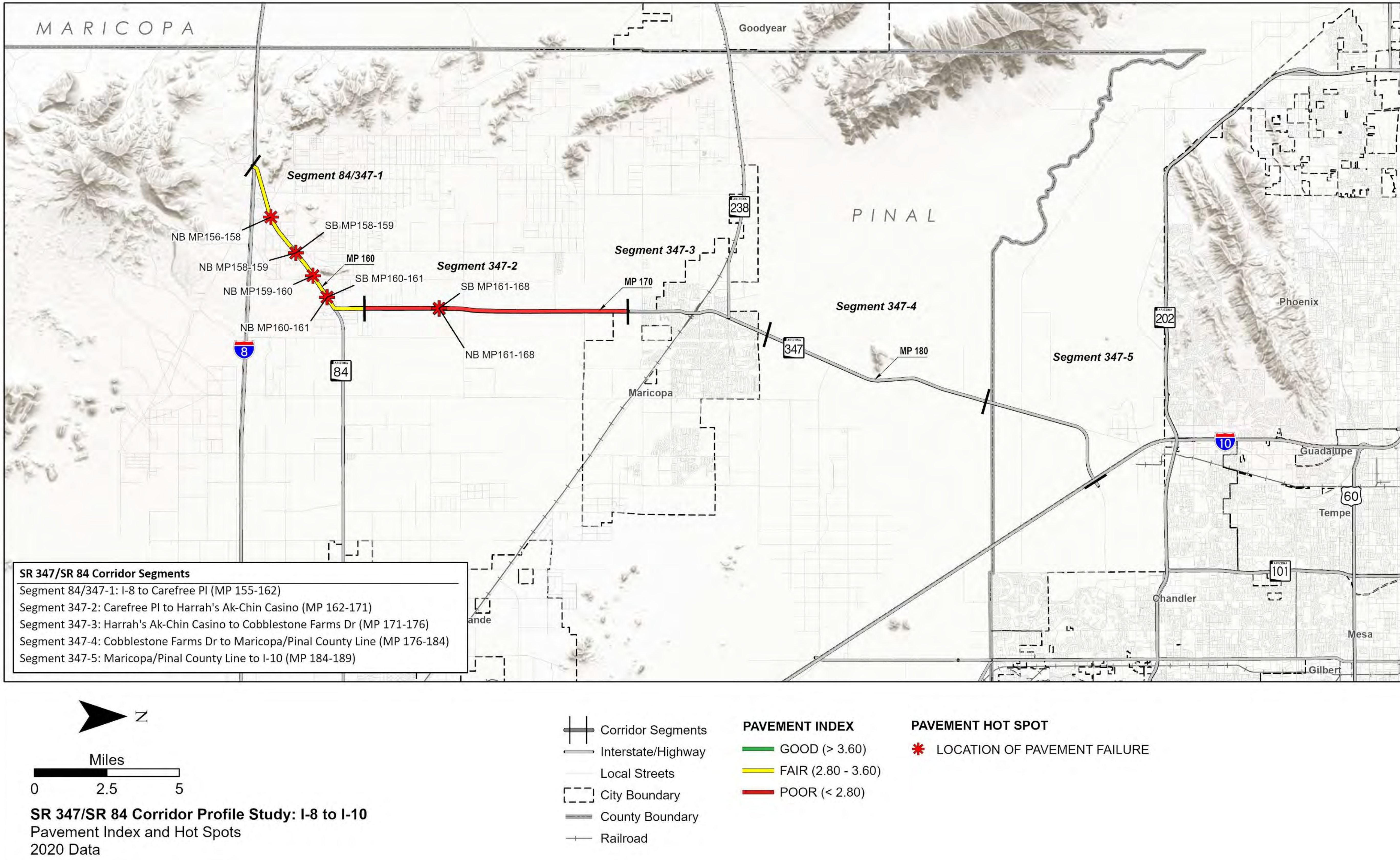
- Mobility Index
- Future Daily V/C Ratio
- Existing Peak Hour V/C Ratio (directional)
- Closure Frequency (directional)
- Level of Travel Time Reliability (directional)
- Multimodal Opportunities
- Percentage of Bicycle Accommodation

Safety Performance Area:

- Safety Index and Hot Spots
- Safety Index and Hot Spots (directional)
- Relative Frequency of Fatal + Suspected Serious Injury Crashes Involving Intersection Crashes Compared to the Statewide Average for Similar Segments (insufficient data – not included)
- Relative Frequency of Fatal + Suspected Serious Injury Crashes Involving Lane Departures Compared to the Statewide Average for Similar Segments (insufficient data – not included)
- Relative Frequency of Fatal + Suspected Serious Injury Crashes Involving Pedestrians Compared to the Statewide Average for Similar Segments (insufficient data – not included)
- Relative Frequency of Fatal + Suspected Serious Injury Crashes Involving Trucks Compared to the Statewide Average for Similar Segments (insufficient data – not included)
- Relative Frequency of Fatal + Suspected Serious Injury Crashes Involving Bicycles Compared to the Statewide Average for Similar Segments (insufficient data – not included)

Freight Performance Area:

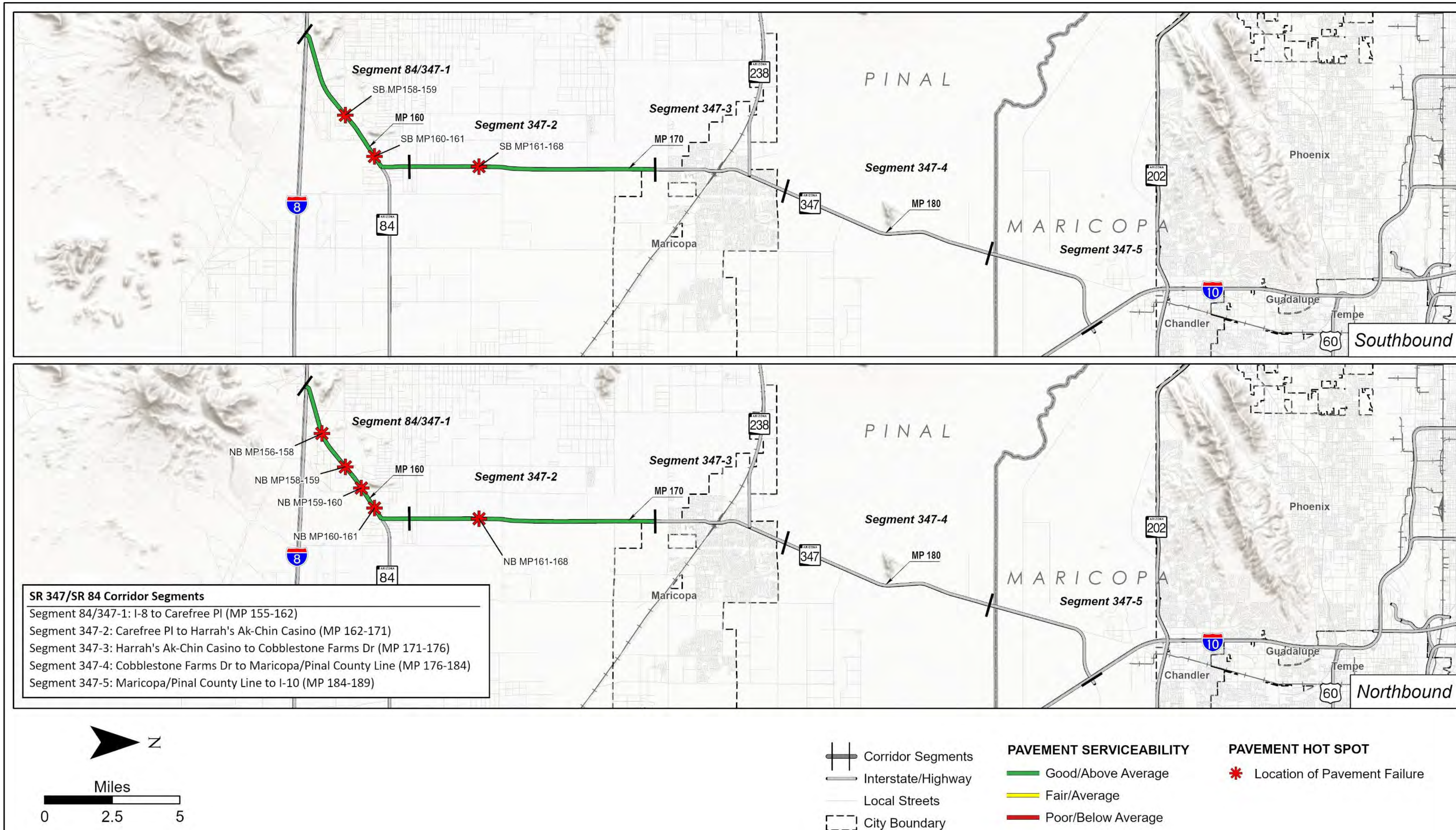
- Freight Index and Hot Spots
- Truck Travel Time Reliability (directional)
- Closure Duration (directional)
- Bridge Vertical Clearance (no bridges – not included)



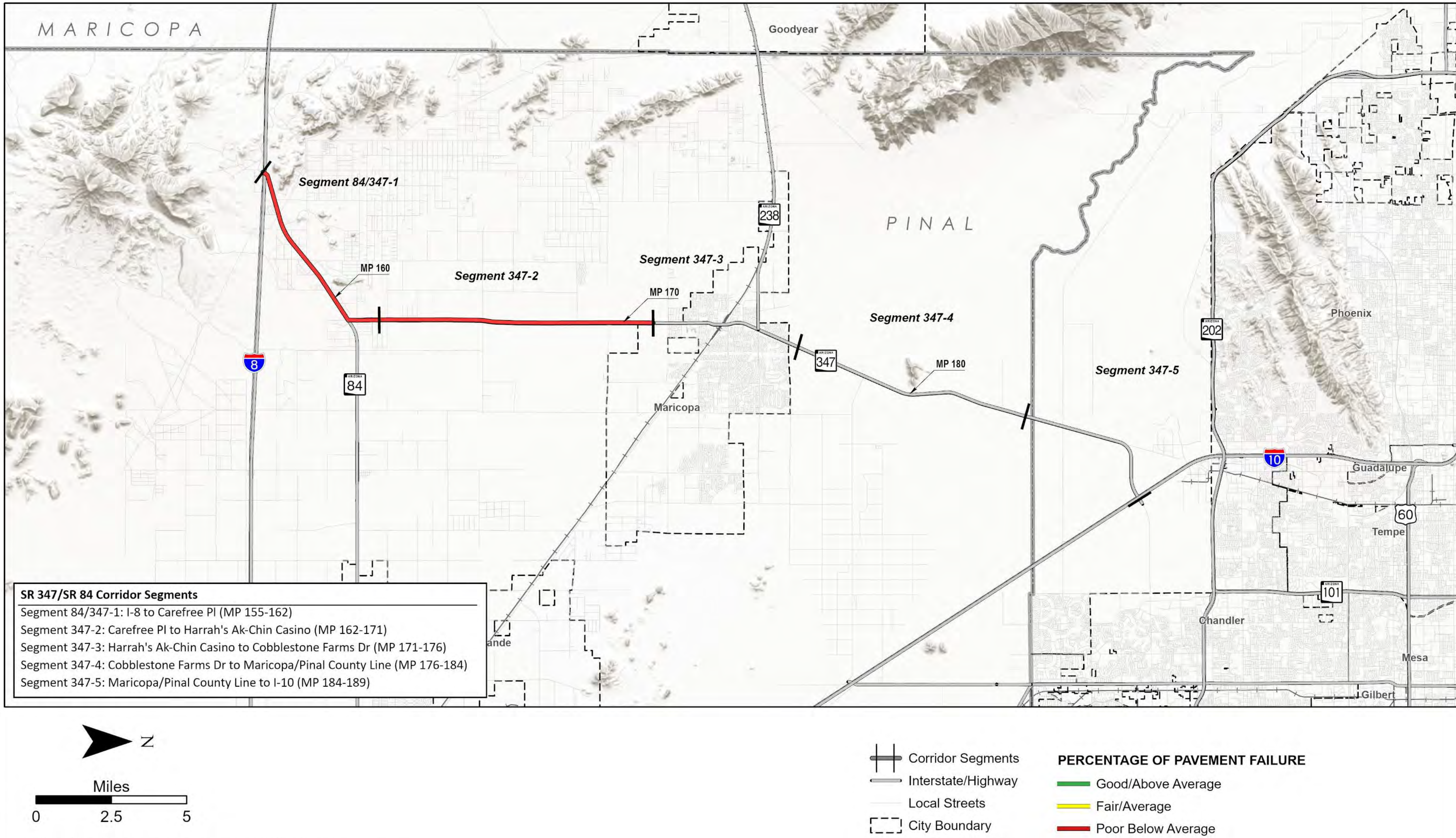
SR 347/SR 84 Corridor Segments

- Segment 84/347-1: I-8 to Carefree Pl (MP 155-162)
- Segment 347-2: Carefree Pl to Harrah's Ak-Chin Casino (MP 162-171)
- Segment 347-3: Harrah's Ak-Chin Casino to Cobblestone Farms Dr (MP 171-176)
- Segment 347-4: Cobblestone Farms Dr to Maricopa/Pinal County Line (MP 176-184)
- Segment 347-5: Maricopa/Pinal County Line to I-10 (MP 184-189)

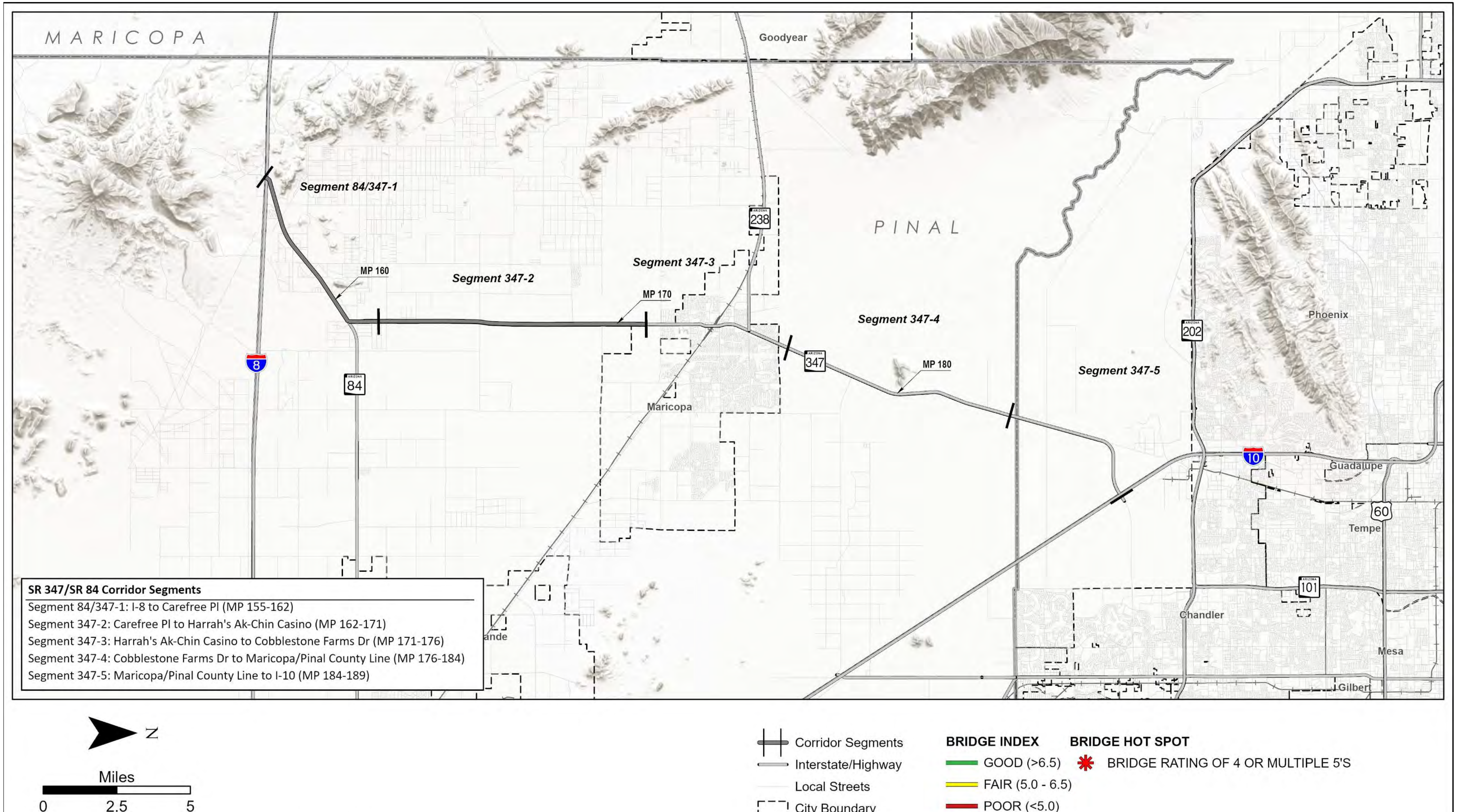
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Pavement Index and Hot Spots
2020 Data



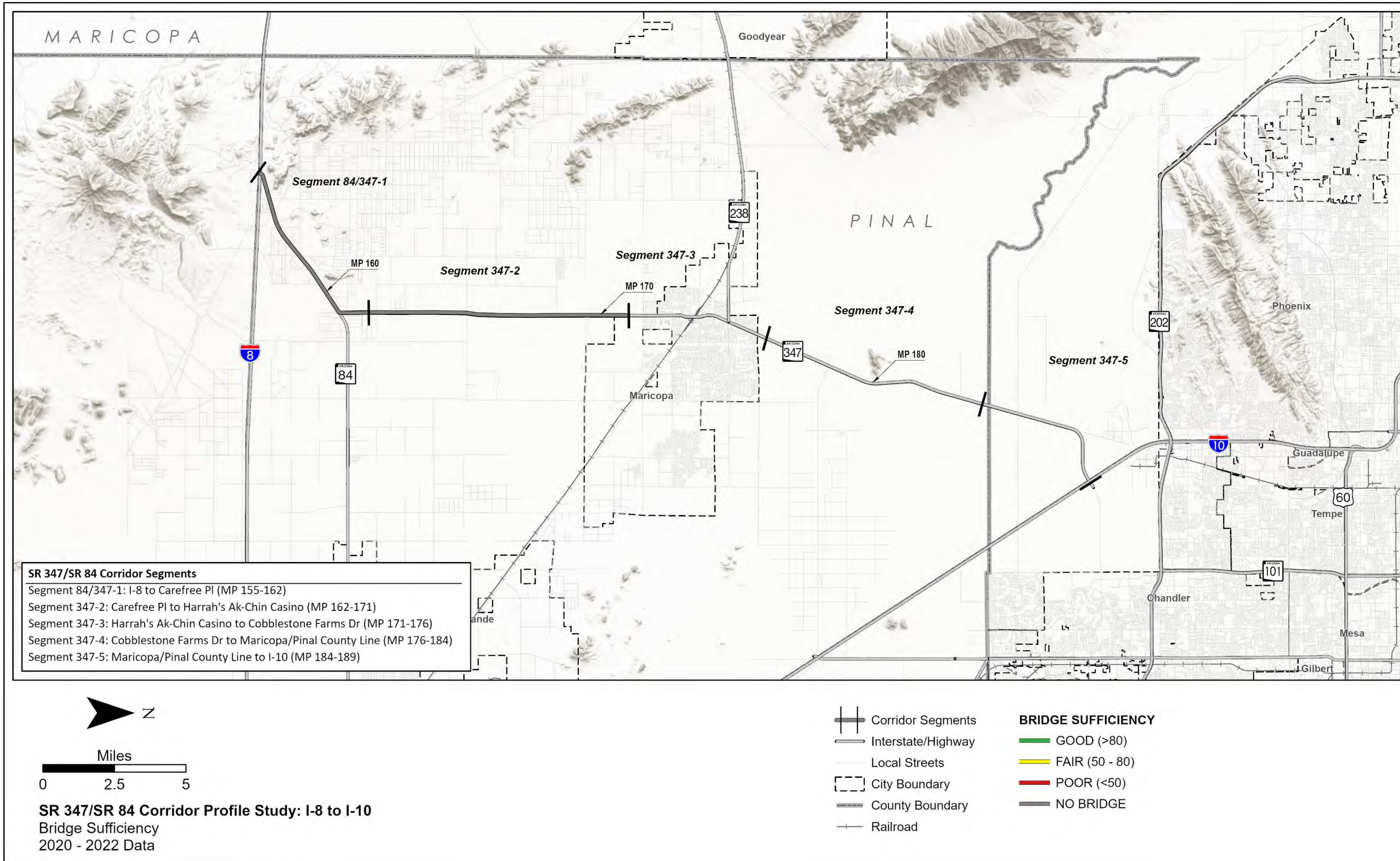
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Pavement Serviceability and Hot Spots
2020 Data



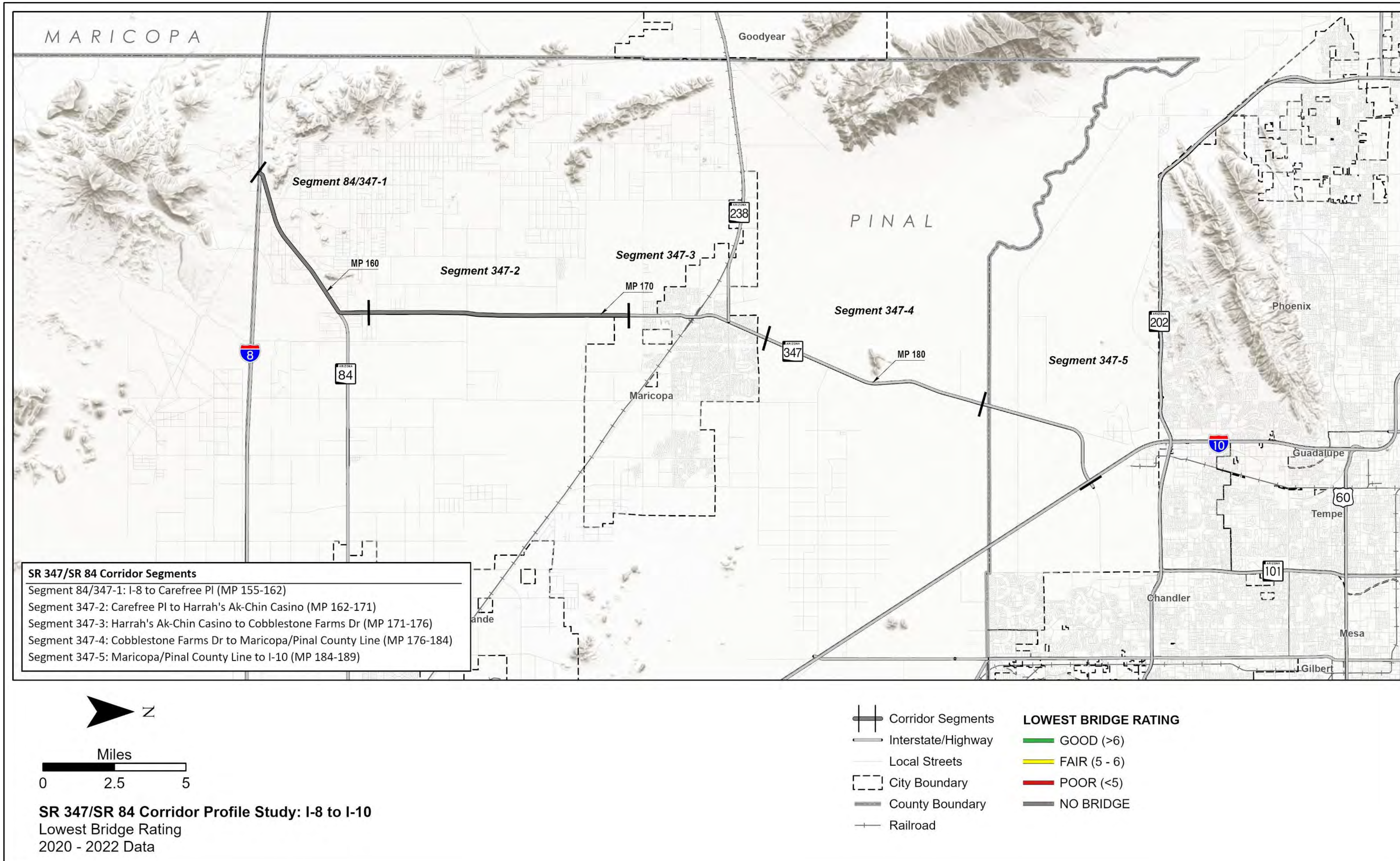
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Percentage of Pavement Area Failure
2020 Data



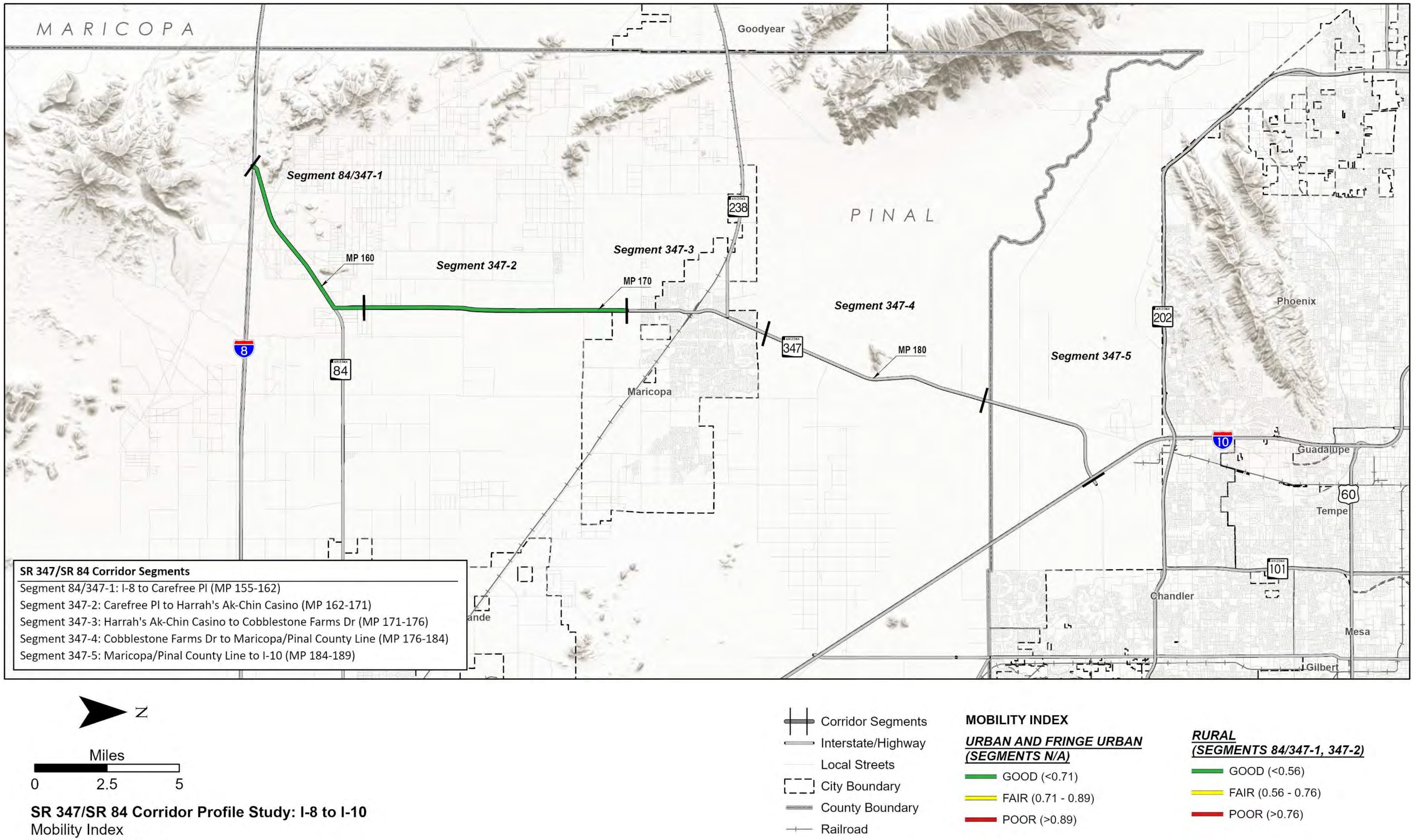
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Bridge Index and Hot Spots
2020 - 2022 Data



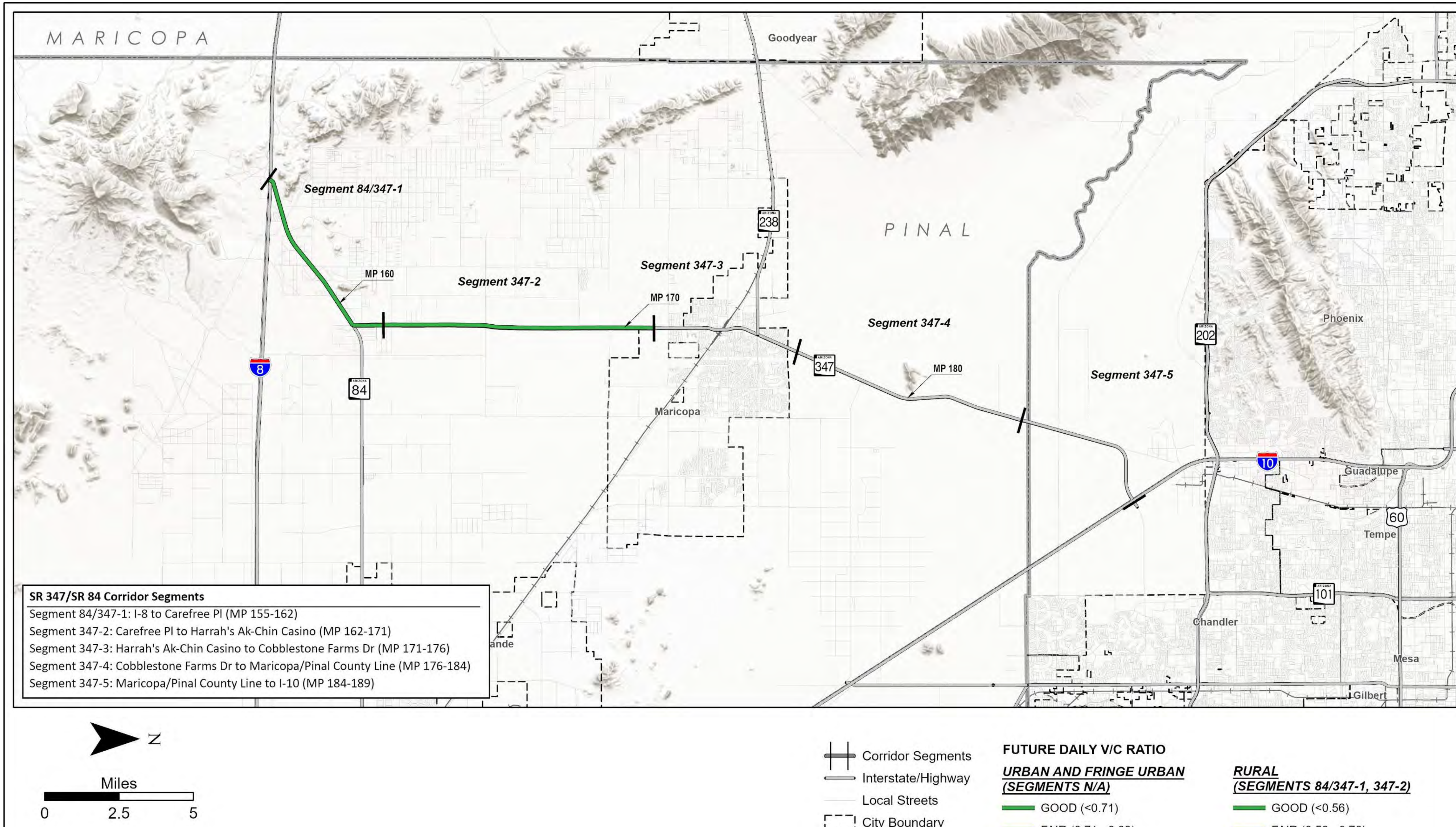
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Bridge Sufficiency
2020 - 2022 Data



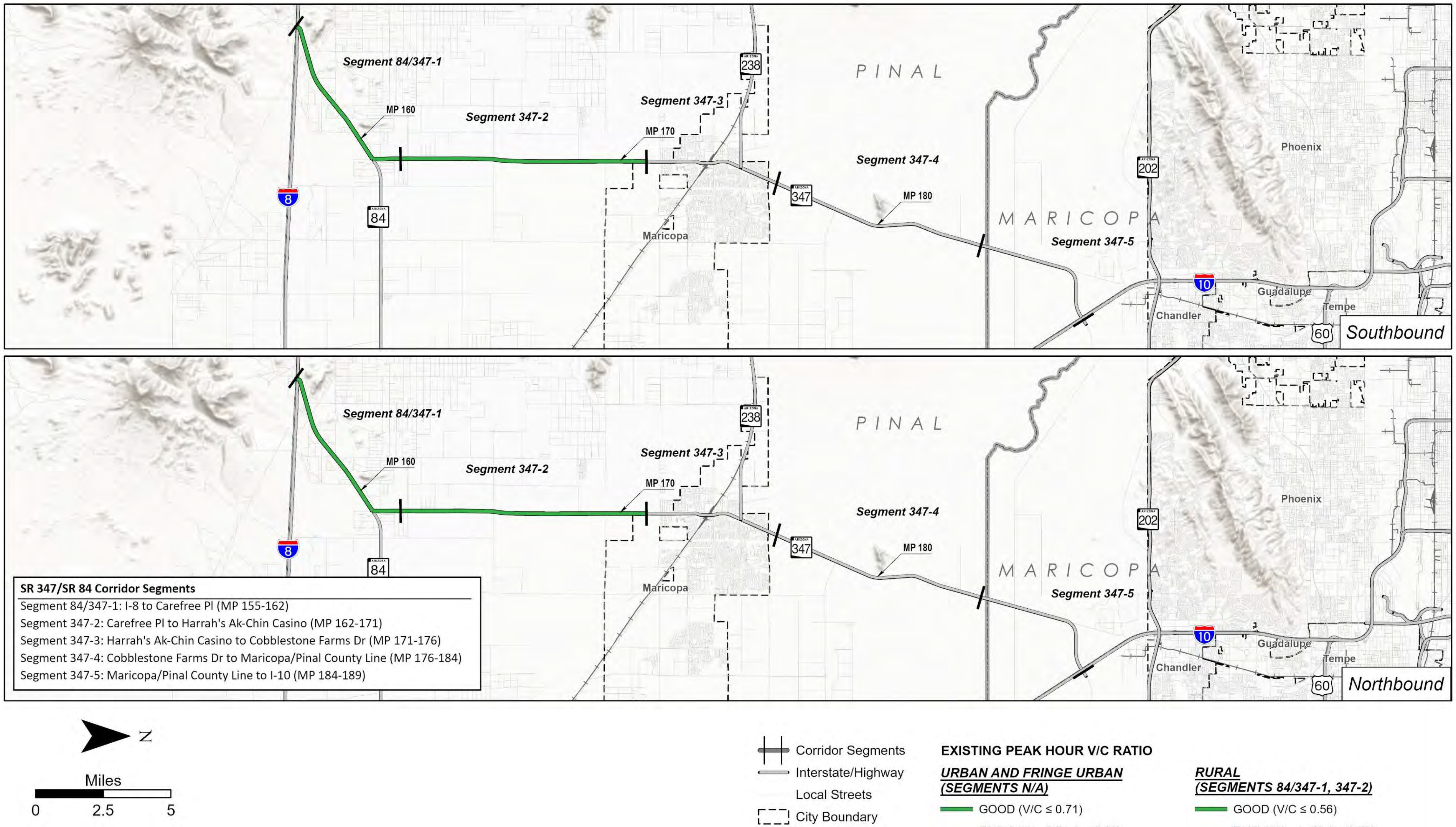
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Lowest Bridge Rating
2020 - 2022 Data



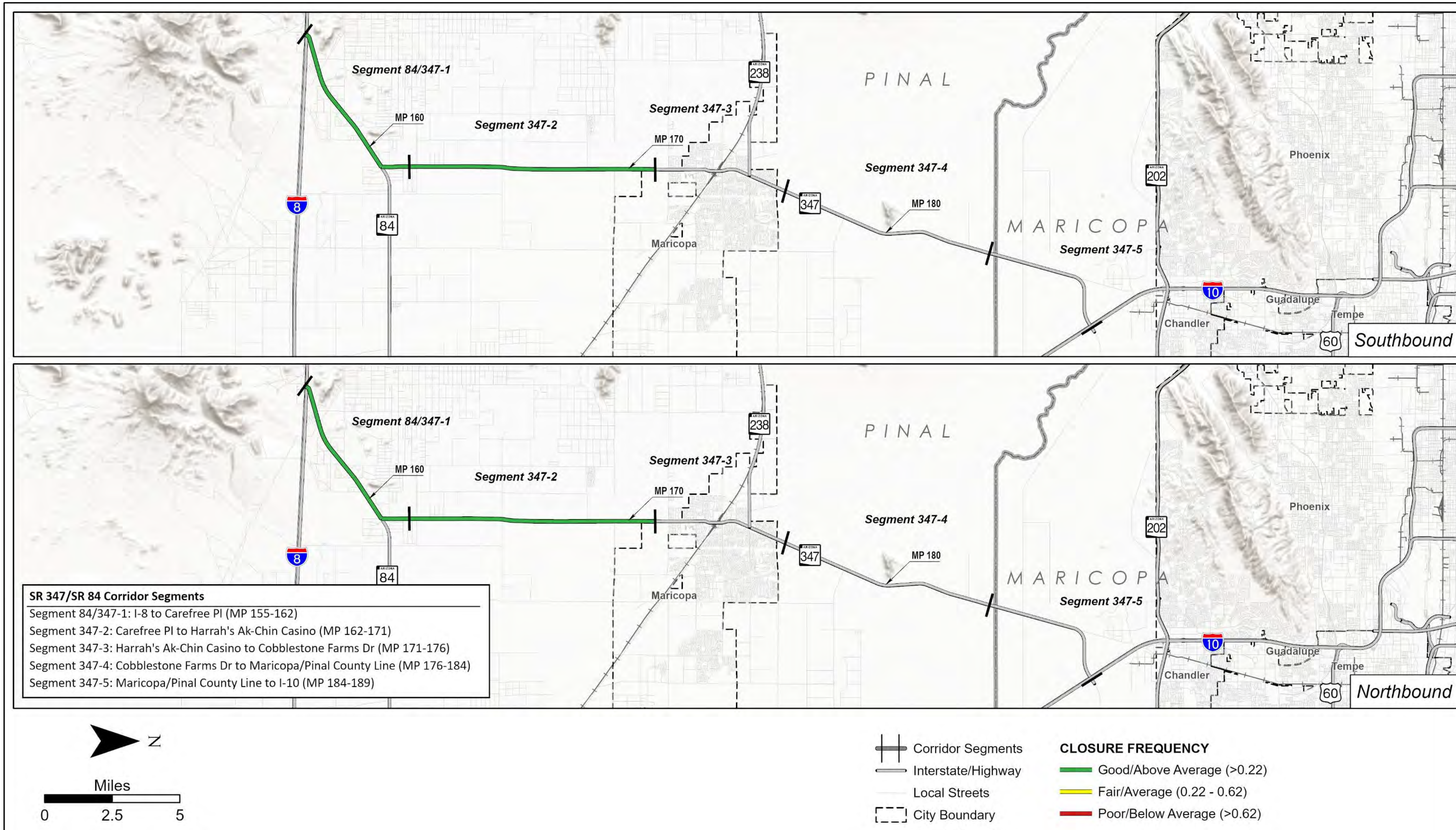
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Mobility Index
2020 and 2040 Data



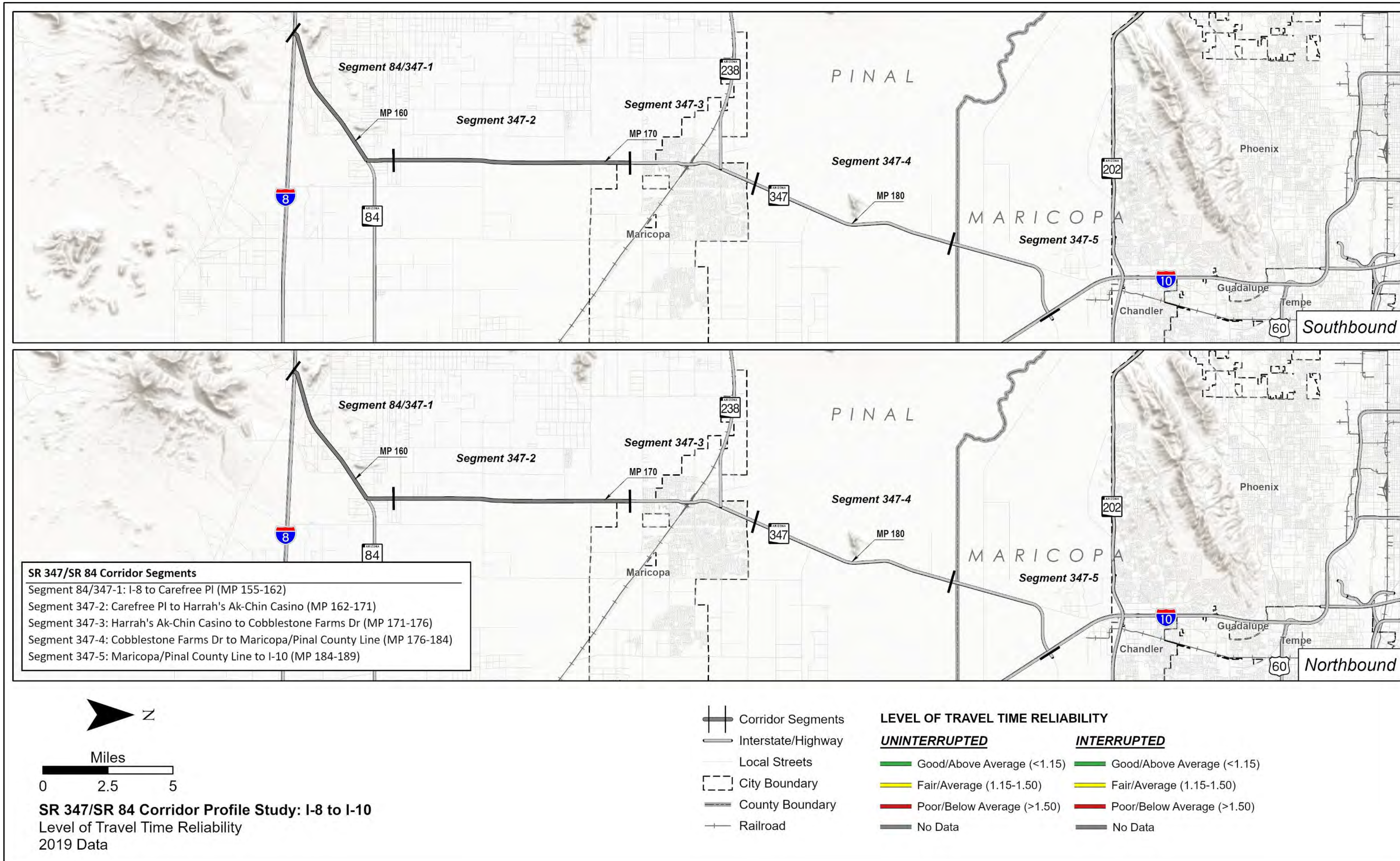
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Future Daily Volume/Capacity (V/C) Ratio
2040 Data

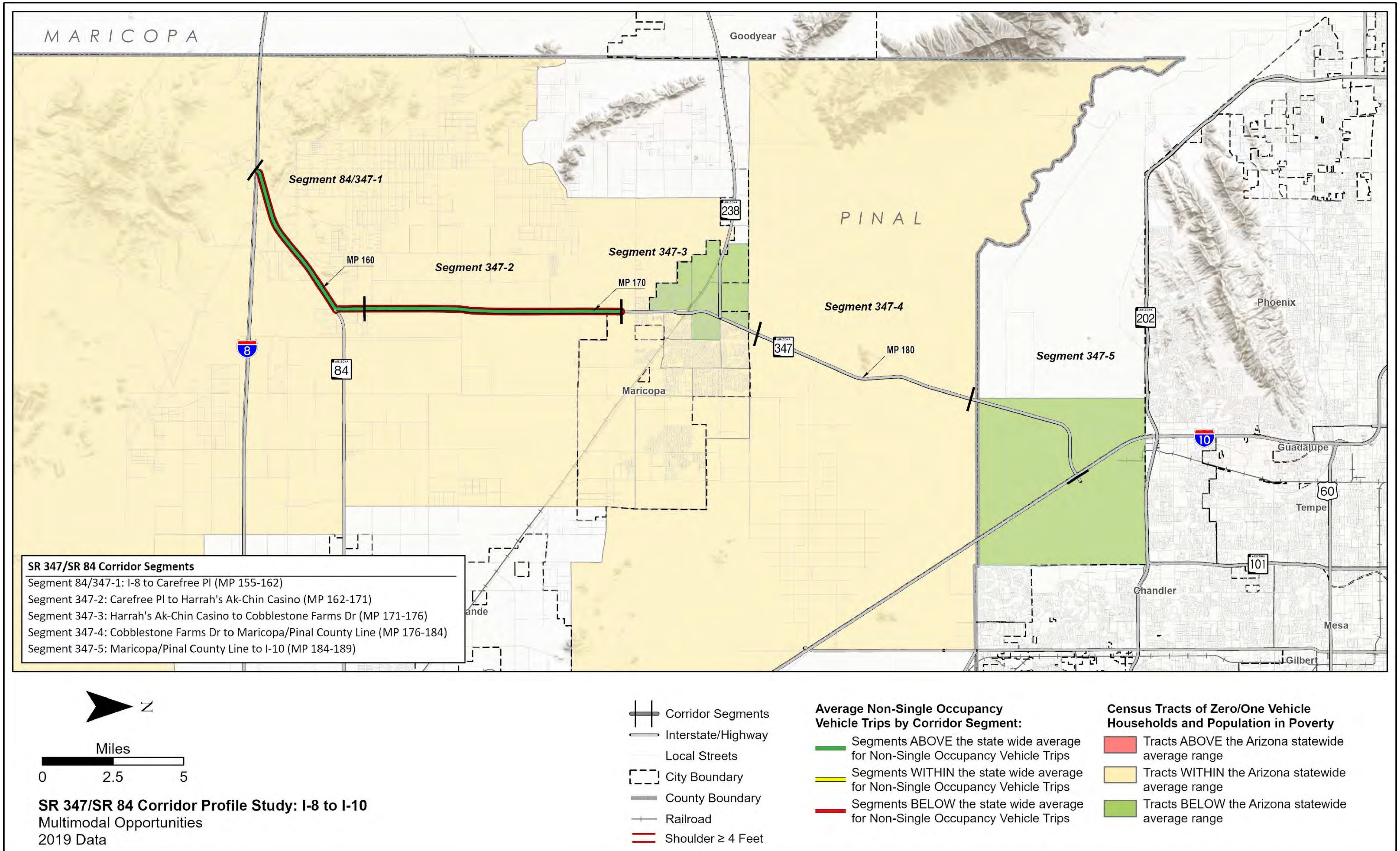


SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Existing Peak Hour Volume/Capacity (V/C) Ratio

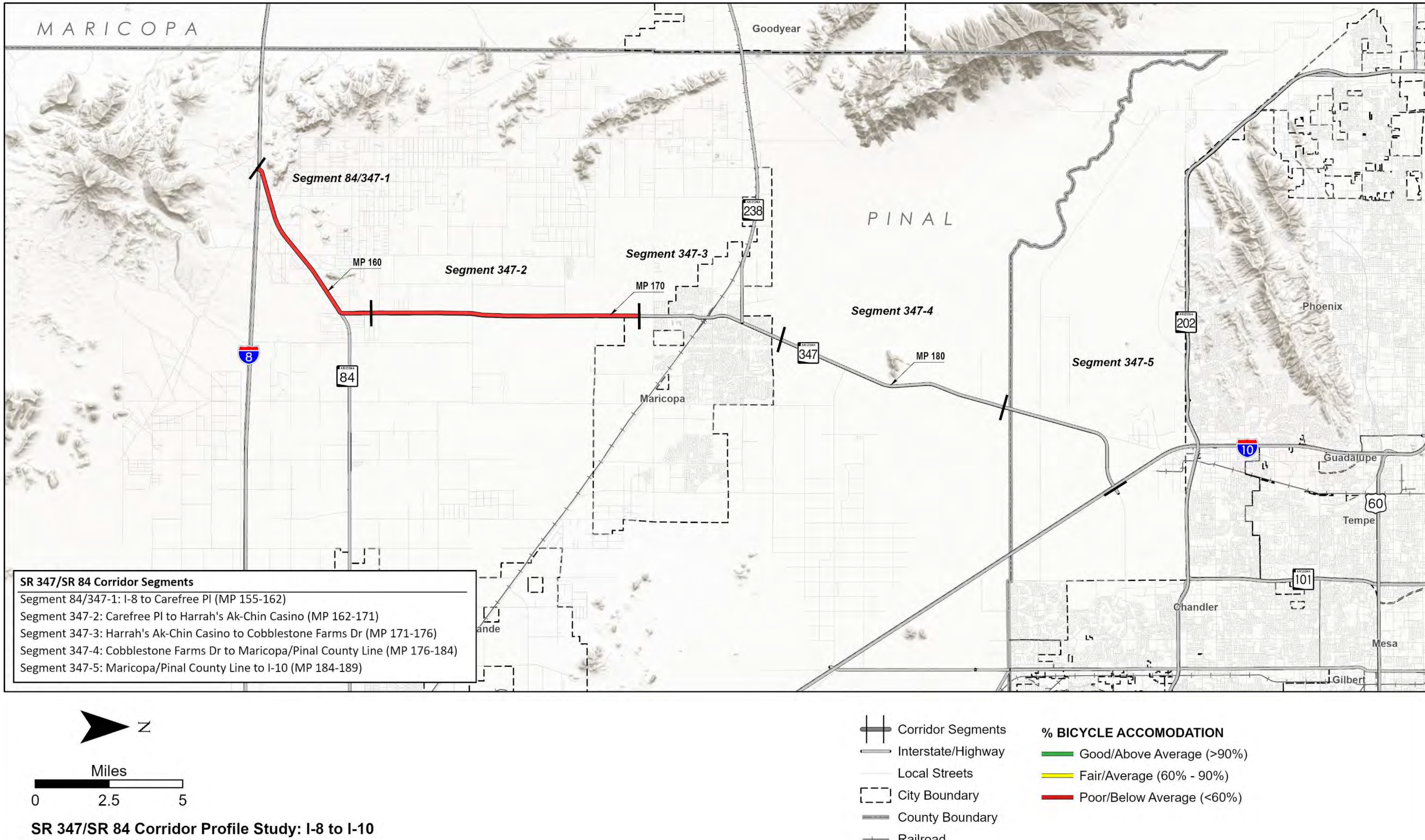


SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Closure Frequency
2014 - 2019 Data

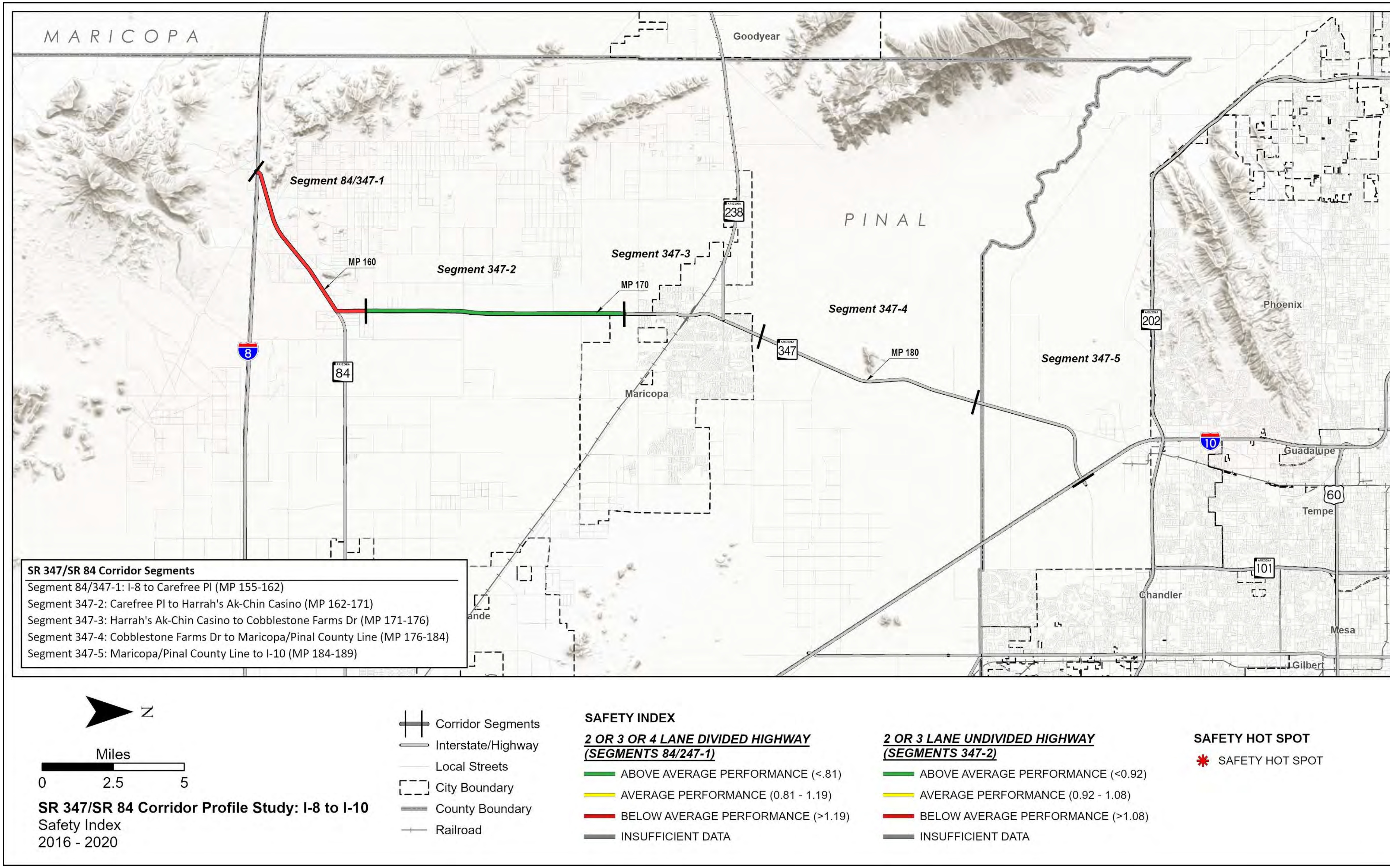

Segment 84/347-1
MP 160
Segment 347-2
Segment 347-3
MP 170
Segment 347-4
MP 180
Segment 347-5
PINAL
MARICOPA
Maricopa
Phoenix
Guadalupe
Tempe
Chandler
8
84
238
347
202
10
60
Southbound
Northbound
SR 347/SR 84 Corridor Segments
Segment 84/347-1: I-8 to Carefree Pl (MP 155-162)
Segment 347-2: Carefree Pl to Harrah's Ak-Chin Casino (MP 162-171)
Segment 347-3: Harrah's Ak-Chin Casino to Cobblestone Farms Dr (MP 171-176)
Segment 347-4: Cobblestone Farms Dr to Maricopa/Pinal County Line (MP 176-184)
Segment 347-5: Maricopa/Pinal County Line to I-10 (MP 184-189)
N
Miles
0 2.5 5
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Level of Travel Time Reliability
2019 Data
Corridor Segments
Interstate/Highway
Local Streets
City Boundary
County Boundary
Railroad
LEVEL OF TRAVEL TIME RELIABILITY
UNINTERRUPTED
Good/Above Average (<1.15)
Fair/Average (1.15-1.50)
Poor/Below Average (>1.50)
No Data
INTERRUPTED
Good/Above Average (<1.15)
Fair/Average (1.15-1.50)
Poor/Below Average (>1.50)
No Data

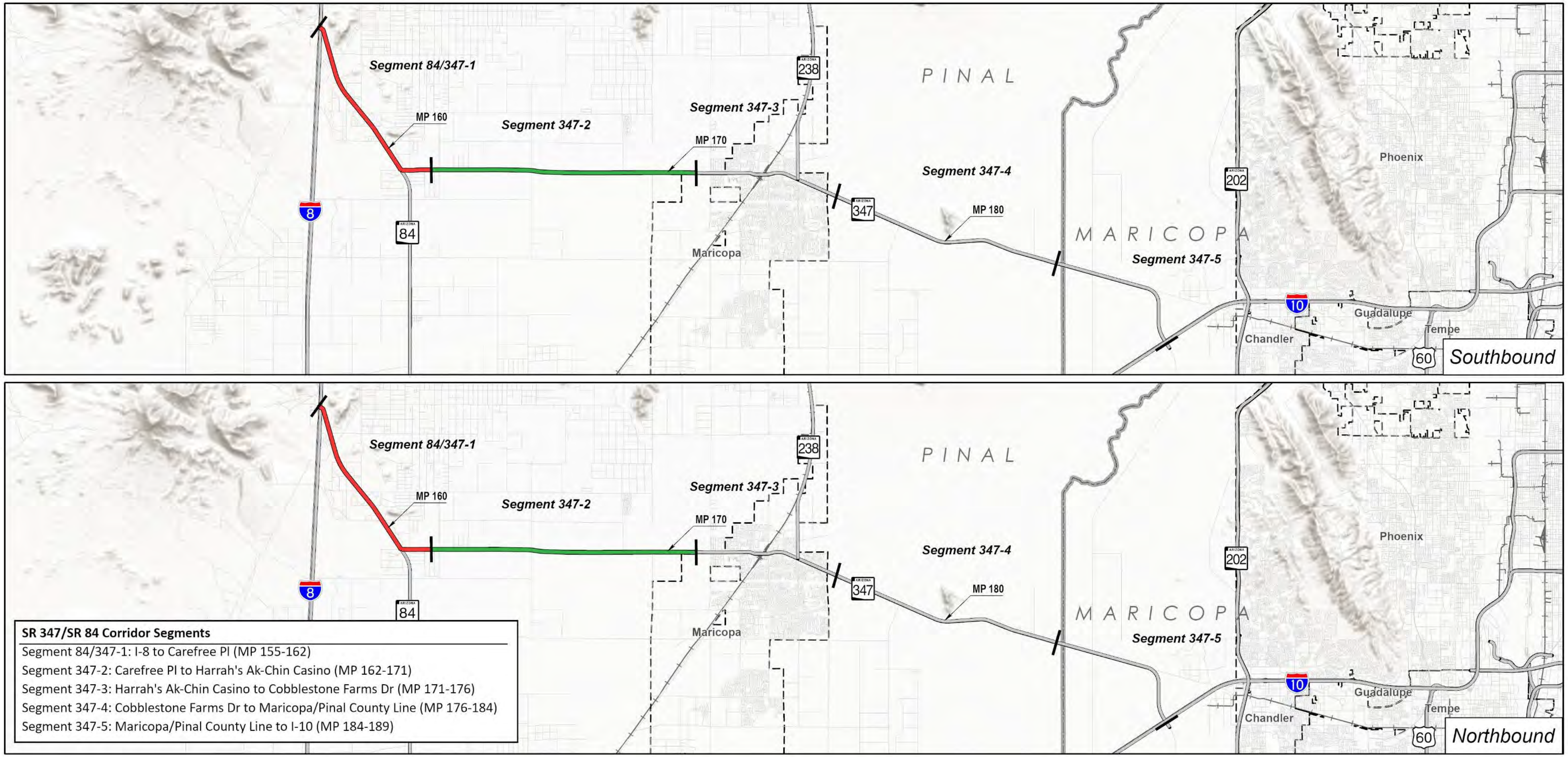


SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Multimodal Opportunities
2019 Data



SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Percentage of Bicycle Accommodation
2019 Data


MARICOPA
PINAL
Goodyear
Maricopa
Phoenix
Guadalupe
Tempe
Chandler
Mesa
Gilbert
Segment 84/347-1
Segment 347-2
Segment 347-3
Segment 347-4
Segment 347-5
MP 160
MP 170
MP 180
8
84
238
347
202
10
60
101
SR 347/SR 84 Corridor Segments
Segment 84/347-1: I-8 to Carefree Pl (MP 155-162)
Segment 347-2: Carefree Pl to Harrah's Ak-Chin Casino (MP 162-171)
Segment 347-3: Harrah's Ak-Chin Casino to Cobblestone Farms Dr (MP 171-176)
Segment 347-4: Cobblestone Farms Dr to Maricopa/Pinal County Line (MP 176-184)
Segment 347-5: Maricopa/Pinal County Line to I-10 (MP 184-189)
N
Miles
0 2.5 5
SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Safety Index
2016 - 2020
Corridor Segments
Interstate/Highway
Local Streets
City Boundary
County Boundary
Railroad
SAFETY INDEX
2 OR 3 OR 4 LANE DIVIDED HIGHWAY (SEGMENTS 84/247-1)
ABOVE AVERAGE PERFORMANCE (<.81)
AVERAGE PERFORMANCE (0.81 - 1.19)
BELOW AVERAGE PERFORMANCE (>1.19)
INSUFFICIENT DATA
2 OR 3 LANE UNDIVIDED HIGHWAY (SEGMENTS 347-2)
ABOVE AVERAGE PERFORMANCE (<0.92)
AVERAGE PERFORMANCE (0.92 - 1.08)
BELOW AVERAGE PERFORMANCE (>1.08)
INSUFFICIENT DATA
SAFETY HOT SPOT
SAFETY HOT SPOT



N

Miles
0 2.5 5

SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Directional Safety Index
2016 - 2020 Data

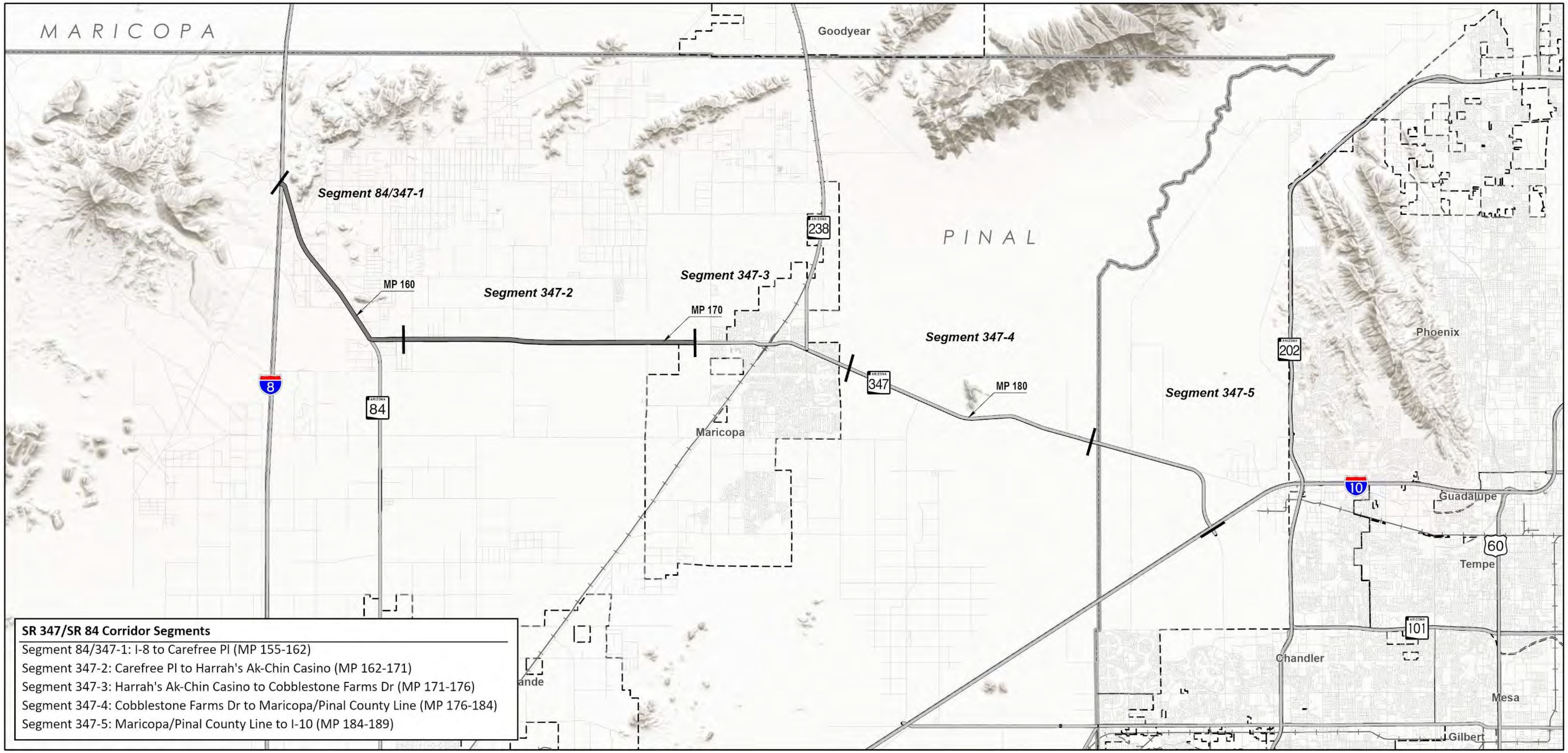
- Corridor Segments
- Interstate/Highway
- Local Streets
- City Boundary
- County Boundary
- Railroad

SAFETY INDEX

2 OR 3 OR 4 LANE DIVIDED HIGHWAY (SEGMENTS 84/247-1)
- ABOVE AVERAGE PERFORMANCE (<.81)
- AVERAGE PERFORMANCE (0.81 - 1.19)
- BELOW AVERAGE PERFORMANCE (>1.19)
- INSUFFICIENT DATA

2 OR 3 LANE UNDIVIDED HIGHWAY (SEGMENTS 347-2)
- ABOVE AVERAGE PERFORMANCE (<0.92)
- AVERAGE PERFORMANCE (0.92 - 1.08)
- BELOW AVERAGE PERFORMANCE (>1.08)
- INSUFFICIENT DATA

SAFETY HOT SPOT
- SAFETY HOT SPOT



SR 347/SR 84 Corridor Segments

Segment 84/347-1: I-8 to Carefree Pl (MP 155-162)
Segment 347-2: Carefree Pl to Harrah's Ak-Chin Casino (MP 162-171)
Segment 347-3: Harrah's Ak-Chin Casino to Cobblestone Farms Dr (MP 171-176)
Segment 347-4: Cobblestone Farms Dr to Maricopa/Pinal County Line (MP 176-184)
Segment 347-5: Maricopa/Pinal County Line to I-10 (MP 184-189)

SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Freight Index and Hot Spots
2019 Data

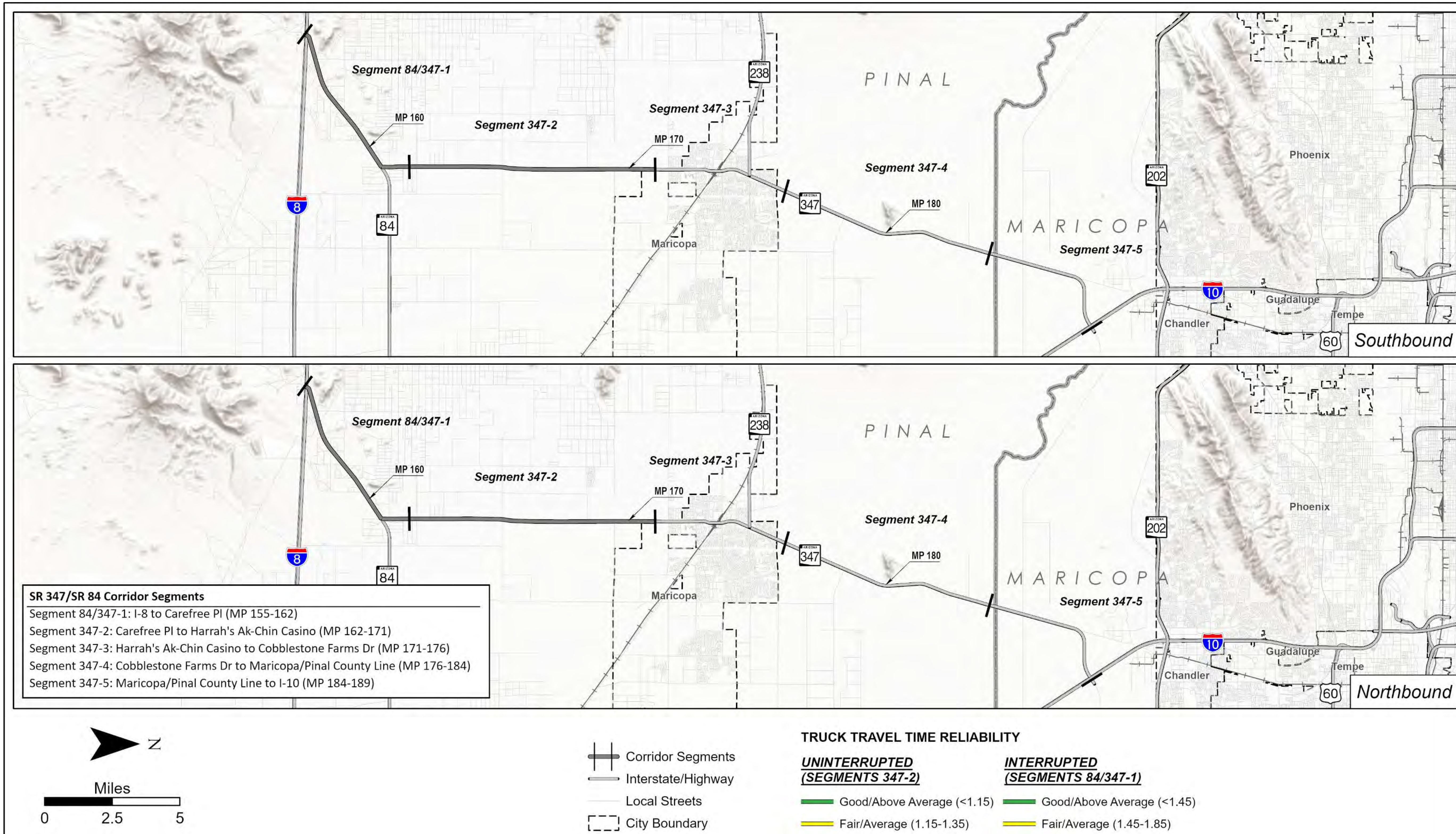
Corridor Segments
Interstate/Highway
Local Streets
City Boundary
County Boundary
Railroad

FREIGHT INDEX

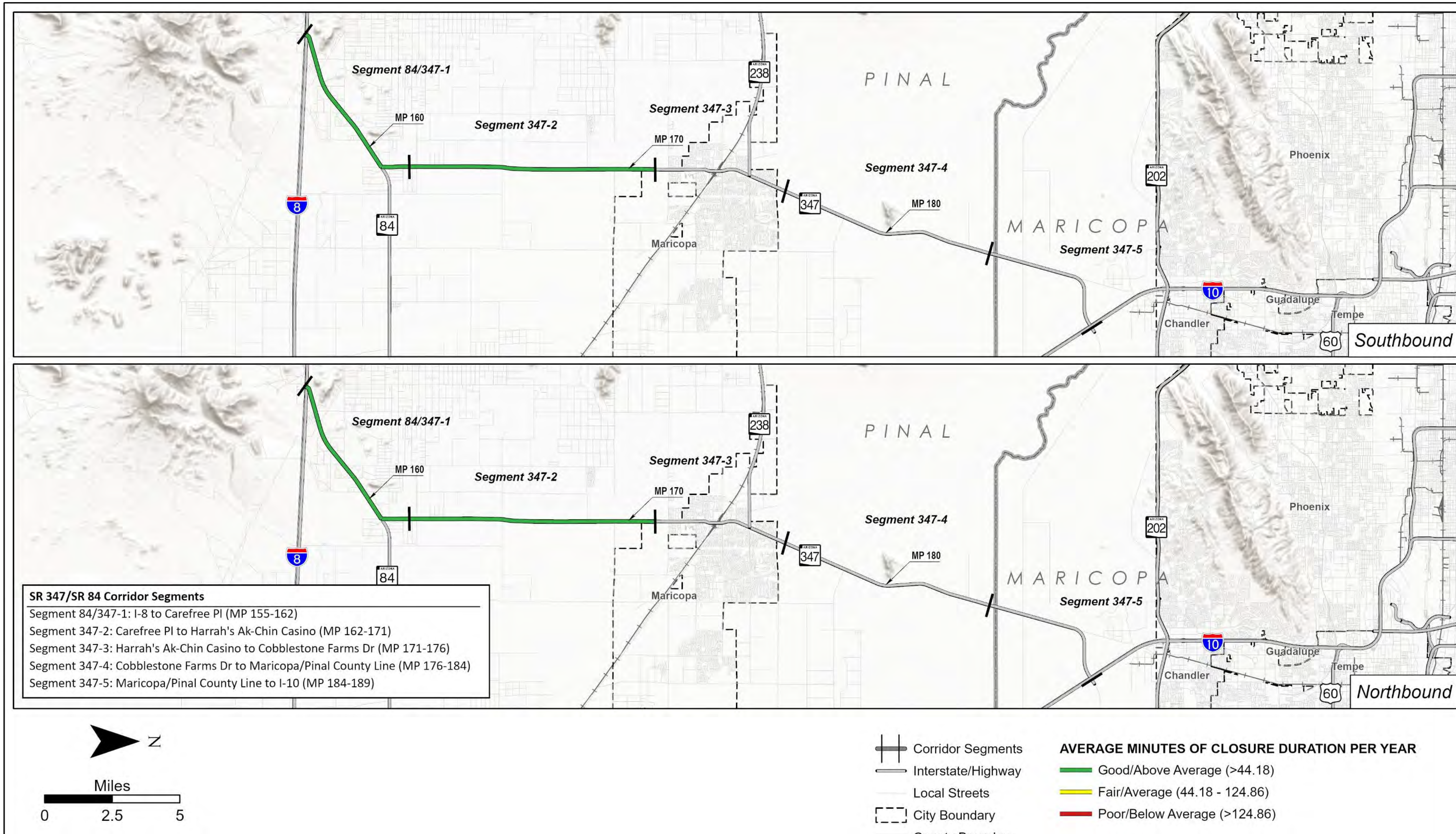
UNINTERRUPTED (SEGMENTS 347-2)	***INTERRUPTED (SEGMENTS 84/347-1)***
Good/Above Average (<1.15)	Good/Above Average (<1.45)
Fair/Average (1.15-1.35)	Fair/Average (1.45-1.85)
Poor/Below Average (>1.35)	Poor/Below Average (>1.85)
Insufficient Data	Insufficient Data

FREIGHT HOT SPOT

Bridge Vertical Clearance Less Than 16.25 Feet and No Ramp Around



SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Truck Travel Time Reliability
2019 Data

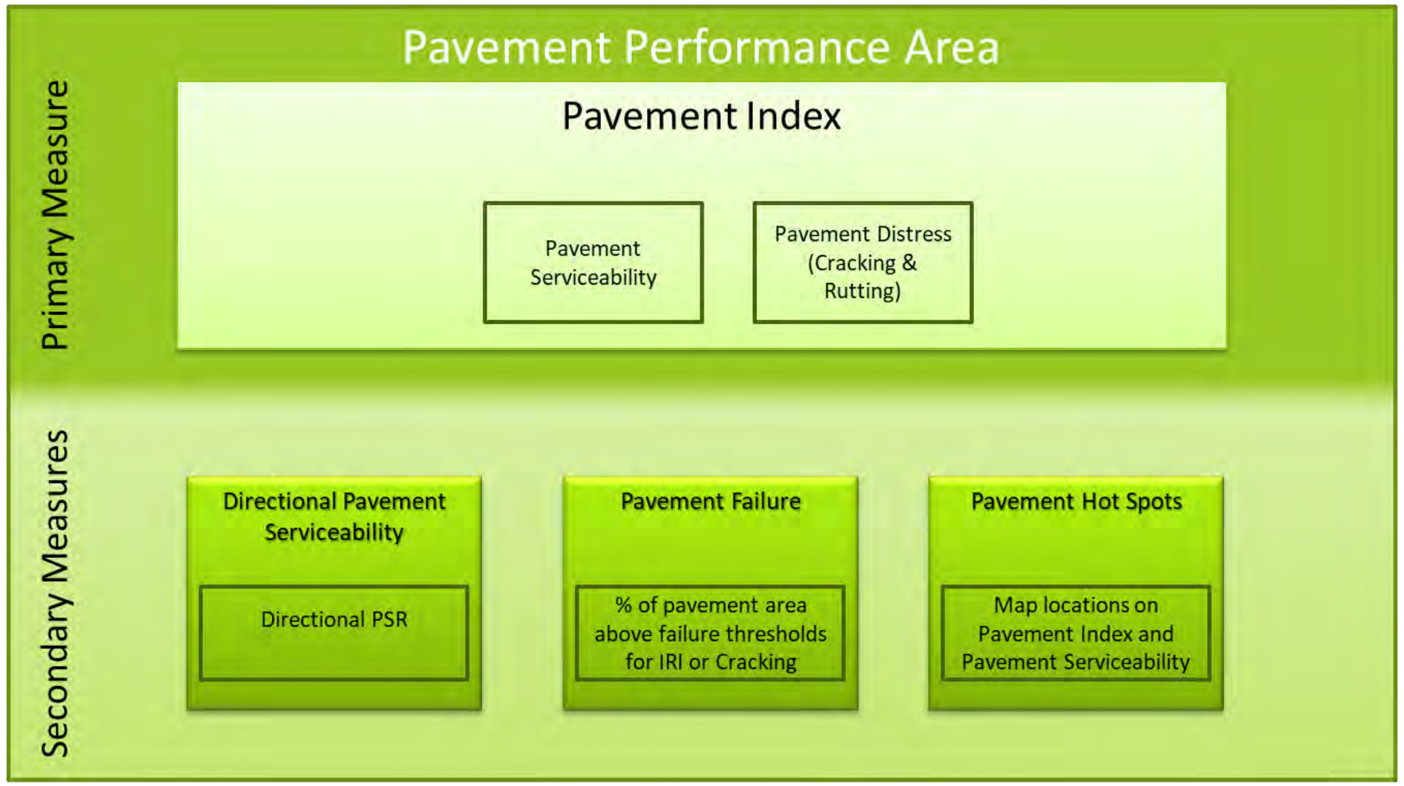


SR 347/SR 84 Corridor Profile Study: I-8 to I-10
Closure Duration
2014 - 2019 Data

Appendix B: Performance Area Detailed Calculation Methodologies

Pavement Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Pavement performance area as shown in the following graphic:



This performance area is used to evaluate mainline pavement condition. Pavement condition data for ramps, frontage roads, crossroads, etc. was not included in the evaluation.

Primary Pavement Index

The Pavement Index is calculated based on the use of three pavement condition ratings from the ADOT Pavement Database. The three ratings are the International Roughness Index (IRI), the Cracking rating, and the Rutting rating. The calculation of the Pavement Index uses a combination of these three ratings.

The IRI is a measurement of the pavement roughness based on field-measured longitudinal roadway profiles. To facilitate the calculation of the index, the IRI rating was converted to a Pavement Serviceability Rating (PSR) using the following equation:

$$PSR = 5 * e^{-0.0038*IRI}$$

The Cracking rating is a measurement of the amount of surface cracking based on a field-measured area of 1,000 square feet that serves as a sample for each mile. The Rutting rating is a measurement of the depth of pavement rutting based on field measurements. To facilitate the calculation of the index, the Cracking Rating and Rutting Rating were combined and converted to a Pavement Distress Index (PDI) using the following equation:

$$PDI = 5 - [\,(0.345 * C^{0.66}) + \left(0.01428 * \left(\frac{R}{2} * 100\right)^{1.32}\right) - \left(0.0823 * C^{0.18} * \left(\frac{R}{2} * 100\right)^{0.50}\right)\,]$$

Both the PSR and PDI use a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest performance. The performance thresholds for interstates and non-interstates shown in the tables below were used for the PSR and PDI.

Performance Level for Interstates	IRI (PSR)	Cracking & Rutting (PDI)
Good	<75 (>3.75)	Cracking <5.75 Rutting < 0.35
Fair	75 - 102 (3.40 - 3.75)	Cracking 5.75 - 12 Rutting 0.35 – 0.55
Poor	>102(<3.40)	Cracking >12 Rutting > 0.55

Performance Level for Non-Interstates	IRI (PSR)	Cracking & Rutting (PDI)
Good	<94 (>3.5)	Cracking < 5.75 Rutting < 0.35
Fair	94 - 142 (2.90 - 3.5)	Cracking 5.75 - 12 Rutting 0.35 – 0.55
Poor	>142 (<2.90)	Cracking >12 Rutting > 0.55

The PSR and PDI are calculated for each 1-mile section of roadway. If PSR or PDI falls into a poor rating (<3.4 for PSR for interstates, for example) for a 1-mile section, then the score for that 1-mile section is entirely (100%) based on the lower score (either PSR or PDI). If neither PSR or PDI fall into a poor rating for a 1-mile section, then the score for that 1-mile section is based on a combination of the lower rating (70% weight) and the higher rating (30% weight). The result is a score between 0 and 5 for each direction of travel of each mile of roadway based on a combination of both the PSR and the PDI.

The project corridor has been divided into segments. The Pavement Index for each segment is a weighted average of the directional ratings based on the number of travel lanes. Therefore, the condition of a section with more travel lanes will have a greater influence on the resulting segment Pavement Index than a section with fewer travel lanes.

Secondary Pavement Measures

Three secondary measures are evaluated:

- Directional Pavement Serviceability
- Pavement Failure
- Pavement Hot Spots

Directional Pavement Serviceability: Similar to the Pavement Index, the Directional Pavement Serviceability is calculated as a weighted average (based on number of lanes) for each segment. However, this rating only utilizes the PSR and is calculated separately for each direction of travel. The PSR uses a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest performance.

Pavement Failure: The percentage of pavement area rated above the failure thresholds for IRI, Cracking, or Rutting is calculated for each segment. In addition, the Standard score (z-score) is calculated for each segment.

The Standard score (z-score) is the number of standard deviations above or below the mean. Therefore, a Standard score between -0.5 and +0.5 is “average”, less than -0.5 is lower (better) than average, and higher than +0.5 is above (worse) than average.

Pavement Hot Spots: The Pavement Index map identifies locations that have an IRI rating, Cracking rating, or Rutting rating that fall above the failure threshold as identified by ADOT Pavement Group. For interstates, an IRI rating above 105, a Cracking rating above 10, or a Rutting rating above 0.4 will be used as the thresholds which are slightly different than the ratings shown previously. For non-interstates, an IRI rating above 142, a Cracking rating above 10, or a Rutting rating above 0.4 will be used as the thresholds.

<u>Scoring</u>

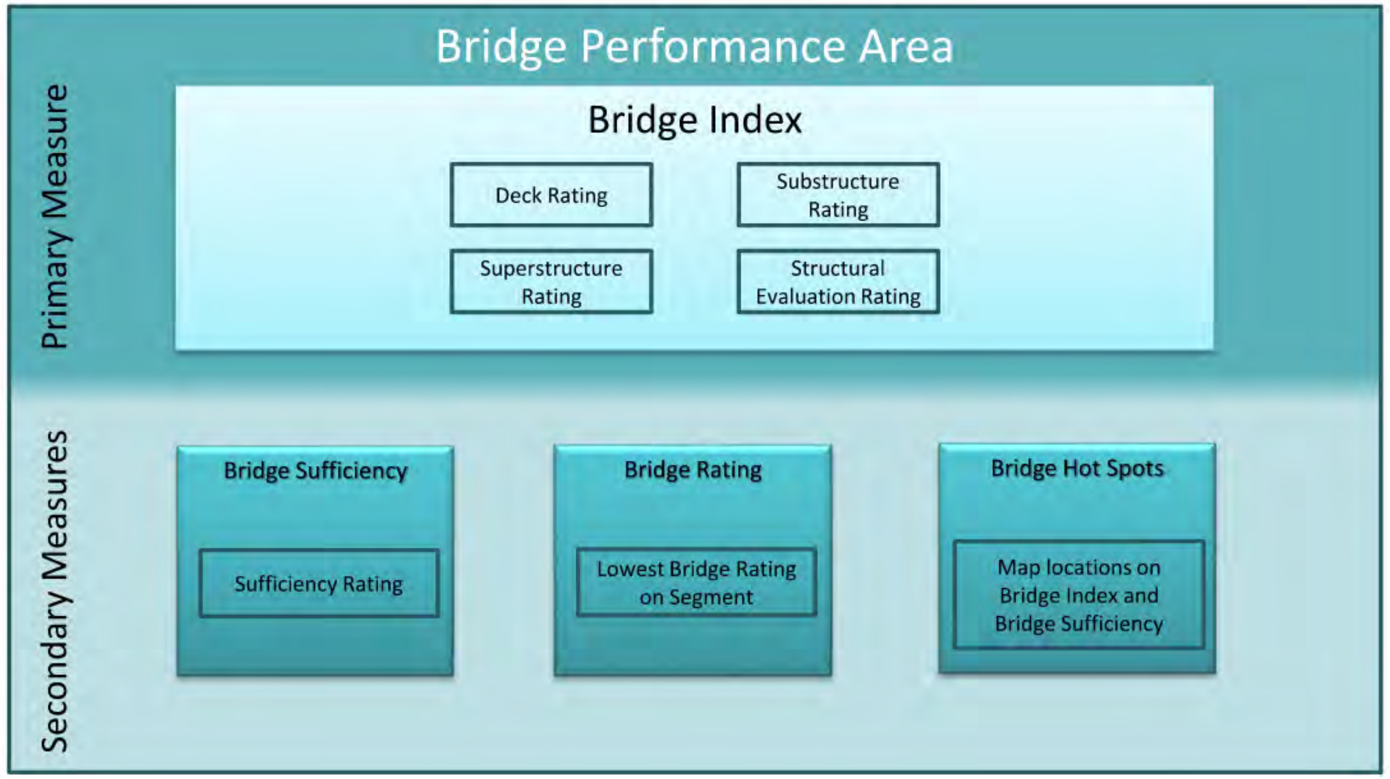
Performance Level	Pavement Index	
	Interstates	Non-Interstates
Good	>3.75	>3.6
Fair	3.0 - 3.75	2.8 - 3.6
Poor	<3.0	<2.8

Performance Level	Directional Pavement Serviceability	
	Interstates	Non-Interstates
Good	>3.75	>3.5
Fair	3.4 - 3.75	2.9 - 3.5
Poor	<3.4	<2.9

Performance Level	% Pavement Failure
Good	< 5%
Fair	5% – 20%
Poor	>20%

Bridge Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Bridge performance area as shown in the following graphic:



This performance area is used to evaluate mainline bridges. Bridges on ramps (that do not cross the mainline), frontage roads, etc. should not be included in the evaluation. Basically, any bridge that carries mainline traffic or carries traffic over the mainline should be included and bridges that do not carry mainline traffic, run parallel to the mainline (frontage roads), or do not cross the mainline should not be included.

<u>Primary Bridge Index</u>

The Bridge Index is calculated based on the use of four bridge condition ratings from the ADOT Bridge Database, also known as the Arizona Bridge Information and Storage System (ABISS). The four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating. The calculation of the Bridge Index uses the lowest of these four ratings.

Each of the four condition ratings use a 0 to 9 scale with 0 representing the lowest performance and 9 representing the highest performance.

The project corridor has been divided into segments and the bridges are grouped together according to the segment definitions. In order to report the Bridge Index for each corridor segment, the Bridge Index for each segment is a weighted average based on the deck area for each bridge. Therefore, the condition of a larger bridge will have a greater influence on the resulting segment Bridge Index than a smaller bridge.

<u>Secondary Bridge Measures</u>

Three secondary measures will be evaluated:

- Bridge Sufficiency
- Bridge Rating
- Bridge Hot Spots

Bridge Sufficiency: Similar to the Bridge Index, the Bridge Sufficiency rating is calculated as a weighted average (based on deck area) for each segment. The Bridge Sufficiency rating is a scale of 0 to 100 with 0 representing the lowest performance and 100 representing the highest performance. A rating of 80 or above represents “good” performance, a rating between 50 and 80 represents “fair” performance, and a rating below 50 represents “poor” performance.

Bridge Rating: The Bridge Rating simply identifies the lowest bridge rating on each segment. This performance measure is not an average and therefore is not weighted based on the deck area. The Bridge Index identifies the lowest rating for each bridge, as described above. Each of the four condition ratings use a 0 to 9 scale with 0 representing the lowest performance and 9 representing the highest performance.

Bridge Hot Spots: The Bridge Index map identifies individual bridge locations that are identified as hot spots. Hot spots are bridges that have a single rating of 4 in any of the four ratings, or multiple ratings of 5 in the deck, substructure or superstructure ratings.

Scoring:

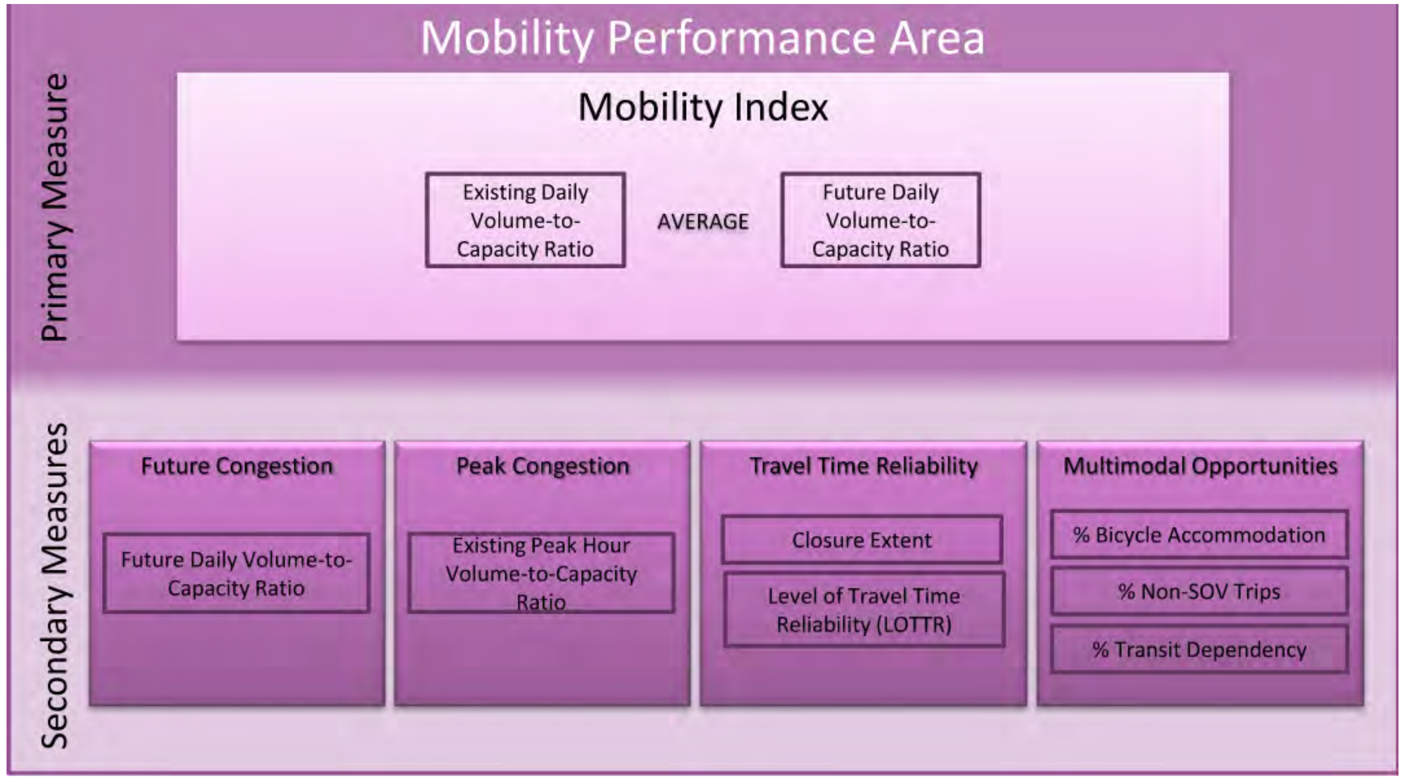
Performance Level	Bridge Index
Good	>6.5
Fair	5.0-6.5
Poor	<5.0

Performance Level	Sufficiency Rating
Good	>80
Fair	50-80
Poor	<50

Performance Level	Bridge Rating
Good	>6
Fair	5-6
Poor	<5

Mobility Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Mobility performance area as shown in the following graphic:



<u>Primary Mobility Index</u>

The primary Mobility Index is an average of the existing daily volume-to-capacity (V/C) ratio and the future daily V/C ratio for each segment of the corridor.

Existing Daily V/C: The existing daily V/C ratio for each segment is calculated by dividing the existing Annual Average Daily Traffic (AADT) volume for each segment by the total Level of Service (LOS) E capacity volume for that segment

The capacity is calculated using the HERS Procedures for Estimating Highway Capacity[1]. The HERS procedure incorporates HCM 2010 methodologies. The methodology includes capacity estimation procedures for multiple facility types including freeways, rural two-lane highways, multilane highways, and signalized and non-signalized urban sections.

The segment capacity is defined as a function of the number of mainline lanes, shoulder width, interrupted or uninterrupted flow facilities, terrain type, percent of truck traffic, and the designated urban or rural environment.

The AADT for each segment is calculated by applying a weighted average across the length of the segment based on the individual 24-hour volumes and distances associated with each HPMS count station within each segment.

The following example equation is used to determine the weighted average of a segment with two HPMS count locations within the corridor

((HPMS 1 Distance x HPMS 1 Volume) + (HPMS 2 Distance x HPMS 2 Volume))/Total Segment Length

For specific details regarding the HERS methodology used, refer to the *Procedures for Estimating Highway Capacity, draft Technical Memorandum.*

Future Daily V/C: The future daily V/C ratio for each segment is calculated by dividing the future AADT volume for each segment by the existing LOS E capacity. The capacity volume used in this calculation is the same as is utilized in the existing daily V/C equation.

The future AADT daily volumes are generated by applying an average annual compound growth rate (ACGR) to each existing AADT segment volume. The following equation is used to apply the average annual compound growth rate:

Future AADT = Existing AADT x ((1+ACGR)^(Future Year-Existing Year))

The ACGR for each segment is defined by comparing the total volumes in the existing Arizona Travel Demand Model (AZTDM2) to the future AZTDM2 traffic volumes at each existing HPMS count station location throughout the corridor. Each existing and future segment volume is defined using the same weighted average equation described in the *Existing Daily V/C* section above and then summing the directional volumes for each location. The following equation is used to determine the ACGR for each segment:

ACGR = ((Future Volume/Existing Volume)^(1/(Future Year-Existing Year))))-1

<u>Secondary Mobility Measures</u>

Four secondary measures are evaluated:

- Future Congestion
- Peak Congestion
- Travel Time Reliability
  - Closure Extent
  - Directional Level of Travel Time Reliability
- Multimodal Opportunities
  - % Bicycle Accommodation
  - % Non-Single Occupancy Vehicle (SOV) Trips

[1] HERS Support – 2011, Task 6: Procedures for Estimating Highway Capacity, draft Technical Memorandum. Cambridge Systematics. Prepared for the Federal Highway Administration. March 2013.

- % Transit Dependency

Future Congestion: The future daily V/C ratios for each segment in the corridor that are calculated and used in the Mobility Index as part of the overall average between Existing Daily V/C and Future Daily V/C are applied independently as a secondary measure. The methods to calculate the Future Daily V/C can be referenced in the Mobility Index section.

Peak Congestion: Peak Congestion has been defined as the peak hour V/C ratio in both directions of the corridor. The peak hour V/C ratio is calculated using the HERS method as described previously. The peak hour volume utilizes the directional AADT for each segment, which is calculated by applying a weighted average across the length of the segment based on the individual directional 24-hour volumes and distances associated with each HPMS count station within each segment. The segment capacity is defined based on the characteristics of each segment including number of lanes, terrain type, and environment, similar to the 24-hour volumes using the HERS method.

Travel Time Reliability: Travel time reliability is a secondary measure that includes two indicators. The two indicators are the number of times a piece of a corridor is closed for any specific reason and the directional Level of Travel Time Reliability (LOTTR).

Closure Extent: The number of times a roadway is closed is documented through the HCRS dataset. Closure Extent is defined as the average number of times a particular milepost of the corridor is closed per year per mile in a specific direction of travel. The weighted average of each occurrence takes into account the distance over which a specific occurrence spans.

Thresholds that determine levels of good, fair, and poor are based on the average number of closures per mile per year within each of the identified statewide significant corridors by ADOT. The thresholds shown at the end of this section represent statewide averages across those corridors.

Directional Level of Travel Time Reliability: In terms of overall mobility, the LOTTR is the relationship of 80th percentile travel time to average (50th percentile) travel time for a given corridor segment in a specific direction.

Using INRIX data provided by ADOT, four time periods for each data point were collected throughout the day (AM peak, mid-day, PM peak, and off-peak). The highest value of the four time periods calculation is defined as the LOTTR for that data point. The weighted average LOTTR is calculated within each segment based on the number of data points collected and the length associated with the TMC location. The value of the weighted average LOTTR across each entry is used as the LOTTR for each respective segment within the corridor.

Multimodal Opportunities: Three multimodal opportunity indicators reflect the characteristics of the corridor that promote alternate modes to a single occupancy vehicle (SOV) for trips along the corridor. The three indicators include the percent bicycle accommodation, non-SOV trips, and transit dependency along the corridor.

Percent Bicycle Accommodation: For this secondary performance evaluation, outside shoulder widths are evaluated considering the roadway's context and conditions. This requires use of the roadway data that includes right shoulder widths, shoulder surface types, and speed limits, all of which are available in the following ADOT geographic information system (GIS) data sets:

- Right Shoulder Widths
- Left Shoulder Widths (for undivided roadways)
- Shoulder Surface Type (Both Left/Right)
- Speed Limit

Additionally, each segment's average AADT, estimated earlier in the Mobility performance area methodology, is used for the criteria to determine if the existing shoulder width meets the effective width.

The criteria for screening if a shoulder segment meets the recommended width criteria are as followed:

(1) If AADT <= 1500 OR Speed Limit <= 25 miles per hour (mph):
The segment's general purpose lane can be shared with bicyclists (no effective shoulder width required)

(2) If AADT > 1500 AND Speed Limit between (25 - 50 mph) AND Pavement Surface is Paved:
Effective shoulder width required is 4 feet or greater

(3) If AADT > 1500 AND Speed Limit >= 50 mph and Pavement Surface is Paved:
Effective shoulder width required is 6 feet or greater

The summation of the length of the shoulder sections that meet the defined effective width criteria, based on criteria above, is divided by the segment's total length to estimate the percent of the segment that accommodates bicycles as illustrated at the end of this section. If shoulder data is not available or appears erroneous, field measurements can substitute for the shoulder data.

Percent Non-SOV Trips: The percentage of non-SOV trips over distances less than 50 miles gives an indication of travel patterns along a section of the corridor that could benefit from additional multimodal options in the future.

Thresholds that determine levels of good, fair, and poor are based on the percent non-SOV trips within each of the identified statewide significant corridors by ADOT. The thresholds shown at the end of this section represent statewide averages across those corridors.

Percent Transit Dependency: U.S. Census American Community Survey tract and state level geographic data and attributes from the tables B08201 (Number of Vehicles Available by Household Size) and B17001 (Population in Poverty within the Last 12 Months) were downloaded with margins of error included from the Census data retrieval application Data Ferret. Population ranges for each tract were determined by adding and subtracting the margin of error to each estimate in excel. The tract level attribute data was then joined to geographic tract data in GIS. Only tracts within a one mile buffer of each corridor are considered for this evaluation.

Tracts that have a statistically significantly larger number of either people in poverty or households with only one or no vehicles available than the state average are considered potentially transit dependent.

Example: The state average for zero or one vehicles households (HHs) is between 44.1% and 45.0%. Tracts which have the lower bound of their range above the upper bound of the state range have a greater percentage of zero/one vehicle HHs than the state average. Tracts that have their upper bound beneath the lower bound of the state range have a lesser percentage of zero/one vehicles HHs than the state average. All other tracts that have one of their bounds overlapping with the state average cannot be considered statistically significantly different because there is a chance the value is actually the same.

In addition to transit dependency, the following attributes are added to the Multimodal Opportunities map based on available data.

- Shoulder width throughout the corridor based on 'Shoulder Width' GIS dataset provided by ADOT
- Intercity bus routes
- Multiuse paths within the corridor right-of-way, if applicable

Scoring:

Volume-to-Capacity Ratios		
Urban and Fringe Urban		
Good - LOS A-C	V/C ≤ 0.71	*Note - ADOT Roadway Design Standards indicate Urban and Fringe Urban roadways should be designed to level of service C or better
Fair - LOS D	V/C > 0.71 & ≤ 0.89	
Poor - LOS E or less	V/C > 0.89	
Rural		
Good - LOS A-B	V/C ≤ 0.56	*Note - ADOT Roadway Design Standards indicate Rural roadways should be designed to level of service B or better
Fair - LOS C	V/C > 0.56 & ≤ 0.76	
Poor - LOS D or less	V/C > 0.76	

Performance Level	Closure Extent
Good	≤ 0.22
Fair	> 0.22 & ≤ 0.62
Poor	V/C > 0.62

Performance Level	LOTTR on Uninterrupted Flow Facilities
Good	< 1.15
Fair	≥ 1.15 & < 1.50
Poor	≥ 1.50

Performance Level	LOTTR on Interrupted Flow Facilities
Good	< 1.15
Fair	≥ 1.15 & < 1.50
Poor	≥ 1.50

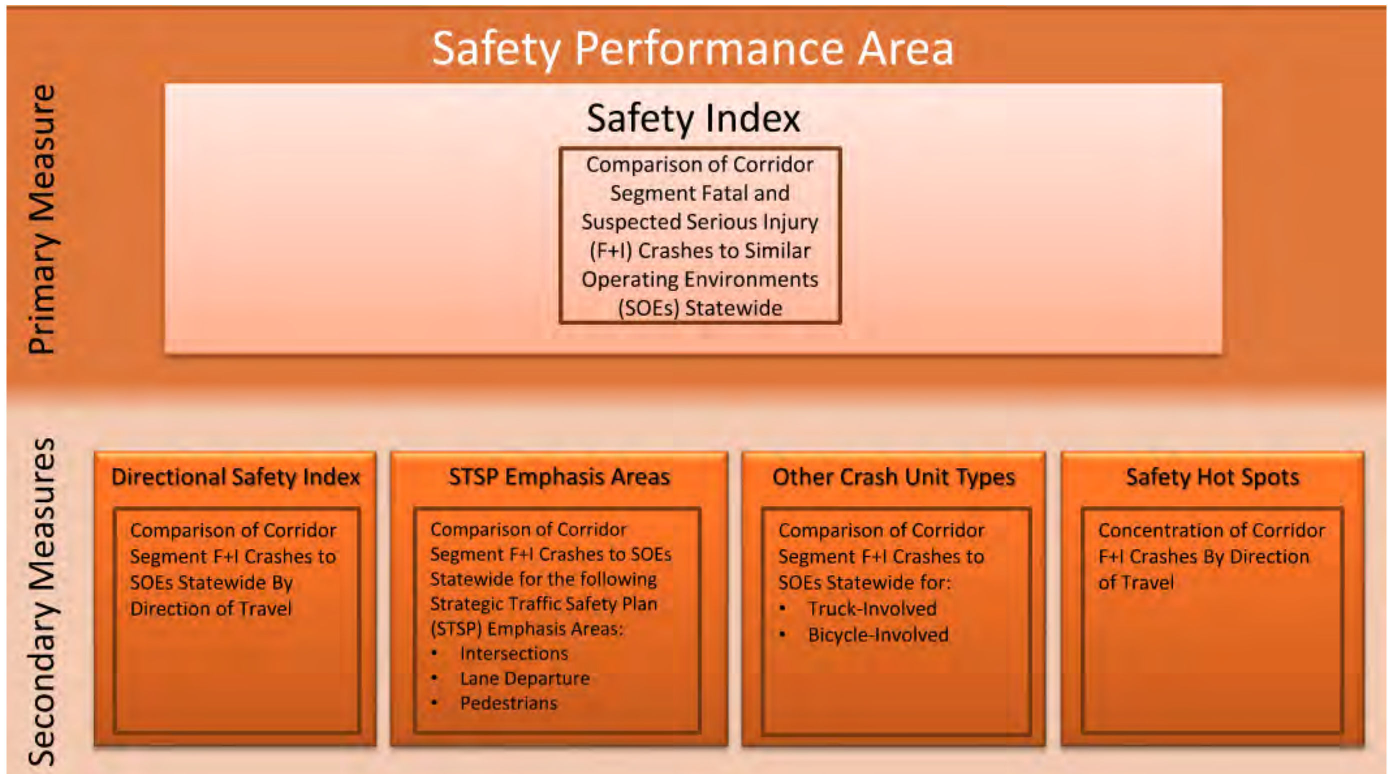
Performance Level	Percent Bicycle Accommodation
Good	≥ 90%
Fair	> 60% & ≤ 90%
Poor	< 60%

Performance Level	Percent Non-SOV Trips
Good	≥ 17%
Fair	> 11% & ≤ 17%
Poor	< 11%

Performance Level	Percent Transit Dependency
Good	Tracts with both zero and one vehicle household population in poverty percentages below the statewide average
Fair	Tracts with either zero and one vehicle household or population in poverty percentages below the statewide average
Poor	Tracts with both zero and one vehicle household and population in poverty percentages above the statewide average

Safety Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Safety performance area as shown in the following graphic:



Primary Safety Index

The Safety Index is a safety performance measure based on the bi-directional (i.e., both directions combined) frequency and rate of fatal and suspected serious injury crashes, the relative cost of those types of crashes, and crash occurrences on similar roadways in Arizona. According to ADOT's 2018 Highway Safety Improvement Program Manual, fatal crashes have an estimated cost that is 17.3 times the estimated cost of suspected serious injury crashes ($9.5 million compared to $550,000).

The Combined Safety Score (CSS) is an interim measure that combines fatal and suspected serious injury crashes into a single value. The CSS is calculated using the following generalized formula:

*CSS = 17.3 * (Normalized Fatal Crash Rate + Frequency) + (Normalized Suspected Serious Injury Crash Rate + Frequency)*

Because crashes vary depending on the operating environment of a particular roadway, statewide CSS values were developed for similar operating environments defined by functional classification, urban vs. rural setting, number of travel lanes, and traffic volumes. To determine the Safety Index of a particular segment, the segment CSS is compared to the average statewide CSS for the similar statewide operating environment.

The Safety Index is calculated using the following formula:

Safety Index = Segment CSS / Statewide Similar Operating Environment CSS

The average annual Safety Index for a segment is compared to the statewide similar operating environment annual average, with one standard deviation from the statewide average forming the scale break points.

The more a particular segment's Safety Index value is below the statewide similar operating environment average, the better the safety performance is for that particular segment as a lower value represents fewer crashes.

Scoring:

The scale for rating the Safety Index depends on the operating environments selected, as shown in the table below.

Similar Operating Environment	Safety Index (Overall & Directional)	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	0.92	1.08
2 or 3 or 4 Lane Divided Highway	0.81	1.19
4 or 5 Lane Undivided Highway	0.78	1.22
6 Lane Highway	0.76	1.24
Rural 4 Lane Freeway with Daily Volume < 25,000	0.84	1.16
Rural 4 Lane Freeway with Daily Volume > 25,000	0.78	1.22
Urban 4 Lane Freeway	0.73	1.27
Urban or Rural 6 Lane Freeway	0.65	1.35
Urban > 6 Lane Freeway	0.89	1.11

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

Some corridor segments may have a very low number of total fatal and suspected serious injury crashes. Low crash frequencies (i.e., a small sample size) can translate into performance ratings that can be unstable. In some cases, a change in crash frequency of one crash (one additional crash or one less crash) could result in a change in segment performance of two levels. To avoid reliance on performance ratings where small changes in crash frequency result in large changes in performance, the following two criteria were developed to identify segments with "insufficient data" for assessing performance for the Safety Index. Both of these criteria must be met for a segment to have "insufficient data" to reliably rate the Safety Index performance:

- If the crash sample size (total fatal plus suspected serious injury crashes) for a given segment is less than five crashes over the five-year analysis period; AND
- If a change in one crash results in a change in segment performance by two levels (i.e., a change from below average to above average performance or a change from above average

to below average frequency), the segment has "insufficient data" and Safety Index performance ratings are unreliable.

Secondary Safety Measures

The Safety performance area has four secondary measures related to fatal and suspected serious injury crashes:

- Directional Safety Index
- Strategic Traffic Safety Plan (SHSP) Emphasis Areas
- Other Crash Unit Types
- Safety Hot Spots

Directional Safety Index: The Directional Safety Index shares the same calculation procedure and thresholds as the Safety Index. However, the measure is based on the directional frequency and rate of fatal and suspected serious injury crashes.

Similar to the Safety Index, the segment CSS is compared to the average statewide CSS for the similar statewide operating environment. The Directional Safety Index follows the lead of the Safety Index in terms of "insufficient data" status. If the Safety Index meets both criteria for "insufficient data", the Directional Safety Index should also be changed to "insufficient data". If the Safety Index does not meet both criteria for "insufficient data", the Directional Safety Index would also not change to say "insufficient data"

STSP Emphasis Areas: ADOT's 2019 STSP identifies several emphasis areas for reducing fatal and suspected serious injury crashes. The three relevant STSP emphasis areas relate to crashes involving:

- Intersections
- Lane departures
- Pedestrians

To develop a performance measure that reflects these emphasis areas, the percentage of total fatal and suspected serious injury crashes that involves a given emphasis area on a particular segment is compared to the statewide average percentage of crashes involving that same emphasis area on roads with similar operating environments in a process similar to how the Safety Index is developed.

The STSP emphasis areas performance is calculated using the following formula:

% Crashes Involving STSP Emphasis Area = Segment Crashes Involving STSP Emphasis Area / Total Segment Crashes

The percentage of total crashes involving STSP emphasis areas for a segment is compared to the statewide percentages on roads with similar operating environments. One standard deviation from the statewide average percentage forms the scale break points.

When assessing the performance of the STSP emphasis areas, the more the frequency of crashes involving STSP emphasis areas is below the statewide average implies better levels of segment performance. Thus, lower values are better, similar to the Safety Index.

Scoring:

The scale for rating the STSP emphasis areas performance depends on the crash history on similar statewide operating environments, as shown in the tables below:

Similar Operating Environment	Crashes at Intersections	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	11.2%	15.6%
2 or 3 or 4 Lane Divided Highway	23.4%	29.3%
4 or 5 Lane Undivided Highway	43.8%	49.5%
6 Lane Highway	57.8%	73.2%
Rural 4 Lane Freeway with Daily Volume < 25,000	0.00%	0.00%
Rural 4 Lane Freeway with Daily Volume > 25,000	0.00%	0.00%
Urban 4 Lane Freeway	0.00%	0.00%
Urban or Rural 6 Lane Freeway	0.00%	0.00%
Urban > 6 Lane Freeway	0.00%	0.00%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

Similar Operating Environment	Crashes Involving Lane Departures	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	66.9%	74.5%
2 or 3 or 4 Lane Divided Highway	56.4%	65.0%
4 or 5 Lane Undivided Highway	21.1%	32.1%
6 Lane Highway	11.7%	38.1%
Rural 4 Lane Freeway with Daily Volume < 25,000	72.8%	76.4%
Rural 4 Lane Freeway with Daily Volume > 25,000	69.0%	77.5%
Urban 4 Lane Freeway	60.6%	78.1%
Urban or Rural 6 Lane Freeway	55.7%	62.9%
Urban > 6 Lane Freeway	40.4%	43.2%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

Similar Operating Environment	Crashes Involving Pedestrians	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	3.8%	7.2%
2 or 3 or 4 Lane Divided Highway	2.4%	3.6%
4 or 5 Lane Undivided Highway	8.8%	13.5%
6 Lane Highway	0.4%	11.9%
Rural 4 Lane Freeway with Daily Volume < 25,000	1.0%	3.3%
Rural 4 Lane Freeway with Daily Volume > 25,000	0.7%	4.7%
Urban 4 Lane Freeway	0.0%	4.9%
Urban or Rural 6 Lane Freeway	4.0%	7.9%
Urban > 6 Lane Freeway	1.6%	4.7%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

The STSP emphasis area secondary safety performance measures for the Safety performance area include proportions of specific types of crashes within the total fatal and suspected serious injury crash frequencies. This more detailed categorization of fatal and suspected serious injury crashes can result in low crash frequencies (i.e., a small sample size) that translate into performance ratings that can be unstable. In some cases, a change in crash frequency of one crash (one additional crash or one less crash) could result in a change in segment performance of two levels. To avoid reliance on performance ratings where small changes in crash frequency result in large changes in performance, the following criteria were developed to identify segments with "insufficient data" for assessing performance for the STSP emphasis area secondary safety performance measures. If any of these criteria are met for a segment, that segment has "insufficient data" to reliably rate that STSP emphasis area performance:

- If the crash sample size (total fatal plus suspected serious injury crashes) for a given segment is less than five crashes over the five-year analysis period, the segment has "insufficient data" and performance ratings are unreliable. OR
- If a change in one crash results in a change in segment performance by two levels (i.e., a change from below average to above average performance or a change from above average to below average frequency), the segment has "insufficient data" and performance ratings are unreliable. OR
- If the corridor average segment crash frequency for any of the STSP emphasis area performance measures is less than two crashes over the five-year analysis period, that entire STSP emphasis area performance measure has "insufficient data" and performance ratings are unreliable.

Other Crash Unit Types: Other crash unit types of interest are:

- Truck-involved crashes
- Bicycle-involved crashes

To develop a performance measure that reflects the aforementioned crash unit types, the percentage of total fatal and suspected serious injury crashes that involves a given crash unit type on a particular segment is compared to the statewide average percentage of crashes involving that same crash unit type on roads with similar operating environments in a process similar to how the Safety Index is developed.

The crash unit type performance is calculated using the following formula:

% Crashes Involving Crash Unit Type = Segment Crashes Involving Crash Unit Type / Total Segment Crashes

The percentage of total crashes involving each crash unit type for a segment is compared to the statewide percentages on roads with similar operating environments. One standard deviation from the statewide average percentage forms the scale break points.

When assessing the performance of the crash unit types, the more the frequency of crashes involving crash unit types is below the statewide average implies better levels of segment performance. Thus, lower values are better, similar to the Safety Index.

Scoring:

The scale for rating the unit-involved crash performance depends on the crash history on similar statewide operating environments, as shown in the following tables.

Similar Operating Environment	Crashes Involving Trucks	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	4.2%	8.0%
2 or 3 or 4 Lane Divided Highway	3.7%	9.9%
4 or 5 Lane Undivided Highway	0.8%	5.5%
6 Lane Highway	4.3%	7.5%
Rural 4 Lane Freeway with Daily Volume < 25,000	19.0%	22.5%
Rural 4 Lane Freeway with Daily Volume > 25,000	8.5%	18.0%
Urban 4 Lane Freeway	6.9%	12.4%
Urban or Rural 6 Lane Freeway	5.0%	12.9%
Urban > 6 Lane Freeway	1.9%	5.1%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

Similar Operating Environment	Crashes Involving Bicycles	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	0.0%	3.3%
2 or 3 or 4 Lane Divided Highway	0.0%	2.2%
4 or 5 Lane Undivided Highway	0.5%	3.8%
6 Lane Highway	0.0%	7.2%
Rural 4 Lane Freeway with Daily Volume < 25,000	0.0%	0.9%
Rural 4 Lane Freeway with Daily Volume > 25,000	0.0%	0.0%
Urban 4 Lane Freeway	0.0%	0.0%
Urban or Rural 6 Lane Freeway	0.0%	1.3%
Urban > 6 Lane Freeway	0.0%	0.0%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

The crash unit types have the same “insufficient data” criteria as the STSP emphasis areas.

Safety Hot Spots: A hot spot analysis was conducted that identified abnormally high concentrations of fatal and suspected serious injury crashes along the study corridor by direction of travel. The identification of crash concentrations involves a GIS-based function known as “kernel density analysis”. This measure is mapped for graphical display purposes with the Directional Safety Index but is not included in the Safety performance area rating calculations.

Freight Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Freight performance area as shown in the following graphic:

Primary Freight Index

The Freight Index is a reliability performance measure based on the bi-directional truck travel time reliability (TTTR) for truck travel. The industry standard definition for the Truck Travel Time Reliability (TTTR) is the ratio of the 95th percentile travel time to average (50th percentile) travel time for trucks.

Using INRIX data provided by ADOT, four time periods for each data point were collected throughout the day (AM peak, mid-day, PM peak, and off-peak).

The highest calculated value of the four time periods is defined as the TTTR for that data point. The weighted average TTTR is calculated within each segment based on the number of data points collected and the length associated with the TMC location. The value of the weighted average TTTR across each entry is used as the TTTR for each respective segment within the corridor.

For each corridor segment, the TTTR is calculated for each direction of travel and then averaged to create a bi-directional TTTR. The Freight Index is equal to the average bi-directional TTTR for the segment.

The scale for rating the Freight Index differs between uninterrupted and interrupted flow facilities.

Secondary Freight Measures

The Freight performance area includes three secondary measures that provide an in-depth evaluation of the different characteristics of freight performance:

- Travel Time Reliability
  - Directional Truck Travel Time Reliability
  - Closure Duration
- Bridge Vertical Clearance
- Bridge Vertical Clearance Hot Spots

Travel Time Reliability: Travel time reliability is a secondary measure that includes two indicators. The two indicators are the directional Truck Travel Time Reliability (TTTR) and the duration a piece of a corridor is closed for any specific reason.

Truck Travel Time Reliability: The performance measure for truck travel time reliability is directional TTTR. The industry standard definition for TTTR is the ratio of 95th percentile travel time to average (50th percentile) travel time for trucks for a given corridor segment in a specific direction.

Using INRIX data provided by ADOT, four time periods for each data point were collected throughout the day (AM peak, mid-day, PM peak, and off-peak). The highest value of the four time periods calculation is defined as the TTTR for that data point. The weighted average TTTR is calculated within each segment based on the number of data points collected and the length associated with the TMC location. The value of the weighted average TTTR across each entry is used as the TTTR for each respective segment within the corridor.

Closure Duration: This performance measure related to road closures is average roadway closure (i.e., full lane closure) duration time in minutes. There are three main components to full closures that affect reliability – frequency, duration, and extent. In the freight industry, closure duration is the most important component because trucks want to minimize travel time and delay.

Data on the frequency, duration, and extent of full roadway closures on the ADOT State Highway System is available in the HCRS database that is managed and updated by ADOT.

The average closure duration in a segment – in terms of the average time a milepost is closed per mile per year on a given segment – is calculated using the following formula:

*Closure Duration = Sum of Segment (Closure Clearance Time * Closure Extent) / Segment Length*

The segment closure duration time in minutes can then be compared to statewide averages for closure duration in minutes, with one-half standard deviation from the average forming the scale break points. The scale for rating closure duration in minutes is found at the end of this section.

Bridge Vertical Clearance: This performance measure uses the vertical clearance information from the ADOT Bridge Database to identify locations with low vertical clearance. The minimum vertical clearance for all underpass structures (i.e., structures under which mainline traffic passes) is determined for each segment.

Bridge Vertical Clearance Hot Spots: This performance measure related to truck restrictions is the locations, or hot spots, where bridge vertical clearance issues restrict truck travel. Sixteen feet three inches (16.25') is the minimum standard vertical clearance value for state highway bridges over travel lanes.

Locations with lower vertical clearance values than the minimum standard are categorized by the ADOT Intermodal Transportation Department Engineering Permits Section as either locations where ramps exist that allow the restriction to be avoided or locations where ramps do not exist and the restriction cannot be avoided. The locations with vertical clearances below the minimum standard that cannot be ramped around are considered hot spots. This measure is mapped for graphical display purposes with the bridge vertical clearance map but is not included in the Freight performance area rating calculations.

Scoring:

Performance Level	Freight Index	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	< 1.15	< 1.45
Fair	1.15 – 1.35	1.45 – 1.85
Poor	> 1.35	> 1.85

Performance Level	TTTR	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	< 1.15	< 1.45
Fair	1.15 – 1.35	1.45 – 1.85
Poor	> 1.35	> 1.85

Performance Level	Closure Duration (minutes)
Good	< 44.18
Fair	44.18 – 124.86
Poor	> 124.86

Performance Level	Bridge Vertical Clearance
Good	> 16.5'
Fair	16.0' – 16.5'
Poor	< 16.0'

Appendix C: Performance Area Data

Pavement Performance Area Data

				Direction 1 (Northbound)				Direction 2 (Southbound)				Direction 1 (Northbound)		Direction 2 (Southbound)		Composite		Pavement Index	% Pavement Failure	
				# of Lanes	IRI	Cracking	Rutting	# of Lanes	IRI	Cracking	Rutting	PSR	PDI	PSR	PDI	Dir 1 (NB)	Dir 2 (SB)		Dir 1 (NB)	Dir 2 (SB)
Segment 1		***Interstate?***		**No**																
Milepost	155	to	156	1	57.20	5.75	0.12	1	55.20	1.38	0.11	4.02	4.03	4.05	4.64	4.03	4.47		0	0
Milepost	156	to	157	1	42.24	13.73	0.13	1	44.55	8.64	0.16	4.26	3.22	4.22	3.69	3.53	3.85		1	0
Milepost	157	to	158	1	47.63	14.90	0.13	1	41.33	7.90	0.13	4.17	3.12	4.27	3.79	3.43	3.93		1	0
Milepost	158	to	159	1	44.73	17.30	0.12	1	45.85	14.60	0.10	4.22	2.92	4.20	3.15	3.31	3.47		1	1
Milepost	159	to	160	1	41.72	14.20	0.15	1	42.60	9.90	0.09	4.27	3.17	4.25	3.59	3.50	3.79		1	0
Milepost	160	to	161	1	48.52	17.78	0.13	1	42.30	10.33	0.09	4.16	2.88	4.26	3.55	3.26	3.76		1	1
Milepost	161	to	162	2	103.86	37.45	0.14	2	77.65	44.36	0.15	3.37	1.46	3.72	1.03	1.46	1.03		2	2
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
			Total	8				8												11
			Weighted Average									3.98	2.78	4.09	3.06	3.00	3.17			
			Factor									1.00		1.00						
			Indicator Score									3.98		4.09						**68.8%**
			Pavement Index															3.08		
Segment 2		***Interstate?***		**No**																
Milepost	162	to	163	2	80.91	36.00	0.10	2	75.26	49.90	0.17	3.68	1.56	3.76	0.69	1.56	0.69		2	2
Milepost	163	to	164	2	79.20	36.50	0.12	2	79.15	53.30	0.24	3.70	1.53	3.70	0.45	1.53	0.45		2	2
Milepost	164	to	165	2	70.83	28.60	0.10	2	90.26	56.10	0.23	3.82	2.06	3.55	0.30	2.06	0.30		2	2
Milepost	165	to	166	2	61.61	19.50	0.17	2	68.39	30.10	0.17	3.96	2.72	3.86	1.94	2.72	1.94		2	2
Milepost	166	to	167	2	74.96	18.80	0.21	2	63.09	30.10	0.21	3.76	2.74	3.93	1.91	2.74	1.91		2	2
Milepost	167	to	168	2	81.34	18.20	0.22	2	65.33	32.40	0.19	3.67	2.78	3.90	1.77	3.05	1.77		2	2
Milepost	168	to	169	2	51.97	9.40	0.13	2	54.13	9.30	0.12	4.10	3.63	4.07	3.65	3.77	3.77		0	0
Milepost	169	to	170	2	40.61	0.30	0.10	2	43.46	0.30	0.10	4.29	4.87	4.24	4.88	4.70	4.69		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0

Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
Milepost		to	1		-	-	-		-	-	-	-	-	-	-	-	-		0	0
			Total	16				16												24
			Weighted Average									3.87	2.74	3.88	1.95	2.77	1.94			
			Factor									1.00		1.00						
			Indicator Score									3.87		3.88						75.0%
			Pavement Index															2.35		

Bridge Performance Area Data

Structure Name (A209)	Structure # (N8)	Milepost (A232)	Area (A225)	Bridge Sufficiency: Sufficiency Rating	Bridge Index: Deck (N58)	Bridge Index: Sub (N59)	Bridge Index: Super (N60)	Bridge Index: Eval (N67)	Bridge Index: Lowest	Functionally Obsolete Bridges: Deck Area on Func Obsolete	Bridge Rating	Hot Spots on Bridge Index map
Segment 1												
N/A - No Bridges in Segment		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		
Total			#N/A									
Weighted Average				#N/A					#N/A	#N/A		
Factor				1.00					1.00	1.00		
Indicator Score				**#N/A**						**#N/A**	**#N/A**	
Bridge Index									**#N/A**			
Segment 2												
N/A - No Bridges in Segment		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		
Total			#N/A									
Weighted Average				#N/A					#N/A	#N/A		
Factor				1.00					1.00	1.00		
Indicator Score				**#N/A**						**#N/A**	**#N/A**	
Bridge Index									**#N/A**			

Mobility Performance Area Data

Segment	Begin MP	End MP	Length (mi)	Facility Type	Flow Type	Terrain	No. of Lanes	Capacity Environment Type	Lane Width (feet)	EB/NB Right Shoulder Width	WB/SB Right Shoulder Width	EB/NB Left Shoulder Width	WB/SB Left Shoulder Width	NB/EB AADT	SB/WB AADT	2020 AADT	K Factor	D Factor	T Factor	Weighted Average Posted Speed Limit (mph)	Divided or Undivided	Access Points (per mile)	% No-Passing Zone	Street Parking
1	155.1	162	6.9	Rural	Interrupted	Level	2	Rural Two-Lane, Non-Signalized	12.00	5.44	5.12	N/A	N/A	1120	1149	2268.09	8.00%	60.00%	25.00%	54	Undivided	1.739	22%	N/A
2	162	169.5	7.5	Rural	Uninterrupted	Level	4	Multilane Highway	12.00	6.50	9.50	9.50	3.50	2021	2532	4553.78	7.00%	58.00%	19.00%	65	Divided	1.067	0%	N/A

Car LOTTR and Truck TTTR - Northbound

No Data

Car LOTTR and Truck TTTR - Southbound

No Data

Closure Data

Segment	Length (miles)	# of closures	# with F&I	Total miles of closures		Avg Occurrences/Mile/Year	
				EB/NB	SB/WB	EB/NB	SB/WB
84/347-1	7.00	7	0	6.0	1.0	0.17	0.03
347-2	8.00	9	0	7.0	2.0	0.18	0.05

	ITIS Category Description											
	Closures		Incidents/Accidents		Incidents/Crashes		Obstruction Hazards		Winds		Winter Storm Codes	
Segment	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB
84/347-1	0	0	0	0	2	0	0	0	0	0	0	0
347-2	0	0	0	0	7	2	0	0	0	0	0	0

HPMS Data

SEGMENT	MP_FROM	MP_TO	WEIGHTED AVERAGE NB/EB/EB AADT	WEIGHTED AVERAGE SB/WB/WB AADT	WEIGHTED AVERAGE AADT	NB/EB/EB AADT	SB/WB/WB AADT	2019 AADT	K Factor	D-Factor	T-Factor
84/347-1	155.00	162.00	1219	1252	2471	1120	1149	2268	8	60	25
347-2	162.00	169.50	2289	2384	4673	2021	2532	4554	7	58	19

Bicycle Accommodation Data

Segment	BMP	EMP	Divided or Non	NB/EB/WB Right Shoulder Width	SB/WB/EB Right Shoulder Width	NB/EB/WB Left Shoulder Width	SB/WB/EB Left Shoulder Width	NB/EB/WB Effective Length of Shoulder	SB/WB/EB Effective Length of Shoulder	% Bicycle Accommodation
84/347-1	155.1	162	Undivided	5.4	5.1	N/A	N/A	1.1	0.5	12%
347-2	162	169.5	Divided	6.5	9.5	3.5		1.1	1.1	14%

AZTDM Data

SEGMENT	Growth Rate	% Non-SOV
84/347-1	3.85%	18.8%
347-2	4.92%	20.1%

HERS Capacity Calculation Data

Segment	Capacity Environment Type	Facility Type	Terrain	Lane Width	NB/EB/EB Rt. Shoulder	SB/WB/WB Rt. Shoulder	F_{lw} or f_w or f_{LS}	NB/EB/EB F_{lc}	SB/WB/WB F_{lc}	Total Ramp Density	PHF	E_T	f_{HV}	f_M	f_A	g/C	f_G	f_{NP}	Nm	f_p	NB/EB/EB FFS	SB/WB/WB FFS	NB/EB/EB Peak-Hour Capacity	SB/WB/WB Peak-Hour Capacity	Major Direction Peak-Hour Capacity	Daily Capacity
84/347-1	4	Rural	Level	12.00	5.44	5.12	0.0	N/A	N/A	N/A	0.88	1.9	0.816	N/A	0.43	N/A	1	0.70	N/A	N/A	63.57	63.57	N/A	N/A	1058.35	20,159
347-2	2	Rural	Level	12.00	6.50	9.50	0.0	0	0.4	N/A	0.88	1.5	0.913	0	0.27	N/A	N/A	N/A	N/A	N/A	64.73	64.33	3536	3536	N/A	67,354

Safety Performance Area Data

Segment	Operating Environment	Segment Length (miles)	NB/EB Fatal Crashes	SB/WB Fatal Crashes	Segment NB/EB/EB Suspected Serious Injury Crashes	Segment SB/WB/WB Suspected Serious Injury Crashes	Fatal + Suspected Serious Injury Crashes at Intersections	Fatal + Suspected Serious Injury Crashes Involving Lane Departures
84/347-1	2 or 3 Lane Undivided Highway	7	1	2	1	0	1	2
347-2	2 or 3 or 4 Lane Divided Highway	7.5	0	0	1	2	1	1

Segment	Operating Environment	Fatal + Suspected Serious Injury Crashes Involving Pedestrians	Fatal + Suspected Serious Injury Crashes Involving Trucks	Fatal + Suspected Serious Injury Crashes Involving Bicycles	Weighted Average NB/EB AADT	Weighted Average SB/WB AADT	Weighted Average Total AADT
84/347-1	2 or 3 Lane Undivided Highway	0	0	0	1219	1252	2471
347-2	2 or 3 or 4 Lane Divided Highway	0	0	0	2289	2384	4673

HPMS Data

2016-2020 Weighted Average						2020			2019			2018			2017			2016		
SEGMENT	MP_FROM	MP_TO	WEIGHTED AVERAGE NB/EB AADT	WEIGHTED AVERAGE SB/WB AADT	WEIGHTED AVERAGE AADT	NB/EB AADT	SB/WB/WB AADT	2020 AADT	NB/EB/ AADT	SB/WB/ AADT	22019 AADT	NB/EB/ AADT	SB/WB/ AADT	2018 AADT	NB/EB/ AADT	SB/WB/ AADT	2017 AADT	NB/EB AADT	SB/WB AADT	2016 AADT
84/347-1	155.00	162.00	1219	1252	2471	1120	1149	2268	1213	1213	2426	1382	1501	2884	1213	1221	2434	1168	1176	2345
347-2	162.00	169.50	2289	2384	4673	2021	2532	4554	2611	2611	5222	2572	2634	5206	2161	2110	4271	2082	2033	4115

Freight Performance Area Data

Segment	Length (miles)	# of closures	# with F&I	Total miles of closures		Avg Occurrences/Mile/Year	
				EB/NB	SB/WB	EB/NB	SB/WB
84/347-1	7.00	7	0	6.0	1.0	0.17	0.03
347-2	*8.00*	*9*	*0*	*7.0*	*2.0*	*0.18*	*0.05*

Segment	ITIS Category Description											
	Closures		Incidents/Accidents		Incidents/Crashes		Obstruction Hazards		Winds		Winter Storm Codes	
	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB	EB/NB	SB/WB
84/347-1	0	0	0	0	2	0	0	0	0	0	0	0
347-2	0	0	0	0	7	2	0	0	0	0	0	0

See the **Mobility Performance Area Data** section for other Freight Performance Area related data.

Appendix D: Needs Analysis Contributing Factors and Scores

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.

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.

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 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 Existing Performance Analysis 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 > 10 or Rutting > 0.4

Non-Interstates: IRI > 142 or Cracking > 10 or Rutting > 0.4

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.

Example Scales for Level of Need

Pavement Index (Interstates) Performance Thresholds		Initial Need	Description (Non-Emphasis Area)
3.75		None	All of Good Performance and upper third of Fair Performance (>3.50)
		Low	Middle third of Fair Perf. (3.25 - 3.5)
3.0		Medium	Lower third of Fair and top third of Poor Performance (2.75-3.25)
		High	Lower two-thirds of Poor Performance (<2.75)

Need Scale for Interstates

Measure	None >=	Low >=	> Medium <		High <=
Pavement Index (corridor non-emphasis area)	3.5	3.25	3.25	2.75	2.75
Pavement Index (corridor emphasis area)	4.0	3.5	3.5	3.00	3.00
Pavement Index (segments)	3.5	3.25	3.25	2.75	2.75
Directional PSR	3.63	3.52	3.52	3.28	3.28
%Pavement Failure	10%	15%	15%	25%	25%

Need Scale for Highways (Non-Interstates)

Measure	None >=	Low >=	> Medium <		High <=
Pavement Index (corridor non-emphasis area)	3.33	3.07	3.07	2.53	2.53
Pavement Index (corridor emphasis area)	3.87	3.33	3.33	2.80	2.80
Pavement Index (segments)	3.33	3.07	3.07	2.53	2.53
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.

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.

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 ≥ 0.01 and < 1.5), "Medium" (score ≥ 1.5 and < 2.5), and "High" (score ≥ 2.5).

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 Existing Performance Analysis 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.
- 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

<table>
<tr><th>Bridge Index Performance Thresholds</th><th colspan="2">Level of Need</th><th>Description (Non-Emphasis Area)</th></tr>
<tr><td rowspan="4">6.5</td><td>Good</td><td rowspan="4">None</td><td rowspan="4">All of Good Performance and upper third of Fair Performance (>6.0)</td></tr>
<tr><td>Good</td></tr>
<tr><td>Good</td></tr>
<tr><td>Fair</td></tr>
<tr><td></td><td>Fair</td><td>Low</td><td>Middle third of Fair Performance (5.5-6.0)</td></tr>
<tr><td rowspan="2">5.0</td><td>Fair</td><td rowspan="2">Medium</td><td rowspan="2">Lower third of Fair and top third of Poor Performance (4.5-5.5)</td></tr>
<tr><td>Poor</td></tr>
<tr><td rowspan="2"></td><td>Poor</td><td rowspan="2">High</td><td rowspan="2">Lower two-thirds of Poor Performance (<4.5)</td></tr>
<tr><td>Poor</td></tr>
</table>

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

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 Existing Performance Analysis. 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.

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.

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 ≥ 0.01 and < 1.5), "Medium" (score ≥ 1.5 and < 2.5), and "High" (score ≥ 2.5).

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 Existing Performance Analysis.

Step 1.3

Select 'Yes' or 'No' from 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 Existing Performance Analysis. 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 the date for which the HPMS data used for traffic volumes would not include. Any completed or under construction roadway project after the HPMS data date 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

Mobility Index (Urban and Fringe Urban) Performance Thresholds	Initial Need	Description (Non-Emphasis Area)
0.71	None	All of Good Performance and upper third of Fair Performance (<0.77)
	Low	Middle third of Fair Performance (0.77 - 0.83)
0.89	Medium	Lower third of Fair and top third of Poor Performance (0.83-0.95)
	High	Lower two-thirds 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 LOTTR	Uninterrupted	1.27	1.38	1.38	1.62	1.62
	Interrupted	1.27	1.38	1.38	1.62	1.62
Bicycle Accommodation		80%	70%	70%	50%	50%

<u>Step 3: Contributing Factors</u>

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 most recent five-year period on ADOT's 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.

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.

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 ≥ 0.01 and < 1.5), "Medium" (score ≥ 1.5 and < 2.5), and "High" (score ≥ 2.5).

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 Goals and Objectives. 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 Existing Performance Analysis. 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 is 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" have been applied and that the resulting Level of Need has been shown as "N/A" where applicable.

- Crash frequency for a segment is less than 5 crashes over the 5-year crash analysis period.
- The change in +/- 1 crash results in the change of need level of 2 levels (i.e., changes from Above Average to Below Average or changes from Below Average to Above Average).
- The average segment crash frequency for the overall corridor (total fatal plus suspected serious 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 five-year crash data analysis period. Any completed or under construction roadway project after the crash analysis period 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.

Example Scales for Level of Need

Safety Index (6 Lane Highway) Performance Thresholds	Initial Need	Description (Non-Emphasis Area)
0.76	None	All of Above Average Performance and upper third of Average Performance (<0.92)
	Low	Middle third of Average Performance (0.92 - 1.08)
1.24	Medium	Lower third of Average and top third of Below Average Performance (1.08-1.40)
	High	Lower two-thirds of Below Average Performance (>1.40)

Needs Scale

Measure		None <=	Low <=	> Medium <		High >=
Safety Index (Corridor Emphasis Area)		Weighted calculation for the segment totals in corridor (operating environments)				
Safety Index (Corridor Non-Emphasis Area)		Weighted calculation for the segment totals in corridor (operating environments)				
Safety Index and Directional Safety Index (Segment)	2 or 3 Lane Undivided Highway	0.97	1.02	1.02	1.13	1.13
	2 or 3 or 4 Lane Divided Highway	0.94	1.07	1.07	1.32	1.32
	4 or 5 Lane Undivided Highway	0.93	1.08	1.08	1.37	1.37
	6 Lane Highway	0.92	1.08	1.08	1.4	1.4
	Rural 4 Lane Freeway with Daily Volume < 25,000	0.95	1.06	1.06	1.27	1.27
	Rural 4 Lane Freeway with Daily Volume > 25,000	0.93	1.08	1.08	1.37	1.37
	Urban 4 Lane Freeway	0.91	1.09	1.09	1.45	1.45
	Urban or Rural 6 Lane Freeway	0.88	1.11	1.11	1.58	1.58
	Urban > 6 Lane Freeway	0.96	1.03	1.03	1.18	1.18
% of Fatal + Susp. Serious Injury Crashes at Intersections	2 or 3 Lane Undivided Highway	13%	14%	14%	17%	17%
	2 or 3 or 4 Lane Divided Highway	25%	27%	27%	31%	31%
	4 or 5 Lane Undivided Highway	46%	48%	48%	52%	52%
	6 Lane Highway	63%	68%	68%	78%	78%
	Rural 4 Lane Freeway with Daily Volume < 25,000	0%	0%	0%	0%	0%
	Rural 4 Lane Freeway with Daily Volume > 25,000	0%	0%	0%	0%	0%
	Urban 4 Lane Freeway	0%	0%	0%	0%	0%
	Urban or Rural 6 Lane Freeway	0%	0%	0%	0%	0%
	Urban > 6 Lane Freeway	0%	0%	0%	0%	0%
% of Fatal + Susp. Serious Injury Crashes Involving Lane Departures	2 or 3 Lane Undivided Highway	69%	72%	72%	77%	77%
	2 or 3 or 4 Lane Divided Highway	59%	62%	62%	68%	68%
	4 or 5 Lane Undivided Highway	25%	29%	29%	36%	36%
	6 Lane Highway	21%	30%	30%	47%	47%
	Rural 4 Lane Freeway with Daily Volume < 25,000	74%	75%	75%	78%	78%
	Rural 4 Lane Freeway with Daily Volume > 25,000	72%	75%	75%	81%	81%
	Urban 4 Lane Freeway	66%	72%	72%	84%	84%
	Urban or Rural 6 Lane Freeway	58%	60%	60%	65%	65%
	Urban > 6 Lane Freeway	41%	42%	42%	44%	44%
% of Fatal + Susp. Serious Injury Crashes Involving Pedestrians	2 or 3 Lane Undivided Highway	5%	6%	6%	8%	8%
	2 or 3 or 4 Lane Divided Highway	3%	3%	3%	4%	4%
	4 or 5 Lane Undivided Highway	10%	12%	12%	15%	15%
	6 Lane Highway	4%	8%	8%	16%	16%
	Rural 4 Lane Freeway with Daily Volume < 25,000	2%	3%	3%	4%	4%
	Rural 4 Lane Freeway with Daily Volume > 25,000	2%	3%	3%	6%	6%
	Urban 4 Lane Freeway	2%	4%	4%	7%	7%
	Urban or Rural 6 Lane Freeway	5%	6%	6%	9%	9%
	Urban > 6 Lane Freeway	3%	4%	4%	6%	6%

% of Fatal + Susp. Serious Injury Crashes Involving Trucks	2 or 3 Lane Undivided Highway	5%	6%	6%	9%	9%
	2 or 3 or 4 Lane Divided Highway	6%	8%	8%	12%	12%
	4 or 5 Lane Undivided Highway	2%	4%	4%	7%	7%
	6 Lane Highway	5%	6%	6%	8%	8%
	Rural 4 Lane Freeway with Daily Volume < 25,000	20%	21%	21%	24%	24%
	Rural 4 Lane Freeway with Daily Volume > 25,000	12%	15%	15%	22%	22%
	Urban 4 Lane Freeway	9%	11%	11%	15%	15%
	Urban or Rural 6 Lane Freeway	8%	11%	11%	16%	16%
	Urban > 6 Lane Freeway	3%	4%	4%	6%	6%
% of Fatal + Susp. Serious Injury Crashes Involving Bicycles	2 or 3 Lane Undivided Highway	1%	2%	2%	4%	4%
	2 or 3 or 4 Lane Divided Highway	1%	2%	2%	3%	3%
	4 or 5 Lane Undivided Highway	2%	3%	3%	5%	5%
	6 Lane Highway	2%	4%	4%	9%	9%
	Rural 4 Lane Freeway with Daily Volume < 25,000	0%	0%	0%	1%	1%
	Rural 4 Lane Freeway with Daily Volume > 25,000	0%	0%	0%	0%	0%
	Urban 4 Lane Freeway	0%	0%	0%	0%	0%
	Urban or Rural 6 Lane Freeway	0%	0%	0%	1%	1%
	Urban > 6 Lane Freeway	0%	0%	0%	0%	0%

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 Existing Performance Analysis (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 suspected serious 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 Existing Performance Analysis. 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 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 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 15 years) 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 suspected serious injury crashes). Identify likely contributing factors and compare that to the above statewide average comparison findings already calculated for fatal and suspected serious 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 suspected serious injury 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.

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.

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 ≥ 0.01 and < 1.5), "Medium" (score ≥ 1.5 and < 2.5), and "High" (score ≥ 2.5).

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 Existing Performance Analysis. 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 truck height restriction hot spots (clearance < 16.25') identified as part of the baseline corridor performance. For each entry, note the milepost of the height restriction and if the height restriction can be detoured by ramping around the obstruction. If it is not possible for a truck to ramp around the height restriction, note the existing height as well.

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 truck height 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.

Example Scales for Level of Need

Freight Index (Interrupted) Performance Score Thresholds	Performance Level	Initial Performance Level of Need	Description (Non-emphasis Area)
	Good	None	All levels of Good and the top third of Fair (<1.58)
	Good		
1.45	Good		
	Fair		
	Fair	Low	Middle third of Fair (1.58-1.72)
1.85	Fair	Medium	Lower third of Fair and top third of Poor (1.72-1.98)
	Poor		
	Poor	High	Lower two-thirds of Poor (>1.98)
	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)					
Interrupted	1.58	1.72	1.72	1.98	1.98
Uninterrupted	1.22	1.28	1.28	1.42	1.42
Directional TTTR					
Interrupted	1.58	1.72	1.72	1.98	1.98
Uninterrupted	1.22	1.28	1.28	1.42	1.42
Closure Duration					
All Facility Operations	71.07	97.97	97.97	151.75	151.75
Measure	**None >=**	**Low >=**	**< Medium >**		**High <=**
Bridge Clearance (feet)					
All Bridges	16.33	16.17	16.17	15.83	15.83

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 Needs Assessment.

Step 3.2

Input all traffic variables for each segment into the appropriate columns. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Needs Assessment.

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 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 Needs Assessment. 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 Needs Assessment.

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.

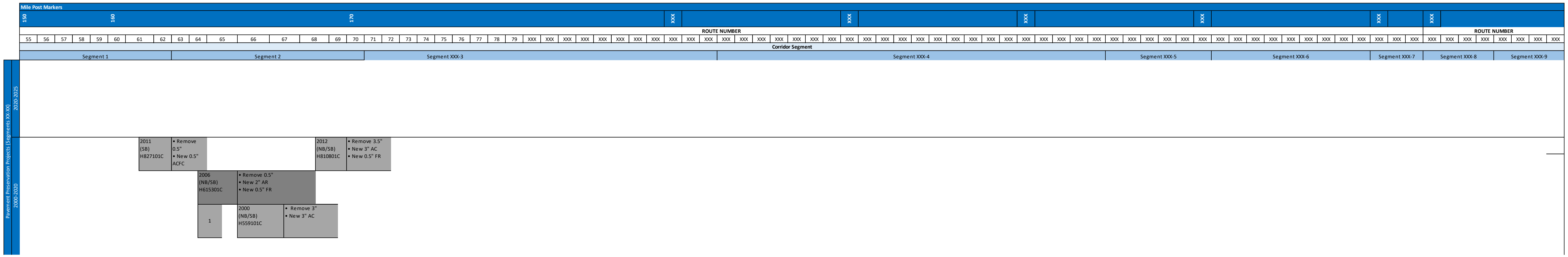
Pavement Performance Needs Analysis

Segment #	Segment Length (miles)	Segment Mileposts (MP)	Facility Type	Pavement Index			Directional PSR					% Area Failure			Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score NB/EB	Performance Score SB/WB	Performance Objective	Level of Need NB/EB	Level of Need SB/WB	Performance Score	Performance Objective	Level of Need	
347/84-1	6.9	155.1-162	Highway	3.08	Fair or Better	Low	3.98	4.09	Fair or Better	None	None	68.75%	Fair or Better	High	Medium
347-2	7.5	162-169.5	Highway	2.35	Fair or Better	High	3.87	3.88	Fair or Better	None	None	75.00%	Fair or Better	High	High
Emphasis Area?	No	Weighted Average		2.70	Fair or Better	Medium									

Segment #	Segment Length (miles)	Segment Mileposts (MP)	Initial Need	Need Adjustments: Hot Spots	Need Adjustments: Previous Projects (which supersede condition data)	Final Need	Comments (may include programmed projects or issues from previous reports)
347/84-1	6.9	155.1-162	Medium	MP 156-162	None	Medium	Hot spots (MP 156-162)
347-2	7.5	162-169.5	High	MP 162-168	None	High	Hot spots (MP 162-168)

Segment	Segment Length (miles)	Segment Mileposts (MP)	Final Need	Bid History Investment	PeCos History Investment	Resulting Historical Investment	Contributing Factors and Comments
347/84-1	6.9	155.1-162	Medium	Low	Low	Low	Hot Spots (156-162) SR 84 - Miller Rd Programmed Preservation project from MP 160.95 to 164.90 - No funding year established
347-2	7.5	162-169.5	High	Medium	Low	Medium	Hot Spots (162-168) Miller Rd to Papago Rd Programmed Preservation project from MP 164.90 to 168.42 - No funding year established

Pavement History



Pavement Treatment Reference Numbers	
1. 2011 (NB/SB) H827101C: Remove 0.5", New 0.5" FC	

Legend

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

Value	Level	Segment Number 1 Uni-Dir	Segment Number 1 Bi-Dir	Segment Number 2 Uni-Dir	Segment Number 2 Bi-Dir
1	L1				
1					
1					
1					
3	L2	19%			32%
3					25%
3					44%
3					13%
3					
3					
3					
4	L3				50%
4					
4					
4					
6	L4				
6					
6					
6					
6					
6					
Sub-Total		0.6	0.0	0.0	5.4
Total		**0.3**		**5.4**	

Value	Level	Segment Number **1**	Segment Number **2**
1	L1	0.0	0.0
3	L2	0.3	3.4
4	L3	0.0	2.0
6	L4	0.0	0.0
Total		0.3	5.4

Bridge Performance Needs Analysis

Segment #	Segment Length (miles)	Segment Mileposts (MP)	Number of Bridges in Segment	Bridge Index			Lowest Bridge Rating			Sufficiency Rating			Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	
347/84-1	6.9	155.1-162	0	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	N/A
347-2	7.5	162-169.5	0	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	N/A
Emphasis Area?	N/A	Weighted Avg		N/A	Fair or Better	N/A							

Segment #	Segment Length (miles)	Segment Mileposts (MP)	Number of Bridges in Segment	Initial Need	Need Adjustments		Final Need	Historical Review	Comments
					Hot Spots (Rating of 4 or multiple 5's)	Previous Projects (which supersede condition data)			
347/84-1	6.9	155.1-162	0	N/A	None	None	None		
347-2	7.5	162-169.5	0	N/A	None	None	None		

Segment	Segment Length (Miles)	Segment Mileposts (MP)	Number of Bridges in Segment	Final Need	Contributing Factors			Comments
					Bridge	Current Ratings	Historical Review	
347/84-1	6.9	155.1-162	0	None				
347-2	7.5	162-169.5	0	None				

Mobility Performance Needs Analysis

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	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	
											NB/EB	SB/WB		NB/EB	SB/WB	NB/EB	SB/WB		NB/EB	SB/WB
347/84-1	155.1-162	6.9	Rural	Interrupted	0.18	Fair or Better	None	0.24	Fair or Better	None	0.08	0.09	Fair or Better	None	None	0.17	0.03	Fair or Better	None	None
347-2	162-169.5	7.5	Rural	Uninterrupted	0.12	Fair or Better	None	0.18	Fair or Better	None	0.04	0.05	Fair or Better	None	None	0.18	0.05	Fair or Better	None	None
Mobility Emphasis Area		No	Weighted Average		0.15	Fair or Better	None													

Segment #	Segment Mileposts	Segment Length (miles)	Environment Type	Facility Operation	Directional LOTTR (all vehicles)					Bicycle Accommodation			Initial Need
					Performance Score		Performance Objective	Level of Need		Performance Score	Performance Objective	Level of Need	
					NB/EB	SB/WB		NB/EB	SB/WB				
347/84-1	155.1-162	6.9	Rural	Interrupted	*No Data*	*No Data*	Fair or Better	N/A	N/A	12%	Fair or Better	High	Low
347-2	162-169.5	7.5	Rural	Uninterrupted	*No Data*	*No Data*	Fair or Better	N/A	N/A	14%	Fair or Better	High	Low

Mobility Performance Needs Analysis (continued)

Segment #	Segment Mileposts (MP)	Segment Length (miles)	Initial Need	Need Adjustments Recently Completed Projects	Final Need	Planned and Programmed Future Projects
347/84-1	155.1-162	6.9	Low	None	Low	None
347-2	162-169.5	7.5	Low	None	Low	None

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	
347/84-1	155.1-162	6.9	Low	State Highway	Rural	Level	2	54	No	Non-Divided	22%	A/B	A/B	25.00%	
347-2	162-169.5	7.5	Low	State Highway	Rural	Level	2	65	No	Divided	0%	A/B	A/B	19.00%	

Mobility Performance Needs Analysis (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			
347/84-1	155.1-162	6.9	Low	2	2	100%	0	0%	0	0%		- 100% of closures were related to incidents/accidents	
347-2	162-169.5	7.5	Low	9	9	100%	0	0%	0	0%		- 100% of closures were related to incidents/accidents	

Safety Performance Needs Analysis

Segment	Operating Environment	Segment Length (miles)	Segment Mileposts (MP)	Safety Index			Directional Safety Index					% of Fatal + Incapacitating Injury Crashes at Intersections		
				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
347/84-1	2 or 3 Lane Undivided Highway	0	7	3.24	Average or Better	High	2.26	4.22	Average or Better	High	High	*Insufficient Data*	Average or Better	N/A
347-2	2 or 3 or 4 Lane Divided Highway	1	7.5	0.12	Average or Better	None	0.08	0.16	Average or Better	None	None	*Insufficient Data*	Average or Better	N/A
Safety Emphasis Area?		Yes	Weighted Average	1.63	Above Average	High								

Segment	Operating Environment	Segment Length (miles)	Segment Mileposts (MP)	% of Fatal + Incapacitating Injury Crashes Involving Lane Departures			% of Fatal + Incapacitating Injury Crashes Involving Pedestrians			% of Fatal + Incapacitating Injury Crashes Involving Trucks		
				Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need
347/84-1	2 or 3 Lane Undivided Highway	7	MP 155 - 162	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A
347-2	2 or 3 or 4 Lane Divided Highway	7	MP 155 - 162	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A

Segment	Operating Environment	Segment Length (miles)	Segment Mileposts (MP)	% of Fatal + Incapacitating Injury Crashes Involving Bicycles			Initial Need
				Performance Score	Performance Objective	Level of Need	
347/84-1	2 or 3 Lane Undivided Highway	7	MP 155 - 162	*Insufficient Data*	Average or Better	N/A	High
347-2	2 or 3 or 4 Lane Divided Highway	7.5	MP 162 - 169.5	*Insufficient Data*	Average or Better	N/A	None

Safety Performance Needs Analysis (continued)

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)
347/84-1	7	MP 155 - 162	High	None	None	High	None
347-2	7.5	MP 162 - 169.5	None	None	None	None	None

Safety Performance Needs Analysis (continued)

	Segment Number	347-1	347-2	Corridor-Wide Crash Characteristics
	Segment Length (miles)	7	7.5	
	Segment Milepost (MP)	MP 155 - 162	MP 162 - 169.5	
	Final Need	High	None	
Segment Crash Overview		3 Crashes were fatal 1 Crashes had suspected serious injuries 1 Crashes at intersections 2 Crashes involve lane departures 0 Crashes involve pedestrians 0 Crashes involve trucks 0 Crashes involve bicycles	0 Crashes were fatal 3 Crashes had suspected serious injuries 1 Crashes at intersections 1 Crashes involve lane departures 0 Crashes involve pedestrians 0 Crashes involve trucks 0 Crashes involve bicycles	3 Crashes were fatal 4 Crashes had suspected serious injuries 2 Crashes at intersections 3 Crashes involve lane departures 0 Crashes involve pedestrians 0 Crashes involve trucks 0 Crashes involve bicycles
Segment Crash Summaries (Fatal and Suspected Serious Injury Crashes)	First Harmful Event Type	N/A - Sample Size too Small	N/A - Sample Size too Small	71% Involve Collision with Motor Vehicle 29% Involve Overturning
	Collision Type	N/A - Sample Size too Small	N/A - Sample Size too Small	29% Involve Single Vehicle 29% Involve Angle 14% Involve Rear End
	Violation or Behavior	N/A - Sample Size too Small	N/A - Sample Size too Small	43% Involve Speed too Fast for Conditions 14% Involve Ran Stop Sign 14% Involve Drove in Opposing Lane
	Lighting Conditions	N/A - Sample Size too Small	N/A - Sample Size too Small	43% Occur in Daylight Conditions 43% Occur in Dark-Unlighted Conditions 14% Occur in Dawn Conditions
	Surface Conditions	N/A - Sample Size too Small	N/A - Sample Size too Small	71% Involve Dry Conditions 29% Involve Wet Conditions
	First Unit Event	N/A - Sample Size too Small	N/A - Sample Size too Small	43% Involve a first unit event of Motor Vehicle in Transport 29% Involve a first unit event of Overturn 14% Involve a first unit event of Ran Off the Road (Left)
	Driver Physical Condition	N/A - Sample Size too Small	N/A - Sample Size too Small	57% Under the Influence of Drugs or Alcohol 29% Unknown 14% No Apparent Influence
	Safety Device Usage	N/A - Sample Size too Small	N/A - Sample Size too Small	43% Shoulder And Lap Belt Used 29% None Used 14% Helmet Used
Hot Spot Crash Summaries		None	None	None
Previously Completed Safety-Related Projects		None	None	None
District Interviews/Discussions		N/A	N/A	N/A
Contributing Factors		N/A - Sample Size too Small	N/A - Sample Size too Small	N/A - Sample Size too Small

Freight Performance Needs Analysis

Segment #	Facility Operations	Segment Mileposts (MP)	Segment Length (miles)	Freight Index			Directional TTTR (trucks only)				
				Performance Score	Performance Objective	Level of Need	Performance Score		Performance Objective	Level of Need	
							NB/EB	SB/WB		NB/EB	SB/WB
347/84-1	Interrupted	155.1-162	6.9	*No Data*	Fair or Better	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A
347-2	Uninterrupted	162-169.5	7.5	*No Data*	Fair or Better	N/A	*No Data*	*No Data*	Fair or Better	N/A	N/A
Emphasis Area?	Yes	**Weighted Average**		0.00	Good	None					

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				
347/84-1	Interrupted	155.1-162	6.9	26.85	6.86	Fair or Better	None	None	No UP	Fair or Better	None	None
347-2	Uninterrupted	162-169.5	7.5	13.37	3.00	Fair or Better	None	None	No UP	Fair or Better	None	None

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)
347/84-1	6.9	155.1-162	None	None	None	None	Initial Need is really N/A as missing data for primary measure, but District input indicates there is no current freight need
347-2	7.5	162-169.5	None	None	None	None	Initial Need is really N/A as missing data for primary measure, but District input indicates there is no current freight need

Freight Performance Needs Analysis (continued)

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	
347/84-1	263-279	16	None	State Highway	Rural	Level	2	54	No	Non-Divided	22%	A/B	A/B	25%	
347-2	279-288	9	None	State Highway	Rural	Level	4	65	No	Divided	0%	A/B	A/B	19%	

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			
347/84-1	263-279	16	None	2	2	100%	0	0%	0	0%			
347-2	279-288	9	None	9	9	100%	0	0%	0	0%			

Needs Summary Table

Performance Area	Segment Number and Mileposts (MP)	
	84/347-1	347-2
	MP 155-162	MP 162-171
Pavement	Medium	High
Bridge	None	None
Mobility*	Low	Low
Safety*	High	None
Freight*	None	None
Average Need	**1.23**	**0.85**

* Identified as Emphasis Area for SR 84/SR 347 Corridor
[#] 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

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

Appendix E: Life-Cycle Cost Analysis

No LCCA conducted for any Pavement or Bridge candidate solutions on the SR 347/SR 84 corridor

Appendix F: Crash Modification Factors and Factored Unit Construction Costs

SOLUTION	2016 CONST UNIT COST	INFLATION FACTOR 2016-2022	2022 CONST UNIT COST	UNIT	FACTOR^	2016 FACTORED CONST UNIT COST	2022 FACTORED CONST UNIT COST	DESCRIPTION	2016 CMF FOR CORRIDOR PROFILE STUDIES	2022 CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
REHABILITATION											
Rehabilitate Pavement (AC)	$276,500	1.74	$481,110	Mile	2.20	$610,000	$1,060,000	Mill and replace 1"-3" AC pavement; accounts for 38' width; for one direction of travel on two-lane roadway; includes pavement, striping, delineators, RPMs, rumble strips	0.70	0.68	Updated to include 2 additional values (in addition to 3 previous values) from CMF Clearinghouse and revised combination of rehabilitate pavement (0.88), striping, delineators, RPMs (0.77 for combination), and rumble strips (0.89) = 0.68
Rehabilitate Bridge	$65	1.74	$113	SF	2.20	$140	$250	Based on deck area; bridge only - no other costs included	0.95	0.95	Assumed - should have a minor effect on crashes at the bridge
GEOMETRIC IMPROVEMENT											
Re-profile Roadway	$974,500	1.74	$1,695,630	Mile	2.20	$2,140,000	$3,730,000	Includes excavation of approximately 3", pavement replacement (AC), striping, delineators, RPMs, rumble strips, for one direction of travel on two-lane roadway (38' width)	0.70	0.70	Assumed - this is similar to rehab pavement. This solution is intended to address vertical clearance at bridge, not profile issue; factor the cost as a ratio of needed depth to 3".
Realign Roadway	$2,960,000	1.74	$5,150,400	Mile	2.20	$6,510,000	$11,330,000	All costs per direction except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.50	0.50	Based on Caltrans and NCDOT
Improve Skid Resistance	$675,000	1.74	$1,174,500	Mile	2.20	$1,490,000	$2,580,000	Average cost of pavement replacement and variable depth paving to increase super-elevation; for one direction of travel on two-lane roadway; includes pavement, striping, delineators, RPMs, rumble strips	0.66	0.65	Updated to include 6 additional values (in addition to 6 previous values) from CMF Clearinghouse (0.71) and calculated composite CMF value using that 0.71 value, the HSM value (0.87) for skid resistance; striping, delineators, RPMs (0.77 for combination), and rumble strips (0.89) = 0.65
INFRASTRUCTURE IMPROVEMENT											
Reconstruct to Urban Section	$1,000,000	1.74	$1,740,000	Mile	2.20	$2,200,000	$3,828,000	Includes widening by 16' total (AC = 12'+2'+2') to provide median, curb & gutter along both side of roadway, single curb for median, striping (doesn't include widening for additional travel lane).	0.88	0.88	From HSM

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Construct Auxiliary Lanes (AC)	$914,000	1.74	$1,590,360	Mile	2.20	$2,011,000	$3,499,000	For addition of aux lane (AC) in one direction of travel; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.78	0.78	Average of 4 values from clearinghouse
Construct Climbing Lane (High)	$3,000,000	1.74	$5,220,000	Mile	2.20	$6,600,000	$11,484,000	In one direction; all costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, steep slopes on both sides of road	0.75	0.75	From HSM
Construct Climbing Lane (Medium)	$2,250,000	1.74	$3,915,000	Mile	2.20	$4,950,000	$8,613,000	In one direction; all costs except bridges; applicable to areas with medium or large fills and cuts, retaining walls, rock blasting, steep slopes on one side of road	0.75	0.75	From HSM
Construct Climbing Lane (Low)	$1,500,000	1.74	$2,610,000	Mile	2.20	$3,300,000	$5,742,000	In one direction; all costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.75	0.75	From HSM
Construct Reversible Lane (Low)	$2,400,000	1.74	$4,176,000	Lane-Mile	2.20	$5,280,000	$9,190,000	All costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.73 for uphill and 0.88 for downhill	0.73 for uphill and 0.88 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a concrete barrier
Construct Reversible Lane (High)	$4,800,000	1.74	$8,352,000	Lane-Mile	2.20	$10,560,000	$18,370,000	All costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, mountainous terrain	0.73 for uphill and 0.88 for downhill	0.73 for uphill and 0.88 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a concrete barrier
Construct Passing Lane	$1,500,000	1.74	$2,610,000	Mile	2.20	$3,300,000	$5,742,000	In one direction; all costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.63	0.63	Average of 3 values from clearinghouse
Construct Entry/Exit Ramp	$730,000	1.74	$1,270,200	Each	2.20	$1,610,000	$2,790,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, typical earthwork & drainage; does not include any major structures or improvements on crossroad	1.09	1.09	Average of 16 values on clearinghouse; for adding a ramp not reconstructing. CMF applied to crashes 0.25 miles upstream/downstream from the gore.
Relocate Entry/Exit Ramp	$765,000	1.74	$1,331,100	Each	2.20	$1,680,000	$2,930,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, typical earthwork, drainage and demolition of existing ramp; does not include any major structures or improvements on crossroad	1.00	1.00	Assumed to not add any crashes since the ramp is simply moving and not being added. CMF applied to crashes 0.25 miles upstream/downstream from the gore.

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Construct Turn Lanes	$42,500	1.74	$73,950	Each	2.20	$93,500	$163,000	Includes 14' roadway widening (AC) for one additional turn lane (250' long) on one leg of an intersection; includes AC pavement, curb & gutter, sidewalk, ramps, striping, and minor signal modifications	0.81	0.81	Average of 7 values from HSM; CMF applied to intersection-related crashes; this solution also applies when installing a deceleration lane
Modify Entry/Exit Ramp	$445,000	1.74	$774,300	Each	2.20	$979,000	$1,703,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting existing ramp to parallel-type configuration	0.21	0.21	Average of 4 values from clearinghouse (for exit ramps) and equation from HSM (for entrance ramp). CMF applied to crashes within 1/8 mile upstream/downstream from the gore.
Widen & Modify Entry/Exit Ramp	$619,000	1.74	$1,077,060	Each	2.20	$1,361,800	$2,370,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting 1-lane ramp to 2-lane ramp and converting to parallel-type ramp	0.21	0.21	Will be same as "Modify Ramp"
Replace Pavement (AC) (with overexcavation)	$1,446,500	1.74	$2,516,910	Mile	2.20	$3,180,000	$5,540,000	Accounts for 38' width; for one direction of travel on two-lane roadway; includes pavement, overexcavation, striping, delineators, RPMs, rumble strips	0.70	0.70	Same as rehab
Replace Pavement (PCCP) (with overexcavation)	$1,736,500	1.74	$3,021,510	Mile	2.20	$3,820,000	$6,650,000	Accounts for 38' width; for one direction of travel on two-lane roadway; includes pavement, overexcavation, striping, delineators, RPMs, rumble strips	0.70	0.70	Same as rehab
Replace Bridge (Short)	$125	1.74	$218	SF	2.20	$280	$480	Based on deck area; bridge only - no other costs included; cost developed generally applies to bridges crossing small washes	0.95	0.95	Assumed - should have a minor effect on crashes at the bridge
Replace Bridge (Medium)	$160	1.74	$278	SF	2.20	$350	$610	Based on deck area; bridge only - no other costs included; cost developed generally applies to bridges crossing over the mainline freeway, crossroads, or large washes	0.95	0.95	Assumed - should have a minor effect on crashes at the bridge
Replace Bridge (Long)	$180	1.74	$313	SF	2.20	$400	$690	Based on deck area; bridge only - no other costs included; cost developed generally applies to bridges crossing large rivers or canyons	0.95	0.95	Assumed - should have a minor effect on crashes at the bridge
Widen Bridge	$175	1.74	$305	SF	2.20	$390	$670	Based on deck area; bridge only - no other costs included	0.90	0.90	Assumed - should have a minor effect on crashes at the bridge

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Install Pedestrian Bridge	$135	1.74	$235	SF	2.20	$300	$520	Includes cost to construct bridge based on linear feet of the bridge. This cost includes and assumes ramps and sidewalks leading to the structure.	0.1 (pedestrian only)	0.1 (pedestrian only)	Assumed direct access on both sides of structure
Implement Automated Bridge De-icing	$115	1.74	$200	SF	2.20	$250	$440	Includes cost to replace bridge deck and install system	0.72 (snow/ice)	0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
Install Wildlife Crossing Under Roadway	$650,000	1.74	$1,131,000	Each	2.20	$1,430,000	$2,488,000	Includes cost of structure for wildlife crossing under roadway and 1 mile of fencing in each direction that is centered on the wildlife crossing	0.25 (wildlife)	0.25 (wildlife)	Assumed; CMF applies to wildlife-related crashes within 0.5 miles both upstream and downstream of the wildlife crossing in both directions
Install Wildlife Crossing Over Roadway	$1,140,000	1.74	$1,983,600	Each	2.20	$2,508,000	$4,364,000	Includes cost of structure for wildlife crossing over roadway and 1 mile of fencing in each direction that is centered on the wildlife crossing	0.25 (wildlife)	0.25 (wildlife)	Assumed; CMF applies to wildlife-related crashes within 0.5 miles both upstream and downstream of the wildlife crossing in both directions
Construct Drainage Structure - Minor	$280,000	1.74	$487,200	Each	2.20	$616,000	$1,072,000	Includes 3-36" pipes and roadway reconstruction (approx. 1,000 ft) to install pipes	0.70	0.70	Same as rehab; CMF applied to crashes 1/8 mile upstream/downstream of the structure
Construct Drainage Structure - Intermediate	$540,000	1.74	$939,600	Each	2.20	$1,188,000	$2,067,000	Includes 5 barrel 8'x6' RCBC and roadway reconstruction (approx. 1,000 ft) to install RCBC	0.70	0.70	Same as rehab; CMF applied to crashes 1/8 mile upstream/downstream of the structure
Construct Drainage Structure - Major	$8,000	1.74	$13,920	LF	2.20	$17,600	$30,600	Includes bridge that is 40' wide and reconstruction of approx. 500' on each approach	0.70	0.70	Same as rehab; CMF applied to crashes 1/8 mile upstream/downstream of the structure
Install Acceleration Lane	$127,500	1.74	$221,850	Each	2.20	$280,500	$488,000	For addition of an acceleration lane (AC) on one leg of an intersection that is 1,000' long plus a taper; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.85	0.85	Average of 6 values from the FHWA Desktop Reference for Crash Reduction Factors
Install Curb and Gutter	$211,200	1.74	$367,488	Mile	2.20	$465,000	$808,000	In both directions; curb and gutter	0.89	0.89	From CMF Clearinghouse
Install Sidewalks, Curb, and Gutter	$475,200	1.74	$826,848	Mile	2.20	$1,045,000	$1,819,000	In both directions; 5' sidewalks, curb, and gutter	0.89 installing sidewalk 0.24 (pedestrian crashes only)	0.89 installing sidewalk 0.24 (pedestrian crashes only)	From CMF Clearinghouse Avg of 6 values from FHWA Desktop Reference

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Install Sidewalks	$264,000	1.74	$459,360	Mile	2.20	$581,000	$1,011,000	In both directions; 5' sidewalks	0.24 (pedestrian crashes only)	0.24 (pedestrian crashes only)	Avg of 6 values from FHWA Desktop Reference
OPERATIONAL IMPROVEMENT											
Implement Variable Speed Limits (Wireless, Overhead)	$718,900	1.25	$898,625	Mile	2.20	$1,580,000	$1,980,000	In one direction; includes 1 sign assembly per mile (foundation and structure), wireless communication, detectors	0.92	0.91 (all crashes) 0.69 (weather-related)	Originally only 1 value from CMF Clearinghouse. Updated to include 1 value for all crashes and 2 additional values for weather-related crashes
Implement Variable Speed Limits (Wireless, Ground-mount)	$169,700	1.25	$212,125	Mile	2.20	$373,300	$467,000	In one direction; includes 2 signs per mile (foundations and posts), wireless communication, detectors	0.92	0.91 (all crashes) 0.69 (weather-related)	Originally only 1 value from CMF Clearinghouse. Updated to include 1 value for all crashes and 2 additional values for weather-related crashes
Implement Variable Speed Limits (Wireless, Solar, Overhead)	$502,300	1.25	$627,875	Mile	2.20	$1,110,000	$1,380,000	In one direction; includes 1 sign assembly per mile (foundation and structure), wireless communication, detectors, solar power	0.92	0.91 (all crashes) 0.69 (weather-related)	Originally only 1 value from CMF Clearinghouse. Updated to include 1 value for all crashes and 2 additional values for weather-related crashes
Implement Variable Speed Limits (Wireless, Solar, Ground-mount)	$88,400	1.25	$110,500	Mile	2.20	$194,500	$243,000	In one direction; includes 2 signs per mile (foundations and posts), wireless communication, detectors, solar power	0.92	0.91 (all crashes) 0.69 (weather-related)	Originally only 1 value from CMF Clearinghouse. Updated to include 1 value for all crashes and 2 additional values for weather-related crashes
Implement Ramp Metering (Low)	$25,000	1.25	$31,250	Each	2.20	$55,000	$68,800	For each entry ramp location; urban area with existing ITS backbone infrastructure; includes signals, poles, timer, pull boxes, etc.	0.64	0.64	From 1 value from clearinghouse; CMF applied to crashes 0.25 miles after gore
Implement Ramp Metering (High)	$150,000	1.25	$187,500	Mile	2.20	$330,000	$413,000	Area without existing ITS backbone infrastructure; in addition to ramp meters, also includes conduit, fiber optic lines, and power	0.64	0.64	From 1 value from clearinghouse
Implement Signal Coordination	$140,000	1.25	$175,000	Mile	2.20	$308,000	$385,000	Includes conduit, conductors, and controllers for 4 intersections that span a total of approximately 2 miles	0.90	0.90	Assumed

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Implement Left-Turn Phasing	$7,500	1.25	$9,375	Each	2.20	$16,500	$20,600	Includes four new signal heads (two in each direction) and associated conductors for one intersection	0.88 (protected) 0.98 (permitted /protected or protected/ permitted)	0.88 (protected) 0.98 (permitted /protected or protected/ permitted)	From HSM; CMF = 0.94 for each protected approach and 0.99 for each permitted/protected or protected/permitted approach. CMFs of different approaches should be multiplied together. CMF applied to crashes within intersection
Install Adaptive Signal Control and Signal Coordination	$363,500	1.25	$454,375	mile	2.20	$800,000	$1,000,000	Controller upgrades, advanced detection, software configuration, cameras; includes conduit, conductors, and controllers for 4 intersections that span a total of approximately 2 miles for coordination	0.81 (adaptive control) 0.90 (signal coordination)	0.78 (adaptive control) 0.90 (signal coordination)	Updated to include 15 additional values (in addition to 2 previous values) for adaptive control from CMF Clearinghouse
ROADSIDE DESIGN											
Install Guardrail	$130,000	1.74	$226,200	Mile	2.20	$286,000	$498,000	One side of road	0.62 (ROR)	0.62 (ROR)	0.62 is average of 2 values from clearinghouse
Install Cable Barrier	$80,000	1.74	$139,200	Mile	2.20	$176,000	$306,000	In median	0.81	0.65	Updated to include 5 additional values (in addition to 5 previous values) from CMF Clearinghouse
Widen Shoulder (AC)	$256,000	1.74	$445,440	Mile	2.20	$563,000	$980,000	Assumes 10' of existing shoulder (combined left and right), includes widening shoulder by a total of 4'; new pavement for 4' width and mill and replace existing 10' width; includes pavement, minor earthwork, striping edge lines, RPMs, high-visibility delineators, safety edge, and rumble strips	0.68 (1-4') 0.64 (>= 4')	0.68 (1-4') 0.64 (>= 4')	0.86 is average of 5 values from clearing house for widening shoulder 1-4'. 0.76 is calculated from HSM for widening shoulder >= 4'. (Cost needs to be updated if dimension of existing and widened shoulder differ from Description.)
Rehabilitate Shoulder (AC)	$113,000	1.74	$196,620	Mile	2.20	$249,000	$433,000	One direction of travel (14' total shoulder width-4' left and 10' right); includes paving (mill and replace), striping, high-visibility delineators, RPMs, safety edge, and rumble strips for both shoulders	0.72	0.72	0.98 is average of 34 values on clearinghouse for shoulder rehab/replace; include striping, delineators, RPMs (0.77 combined CMF), and rumble strips (0.89). (Cost needs to be updated if dimension of existing shoulder differs from Description.)

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Replace Shoulder (AC)	$364,000	1.74	$633,360	Mile	2.20	$801,000	$1,393,000	One direction of travel (14' total shoulder width-4' left and 10' right); includes paving (full reconstruction), striping, high-visibility delineators, RPMs, safety edge, and rumble strips for both shoulders	0.72	0.72	0.98 is average of 34 values on clearinghouse for shoulder rehab/replace; include striping, delineators, RPMs (0.77 combined CMF), and rumble strips (0.89). (Cost needs to be updated if dimension of existing shoulder differs from Description.)
Install Rumble Strip	$5,500	1.74	$9,570	Mile	2.20	$12,000	$21,000	Both edges - one direction of travel; includes only rumble strip; no shoulder rehab or paving or striping	0.89	0.89	Average of 75 values on clearinghouse and consistent with HSM
Install Centerline Rumble Strip	$2,800	1.74	$4,872	Mile	2.20	$6,000	$11,000	Includes rumble strip only; no pavement rehab or striping	0.85	0.85	From HSM
Install Wildlife Fencing	$340,000	1.74	$591,600	Mile	2.20	$748,000	$1,302,000	Fencing only plus jump outs for 1 mile (both directions)	0.50 (wildlife)	0.50 (wildlife)	Assumed
Remove Tree/Vegetation	$200,000	1.74	$348,000	Mile	2.20	$440,000	$766,000	Intended for removing trees that shade the roadway to allow sunlight to help melt snow and ice (see Increase Clear Zone CMF for general tree/vegetation removal in clear zone)	0.72 (snow/ice)	0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
Increase Clear Zone	$59,000	1.74	$102,660	Mile	2.20	$130,000	$226,000	In one direction; includes widening the clear zone by 10' to a depth of 3'	0.71	0.71	Median of 14 values from FHWA Desktop Reference for Crash Reduction Values
Install Access Barrier Fence	$15	1.74	$26	LF	2.20	$33	$60	8' fencing along residential section of roadway	0.10 (pedestrian only)	0.10 (pedestrian only)	Equal to pedestrian overpass
Install Rock-Fall Mitigation - Wire Mesh	$1,320,000	1.74	$2,296,800	Mile	2.20	$2,904,000	$5,053,000	Includes wire mesh and rock stabilization (one direction)	0.75 (debris)	0.75 (debris)	Assumed
Install Rock-Fall Mitigation - Containment Fence & Barrier	$2,112,000	1.74	$3,674,880	Mile	2.20	$4,646,000	$8,085,000	Includes containment fencing, concrete barrier, and rock stabilization (one direction)	0.75 (debris)	0.75 (debris)	Assumed
Install Raised Concrete Barrier in Median	$650,000	1.74	$1,131,000	Mile	2.20	$1,430,000	$2,488,000	Includes concrete barrier with associated striping and reflective markings; excludes lighting in barrier (one direction)	0.90 (Cross-median and head on crashes eliminated completely)	0.90 (Cross-median and head on crashes eliminated completely)	All cross median and head-on fatal or incapacitating injury crashes are eliminated completely; all remaining crashes have 0.90 applied
Formalize Pullout (Small)	$7,500	1.74	$13,050	Each	2.20	$17,000	$29,000	Includes paving and signage (signs, posts, and foundations) - approximately 4,200 sf	0.97	0.97	Assumed - similar to Install Other General Warning Signs; CMF applied to crashes within 0.25 miles after sign

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Formalize Pullout (Medium)	$27,500	1.74	$47,850	Each	2.20	$61,000	$105,000	Includes paving and signage (signs, posts, and foundations) - approximately 22,500 sf	0.97	0.97	Assumed - similar to Install Other General Warning Signs; CMF applied to crashes within 0.25 miles after sign
Formalize Pullout (Large)	$80,500	1.74	$140,070	Each	2.20	$177,100	$308,000	Includes paving and signage (signs, posts, and foundations) - approximately 70,000 sf	0.97	0.97	Assumed - similar to Install Other General Warning Signs; CMF applied to crashes within 0.25 miles after sign
INTERSECTION IMPROVEMENTS											
Construct Traffic Signal	$150,000	1.74	$261,000	Each	2.20	$330,000	$574,000	4-legged intersection; includes poles, foundations, conduit, controller, heads, luminaires, mast arms, etc.	0.95	0.95	From HSM; CMF applied to crashes within intersection only
Improve Signal Visibility	$35,000	1.74	$60,900	Each	2.20	$77,000	$134,000	4-legged intersection; signal head size upgrade, installation of new back-plates, and installation of additional signal heads on new poles.	0.85	0.85	Average of 7 values from clearinghouse; CMF applied to crashes within intersection only
Install Raised Median	$360,000	1.74	$626,400	Mile	2.20	$792,000	$1,378,000	Includes removal of 14' wide pavement and construction of curb & gutter; does not include cost to widen roadway to accommodate the median; if the roadway needs to be widened, include cost from New General Purpose Lane	0.83	0.83	Average from HSM
Install Transverse Rumble Strip/Pavement Markings	$3,000	1.74	$5,220	Each	2.20	$7,000	$11,000	Includes pedestrian markings and rumble strips only across a 30' wide travelway; no pavement rehab or other striping	0.95	0.95	Average of 17 values from clearinghouse; CMF applied to crashes within 0.5 miles after the rumble strips and markings
Construct Single-Lane Roundabout	$1,500,000	1.74	$2,610,000	Each	2.20	$3,300,000	$5,742,000	Removal of signal at 4-legged intersection; realignment of each leg for approx. 800 feet including paving, curbs, sidewalk, striping, lighting, signing	0.22	0.22	From HSM; CMF applied to crashes within intersection only
Construct Double-Lane Roundabout	$1,800,000	1.74	$3,132,000	Each	2.20	$3,960,000	$6,890,000	Removal of signal at 4-legged intersection; realignment of each leg for approx. 800 feet including paving, curbs, sidewalk, striping, lighting, signing	0.40	0.40	From HSM; CMF applied to crashes within intersection only
Install Indirect Left Turn Intersection	$1,140,000	1.74	$1,983,600	each	2.20	$2,500,000	$4,364,000	Raised concrete median improvements; intersection improvements; turn lanes	0.80	0.76	Updated to include 2 additional values (in addition to 1 previous value) from CMF Clearinghouse

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Convert Standard Diamond Interchange to Diverging Diamond Interchange	$2,272,700	1.74	$3,954,498	each	2.20	$5,000,000	$8,700,000	Convert traditional diamond interchange into diverging diamond interchange; assumes re-use of existing bridges	0.67	0.56	Updated to include 2 additional values (in addition to 1 previous value) from CMF Clearinghouse
Left-in Only Center Raised Median Improvements	$84,100	1.74	$146,334	each	2.20	$185,000	$322,000	Left-in only center raised median improvements	0.87	0.87	CMF Clearinghouse
ROADWAY DELINEATION											
Install High-Visibility Edge Line Striping	$10,800	1.25	$13,500	Mile	2.20	$23,800	$29,700	2 edge lines and lane line - one direction of travel	0.77	0.77	Average of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs. (If implemented separately, CMF will be higher.)
Install High-Visibility Delineators	$6,500	1.25	$8,125	Mile	2.20	$14,300	$17,900	Both edges - one direction of travel			Average of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs. (If implemented separately, CMF will be higher.)
Install Raised Pavement Markers	$2,000	1.25	$2,500	Mile	2.20	$4,400	$5,500	Both edges - one direction of travel			Average of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs. (If implemented separately, CMF will be higher.)
Install In-Lane Route Markings	$6,000	1.25	$7,500	Each	2.20	$13,200	$16,500	Installation of a series of three in-lane route markings in one lane	0.95	0.95	Assumed; CMF applied to crashes within 1.0 mile before the gore
IMPROVED VISIBILITY											
Cut Side Slopes	$80	1.74	$139	LF	2.20	$200	$300	For small grading to correct sight distance issues; not major grading	0.85	0.85	Intent of this solution is to improve sight distance. Most CMF's are associated with vehicles traveling on slope. Recommended CMF is based on FDOT and NCDOT but is more conservative.
Install Lighting (connect to existing power)	$270,000	1.74	$469,800	Mile	2.20	$594,000	$1,034,000	One side of road only; offset lighting, not high-mast; does not include power supply; includes poles, luminaire, pull boxes, conduit, conductor	0.75 (night)	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM

SOLUTION	2016 CONST UNIT COST	INFLATION FACTOR 2016-2022	2022 CONST UNIT COST	UNIT	FACTOR^	2016 FACTORED CONST UNIT COST	2022 FACTORED CONST UNIT COST	DESCRIPTION	2016 CMF FOR CORRIDOR PROFILE STUDIES	2022 CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Install Lighting (solar powered LED)	$10,000	1.74	$17,400	Pole	2.20	$22,000	$38,300	Offset lighting, not high-mast; solar power LED; includes poles, luminaire, solar panel	0.75 (night)	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM
DRIVER INFORMATION/WARNING											
Install Dynamic Message Sign (DMS)	$250,000	1.25	$312,500	Each	2.20	$550,000	$688,000	Includes sign, overhead structure, and foundations; wireless communication; does not include power supply	1.00	1.00	Not expected to reduce crashes
Install Dynamic Weather Warning Beacons	$40,000	1.25	$50,000	Each	2.20	$88,000	$110,000	Assumes solar operation and wireless communication or connection to existing power and communication; ground mounted; includes posts, foundations, solar panel, and dynamic sign	0.80 (weather-related)	0.80 (weather-related)	Average of 3 values from FHWA Desktop Reference for Crash Reduction Factors; CMF applies to crashes within 0.25 miles after a sign
Install Dynamic Speed Feedback Signs	$25,000	1.25	$31,250	Each	2.20	$55,000	$68,800	Assumes solar operation and no communication; ground mounted; includes regulatory sign, posts, foundations, solar panel, and dynamic sign	0.94	0.94	Average of 2 clearinghouse values; CMF applies to crashes within 0.50 miles after a sign
Install Chevrons	$18,400	1.25	$23,000	Mile	2.20	$40,500	$50,600	On one side of road - includes signs, posts, and foundations	0.79	0.79	Average of 11 clearinghouse values
Install Curve Warning Signs	$2,500	1.25	$3,125	Each	2.20	$5,500	$6,900	Includes 2 signs, posts, and foundations	0.83	0.83	Average of 4 clearinghouse values; CMF applies to crashes within 0.25 miles after a sign
Install Traffic Control Device Warning Signs (e.g., stop sign ahead, signal ahead, etc.)	$2,500	1.25	$3,125	Each	2.20	$5,500	$6,900	Includes 2 signs, posts, and foundations	0.85	0.85	FHWA Desktop Reference for Crash Reduction Factors; CMF applies to crashes within 0.25 miles after a sign
Install Other General Warning Signs (e.g., intersection ahead, wildlife in area, slow vehicles, etc.)	$2,500	1.25	$3,125	Each	2.20	$5,500	$6,900	Includes 2 signs, posts, and foundations	0.97	0.97	Assumed; CMF applies to crashes within 0.25 miles after a sign

SOLUTION	2016 CONST UNIT COST	INFLATION FACTOR 2016-2022	2022 CONST UNIT COST	UNIT	FACTOR^	2016 FACTORED CONST UNIT COST	2022 FACTORED CONST UNIT COST	DESCRIPTION	2016 CMF FOR CORRIDOR PROFILE STUDIES	2022 CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Install Wildlife Warning System	$162,000	1.25	$202,500	Each	2.20	$356,400	$446,000	Includes wildlife detection system at a designated wildlife crossing, flashing warning signs (assumes solar power), advance signing, CCTV (solar and wireless), game fencing for approximately 0.25 miles in each direction - centered on the wildlife crossing, and regular fencing for 1.0 mile in each direction - centered on the wildlife crossing.	0.50 (wildlife)	0.50 (wildlife)	Assumed; CMF applies to wildlife-related crashes within 0.5 miles both upstream and downstream of the wildlife crossing in both directions
Install Warning Sign with Beacons	$15,000	1.25	$18,750	Each	2.20	$33,000	$41,300	In both directions; includes warning sign, post, and foundation, and flashing beacons (assumes solar power) at one location	0.75	0.75	FHWA Desktop Reference for Crash Reduction Factors for Installing Flashing Beacons as Advance Warning; CMF applies to crashes within 0.25 miles after a sign
DATA COLLECTION											
Install Roadside Weather Information System (RWIS)	$60,000	1.25	$75,000	Each	2.20	$132,000	$165,000	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	1.00	Not expected to reduce crashes
Install Closed Circuit Television (CCTV) Camera	$25,000	1.25	$31,250	Each	2.20	$55,000	$68,800	Assumes connection to existing ITS backbone or wireless communication; does not include fiber-optic backbone infrastructure; includes pole, camera, etc.	1.00	1.00	Not expected to reduce crashes
Install Vehicle Detection Stations	$15,000	1.25	$18,750	Each	2.20	$33,000	$41,300	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	1.00	Not expected to reduce crashes
Install Flood Sensors (Activation)	$15,000	1.25	$18,750	Each	2.20	$33,000	$41,300	Sensors with activation cabinet to alert through texting (agency)	1.00	1.00	Not expected to reduce crashes
Install Flood Sensors (Gates)	$100,000	1.25	$125,000	Each	2.20	$220,000	$275,000	Sensors with activation cabinet to alert through texting (agency) and beacons (public) plus gates	1.00	1.00	Not expected to reduce crashes
WIDEN CORRIDOR											
Construct New General Purpose Lane (PCCP)	$1,740,000	1.74	$3,027,600	Mile	2.20	$3,830,000	$6,660,000	For addition of 1 GP lane (PCCP) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.87

SOLUTION	2016 CONST UNIT COST	INFLATION FACTOR 2016-2022	2022 CONST UNIT COST	UNIT	FACTOR^	2016 FACTORED CONST UNIT COST	2022 FACTORED CONST UNIT COST	DESCRIPTION	2016 CMF FOR CORRIDOR PROFILE STUDIES	2022 CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Construct New General Purpose Lane (AC)	$1,200,000	1.74	$2,088,000	Mile	2.20	$2,640,000	$4,590,000	For addition of 1 GP lane (AC) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.88
Convert a 2-Lane undivided highway to a 5-Lane highway	$1,576,000	1.74	$2,742,240	Mile	2.20	$3,467,200	$6,030,000	For expanding a 2-lane undivided highway to a 5-lane highway (4 through lanes with TWLTL), includes standard shoulder widths but no curb, gutter, or sidewalks	0.60	0.60	Assumed to be slightly lower than converting from a 4-lane to a 5-lane highway
Install Center Turn Lane	$1,053,000	1.74	$1,832,220	Mile	2.20	$2,316,600	$4,030,000	For adding a center turn lane (i.e., TWLTL); assumes symmetrical widening on both sides of the road; includes standard shoulder widths but no curb, gutter, or sidewalk	0.75	0.75	From FHWA Desktop Reference for Crash Reduction Factors, CMF Clearinghouse, and SR 87 CPS comparison
Construct 4-Lane Divided Highway (Using Existing 2-Lane Road for one direction)	$3,000,000	1.74	$5,220,000	Mile	2.20	$6,600,000	$11,484,000	In both directions; one direction uses existing 2-lane road; other direction assumes addition of 2 new lanes (AC) with standard shoulders; includes all costs except bridges	0.67	0.67	Assumed
Construct 4-Lane Divided Highway (No Use of Existing Roads)	$6,000,000	1.74	$10,440,000	Mile	2.20	$13,200,000	$22,968,000	In both directions; assumes addition of 2 new lanes (AC) with standard shoulders in each direction; includes all costs except bridges	0.67	0.67	Assumed
Construct Bridge over At-Grade Railroad Crossing	$10,000,000	1.74	$17,400,000	Each	2.20	$22,000,000	$38,280,000	Assumes bridge width of 4 lanes (AC) with standard shoulders; includes abutments and bridge approaches; assumes vertical clearance of 23'4" + 6'8" superstructure	0.72 (All train-related crashes eliminated)	0.72 (All train-related crashes eliminated)	Removes all train-related crashes at at-grade crossing; all other crashes CMF = 0.72
Construct Underpass at At-Grade Railroad Crossing	$15,000,000	1.74	$26,100,000	Each	2.20	$33,000,000	$57,420,000	Assumes underpass width of 4 lanes (AC) with standard shoulders; includes railroad bridge with abutments and underpass approaches; assumes vertical clearance of 16'6" + 6'6" superstructure	0.72 (All train-related crashes eliminated)	0.72 (All train-related crashes eliminated)	Removes all train-related crashes at at-grade crossing; all other crashes CMF = 0.72
Construct High-Occupancy Vehicle (HOV) Lane	$900,000	1.74	$1,566,000	Mile	2.20	$1,980,000	$3,445,000	For addition of 1 HOV lane (AC) in one direction with associated signage and markings; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.95	0.95	Similar to general purpose lane

SOLUTION	2016 CONST UNIT COST	INFLATION FACTOR 2016-2022	2022 CONST UNIT COST	UNIT	FACTOR^	2016 FACTORED CONST UNIT COST	2022 FACTORED CONST UNIT COST	DESCRIPTION	2016 CMF FOR CORRIDOR PROFILE STUDIES	2022 CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
ALTERNATE ROUTE											
Construct Frontage Roads	$2,400,000	1.74	$4,176,000	Mile	2.20	$5,280,000	$9,190,000	For 2-lane AC frontage road; includes all costs except bridges; for generally at-grade facility with minimal walls	0.90	0.90	Assumed - similar to new general purpose lane
Construct 2-Lane Undivided Highway	$3,000,000	1.74	$5,220,000	Mile	2.20	$6,600,000	$11,484,000	In both directions; assumes addition of 2 new lanes (AC) with standard shoulders in each direction; includes all costs except bridges	0.90	0.90	Assuming new alignment for a bypass

^ Factor accounts for traffic control, erosion control, construction surveying and quality control, mobilization, construction engineering, contingencies, indirect cost allocation, and miscellaneous work

Appendix G: Performance Area Risk Factors

Pavement Performance Area

- Elevation
- Mainline Daily Traffic Volume
- Mainline Daily Truck Volume

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5	> 9000’

Mainline Daily Traffic Volume

Exponential equation; score = 5-(5*e$^{(ADT*-0.000039)}$)

Score	Condition
0	< 6,000
0-5	6,000 – 160,000
5	>160,000

Mainline Daily Truck Volume

Exponential equation; score = 5-(5*e$^{(ADT*-0.00025)}$)

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Bridge Performance Area

- Mainline Daily Traffic Volume
- Elevation
- Carries Mainline Traffic
- Detour Length
- Scour Critical Rating
- Vertical Clearance

Mainline Daily Traffic Volume

Exponential equation; score = 5-(5*e$^{(ADT*-0.000039)}$)

Score	Condition
0	<6,000
0-5	6,000-160,000
5	>160,000

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5	> 9000’

Carries Mainline Traffic

Score	Condition
0	Does not carry mainline traffic
5	Carries mainline traffic

Detour Length

Divides detour length by 10 and multiplies by 2.5

Score	Condition
0	0 miles
0-5	0-20 miles
5	> 20 miles

Scour Critical Rating

Variance below 8

Score	Condition
0	Rating > 8
0-5	Rating 8 - 3
5	Rating < 3

Vertical Clearance

Variance below 16’ x 2.5; (16 –Clearance) x 2.5

Score	Condition
0	>16’
0-5	16’-14’
5	<14’

Mobility Performance Area

- Mainline VMT
- Detour Length
- Outside Shoulder Width

Mainline VMT

Exponential equation; score = 5-(5*e(ADT*-0.0000139))

Score	Condition
0	<16,000
0-5	16,000-400,000
5	>400,000

Detour Length

Score	Condition
0	Detour < 10 miles
5	Detour > 10 miles

Outside Shoulder Width

Variance below 10’, if only 1 lane in each direction

Score	Condition
0	10’ or above or >1 lane in each direction
0-5	10’-5’ and 1 lane in each direction
5	5’ or less and 1 lane in each direction

Safety Performance Area

- Mainline Daily Traffic Volume
- Interrupted Flow
- Elevation
- Outside Shoulder Width
- Vertical Grade

Mainline Daily Traffic Volume

Exponential equation; score = 5-(5*e$^{(ADT*-0.000039)}$)

Score	Condition
0	<6,000
0-5	6,000-160,000
5	>160,000

Interrupted Flow

Score	Condition
0	Not interrupted flow
5	Interrupted Flow

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5	> 9000’

Outside Shoulder Width

Variance below 10'

Score	Condition
0	10’ or above
0-5	10’ - 5’
5	5’ or less

Grade

Variance above 3% x 1.5

Score	Condition
0	< 3%
0-5	3% - 6.33%
5	>6.33%

Freight Performance Area

- Mainline Daily Truck Volume
- Detour Length
- Outside Shoulder Width

Mainline Daily Truck Volume

Exponential equation; score = 5-(5*e$^{(ADT*-0.00025)}$)

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Detour Length

Score	Condition
0	Detour < 10 miles
5	Detour > 10 miles

Outside Shoulder Width

Variance below 10’, if only 1 lane in each direction

Score	Condition
0	10’ or above or >1 lane in each direction
0-5	10’-5’ and 1 lane in each direction
5	5’ or less and 1 lane in each direction

Solution Number	Mainline Traffic Vol (vpd) (2-way)	Solution Length (miles)	Bridge Detour Length (miles) (N19)	Elevation (ft)	Scour Critical Rating (0-9)	Carries Mainline Traffic (Y/N)	Bridge Vert. Clear (ft)	Mainline Truck Vol (vpd) (2-way)	Detour Length > 10 miles (Y/N)	Grade (%)	Interrupted Flow (Y/N)	Outside/ Right Shoulder Width (ft)	1-lane each direction
CS347.1	2,268	7		1,848				567	Y	1.4	Y	5.1	Y

Solution Number	Bridge	Pavement	Mobility	Safety	Freight	Risk Score (0 to 10)				
						Bridge	Pavement	Mobility	Safety	Freight
CS347.1	N	N	Y	Y	Y	0.00	0.00	7.26	4.13	7.04

Appendix H: Candidate Solution Cost Estimates

Solution #	Location #	Name	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Option	Scope	BMP	EMP	Unit	Quantity	Factored Construction Unit Cost	Preliminary Engineering Cost	Design Cost	Right-of-Way Cost (assuming $12/sf)	Construction Cost	Total Cost	Notes	CMF
CS347.1	L2	Stanfield Area Safety Improvements	M	-	Rehabilitate Shoulder (AC) (NB)	155	162	Mile	7	$202,279	$42,500	$141,600		$1,415,950	$1,600,050	Average 5-foot shoulder in one direction (two lane undivided road)	0.72
					Rehabilitate Shoulder (AC) (SB)	155	162	Mile	7	$202,279	$42,500	$141,600		$1,415,950	$1,600,050	Average 5-foot shoulder in one direction (two lane undivided road)	0.72
										Solution Total	**$85,000**	**$283,200**	**$0**	**$2,831,900**	**$3,200,100**		

Appendix I: Performance Effectiveness Scores

Need Reduction

			Solution #	**CS347.1**
			Description	West Stanfield Area Safety Improvements
	LEGEND:		Project Beg MP	155
		- user entered value	Project End MP	162
		- calculated value for reference only	Project Length (miles)	7
		- calculated value for entry/use in other spreadsheet	Segment Beg MP	155
		- for input into Performance Effectiveness Score spreadsheet	Segment End MP	162
		- assumed values (do not modify)	Segment Length (miles)	7
			Segment #	1
			Current # of Lanes (both directions)	2
			Project Type (one-way or two-way)	two-way
			Additional Lanes (one-way)	0
			Pro-Rated # of Lanes	2.00
		Notes and Directions	**Description**	
SAFETY	DIRECTIONAL SAFETY	Input current value from performance system (direction 1)	Orig Segment Directional Safety Index (NB)	2.260
		Input current value from performance system (direction 1)	Orig Segment Directional Fatal Crashes (NB)	1
		Input current value from performance system (direction 1)	Orig Segment Directional Suspected Serious Crashes (NB)	1
		Input current value from performance system (direction 1)	Original Fatal Crashes in project limits (NB)	1
		Input current value from performance system (direction 1)	Original Suspected Serious Crashes in project limits (NB)	1
		Input CMF value (direction 1) - If no CMF enter 1.0	CMF 1 (NB)(lowest CMF)	0.72
		Input CMF value (direction 1) - If no CMF enter 1.0	CMF 2 (NB)	1
		Input CMF value (direction 1) - If no CMF enter 1.1	CMF 3 (NB)	1
		Input CMF value (direction 1) - If no CMF enter 1.2	CMF 4 (NB)	1
		Input CMF value (direction 1) - If no CMF enter 1.0	CMF 5 (NB)	1
		Calculated Value (direction 1)	Total CMF (NB)	0.720
		Calculated Value (direction 1)	Fatal Crash reduction (NB)	0.280
		Calculated Value (direction 1)	Suspected Serious Crash reduction (NB)	0.280
		Enter in Safety Index spreadsheet to calculate new Safety Index (direction 1)	Post-Project Segment Directional Fatal Crashes (NB)	0.720
		Enter in Safety Index spreadsheet to calculate new Safety Index (direction 1)	Post-Project Segment Directional Suspected Serious Crashes (NB)	0.720
		Input value from updated Safety Index spreadsheet (direction 1)	Post-Project Segment Directional Safety Index (NB)	1.630
		Enter in Safety Needs spreadsheet to calculate new segment level Safety Need (direction 1)	Post-Project Segment Directional Safety Index (NB)	1.630
		Input current value from performance system (direction 2)	Orig Segment Directional Safety Index (SB)	4.220
		Input current value from performance system (direction 2)	Orig Segment Directional Fatal Crashes (SB)	2
		Input current value from performance system (direction 2)	Orig Segment Directional Suspected Serious Crashes (SB)	0
		Input current value from performance system (direction 2)	Original Fatal Crashes in project limits (SB)	2
		Input current value from performance system (direction 2)	Original Suspected Serious Crashes in project limits (SB)	0
		Input CMF value (direction 2) - If no CMF enter 1.0	CMF 1 (SB)(lowest CMF)	0.72
		Input CMF value (direction 2) - If no CMF enter 1.0	CMF 2 (SB)	1
		Input CMF value (direction 2) - If no CMF enter 1.1	CMF 3 (SB)	1
		Input CMF value (direction 2) - If no CMF enter 1.2	CMF 4 (SB)	1
		Input CMF value (direction 2) - If no CMF enter 1.0	CMF 5 (SB)	1
		Calculated Value (direction 2)	Total CMF (SB)	0.720
		Calculated Value (direction 2)	Fatal Crash reduction (SB)	0.560
		Calculated Value (direction 2)	Suspected Serious Crash reduction (SB)	0.000
		Enter in Safety Index spreadsheet to calculate new Safety Index (direction 2)	Post-Project Segment Directional Fatal Crashes (SB)	1.440
		Enter in Safety Index spreadsheet to calculate new Safety Index (direction 2)	Post-Project Segment Directional Suspected Serious Crashes (SB)	0.000
		Input value from updated Safety Index spreadsheet (direction 2)	Post-Project Segment Directional Safety Index (SB)	3.040
		Enter in Safety Needs spreadsheet to calculate new segment level Safety Need (direction 2)	Post-Project Segment Directional Safety Index (SB)	3.040
	SAFETY INDEX	Calculated Value - verify that it matches current performance system	Current Safety Index	3.240
		Enter in Safety Needs spreadsheet to calculate new segment level Safety Need	Post-Project Safety Index	2.335
	Needs	User entered value from Safety Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Safety Need	**12.301**
		User entered value from Safety Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Safety Need	**8.385**

Solution #	**CS347.1**
Description	West Stanfield Area Safety Improvements
Project Beg MP	155
Project End MP	162
Project Length (miles)	7
Segment Beg MP	155
Segment End MP	162
Segment Length (miles)	7
Segment #	1
Current # of Lanes (both directions)	2
Project Type (one-way or two-way)	two-way
Additional Lanes (one-way)	0
Pro-Rated # of Lanes	2.00

LEGEND:
- user entered value
- calculated value for reference only
- calculated value for entry/use in other spreadsheet
- for input into Performance Effectiveness Score spreadsheet
- assumed values (do not modify)

		Notes and Directions	Description	
MOBILITY	MOBILITY INDEX	Input current value from performance system	Original Segment Mobility Index	0.180
		Enter in Mobility Index Spreadsheet to determine new segment level Mobility Index	Post-Project # of Lanes (both directions)	2.00
		Input value from updated Mobility Index spreadsheet	Post-Project Segment Mobility Index	0.18
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Mobility Index	0.180
	FUT V/C	Input current value from performance system	Original Segment Future V/C	0.240
		Input value from updated Mobility Index spreadsheet	Post-Project Segment Future V/C	0.240
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Future V/C	0.240
	PEAK HOUR V/C	Input current value from performance system (direction 1)	Original Segment Peak Hour V/C (NB)	0.080
		Input current value from performance system (direction 2)	Original Segment Peak Hour V/C (SB)	0.090
		***If One-Way project**, enter in Mobility Index Spreadsheet to determine new segment level Peak Hour V/C. **If Two-Way project,** disregard	Adjusted total # of Lanes for use in directional peak hr	N/A
		Input value from updated Mobility Index spreadsheet (direction 1)	Post-Project Segement Peak Hr V/C (NB)	0.080
		Input value from updated Mobility Index spreadsheet (direction 2)	Post-Project Segement Peak Hr V/C (SB)	0.090
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Peak Hr V/C (NB)	0.080
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Peak Hr V/C (SB)	0.090
	LOTTR	Calculated Value (both directions)	Safety Reduction Factor	0.721
		Calculated Value (both directions)	Safety Reduction	0.279
		Calculated Value (both directions)	Mobility Reduction Factor	1.000
		Calculated Value (both directions)	Mobility Reduction	0.000
		Assumed effect on LOTTR(% of mobility reduction)	Mobility effect on LOTTR	0.20
		Assumed effect on LOTTR (% of safety reduction)	Safety effect on LOTTR	0.30
		Input current value from performance system (direction 1)	Original Directional Segment LOTTR (NB)	NA
		Input current value from performance system (direction 2)	Original Directional Segment LOTTR (SB)	NA
		Calculated Value (both directions)	Reduction Factor for Segment LOTTR	0.084
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need (direction 1)	Post-Project Directional Segment LOTTR (NB)	NA
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need (direction 2)	Post-Project Directional Segment LOTTR (SB)	NA
	CLOSURE EXTENT	Input current value from performance system (direction 1)	Orig Segment Directional Closure Extent (NB)	0.170
		Input current value from performance system (direction 2)	Orig Segment Directional Closure Extent (SB)	0.030
		Input value from HCRS	Segment Closures with fatalities/injuries	0
		Input value from HCRS	Total Segment Closures	7
		Calculated Value (both directions)	% Closures with Fatality/Injury	0.00
		Calculated Value (both directions)	Closure Reduction	0.000
		Calculated Value (both directions)	Closure Reduction Factor	1.000
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need (direction 1)	Post-Project Segment Directional Closure Extent (NB)	0.170
		Enter in Mobility Needs spreadsheet to update segment level Mobility Need (direction 2)	Post-Project Segment Directional Closure Extent (SB)	0.030
	BICYCLE ACCOM	Input current value from performance system	Orig Segment Bicycle Accomodation %	12.0%
		Input current value from performance system	Orig Segment Outside Shoulder width	5.28
		Input value from updated Mobility Index spreadsheet	Post-Project Segment Outside Shoulder width	5.28
		Input value from updated Mobility Index spreadsheet	Post-Project Segment Bicycle Accomodation (%)	12.0%
		Enter in Mobiity Needs spreadsheet to calculate new segment level Mobility Need	Post-Project Segment Bicycle Accomodation (%)	12.0%
	Needs	User entered value from Mobility Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Mobility Need	**0.876**
		User entered value from Mobility Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Mobility Need	**0.876**

			Solution #	**CS347.1**
			Description	West Stanfield Area Safety Improvements
	LEGEND:		Project Beg MP	155
		- user entered value	Project End MP	162
		- calculated value for reference only	Project Length (miles)	7
		- calculated value for entry/use in other spreadsheet	Segment Beg MP	155
		- for input into Performance Effectiveness Score spreadsheet	Segment End MP	162
		- assumed values (do not modify)	Segment Length (miles)	7
			Segment #	1
			Current # of Lanes (both directions)	2
			Project Type (one-way or two-way)	two-way
			Additional Lanes (one-way)	0
			Pro-Rated # of Lanes	2.00
		Notes and Directions	**Description**	
	TTTR	Assumed effect on TTTR (% of mobility reduction)	Mobility effect on TTTR	0.10
	TTTR	Assumed effect on TTTR (% of safety reduction)	Safety effect on TTTR	0.15
	TTTR	Input current value from performance system (direction 1)	Original Directional Segment TTTR (NB)	NA
	TTTR	Input current value from performance system (direction 2)	Original Directional Segment TTTR (SB)	NA
	TTTR	Calculated Value (both directions)	Reduction Factor for Segment TTTR (both directions)	0.042
	TTTR	Enter in Freight Needs spreadsheet to update segment level Freight Need (direction 1)	Post-Project Directional Segment TTTR (NB)	NA
	TTTR	Enter in Freight Needs spreadsheet to update segment level Freight Need (direction 2)	Post-Project Directional Segment TTTR (SB)	NA
	FREIGHT INDEX	Value from above	Original Segment MAX TTTR (NB)	NA
	FREIGHT INDEX	Value from above	Original Segment MAX TTTR (SB)	NA
	FREIGHT INDEX	Calculated Value	Original Segment Freight Index	#DIV/0!
	FREIGHT INDEX	Calculated Value	Post-Project Segment MAX TTTR (NB)	NA
	FREIGHT INDEX	Calculated Value	Post-Project Segment MAX TTTR (SB)	NA
	FREIGHT INDEX	Enter in Freight Needs spreadsheet to update segment level Freight Need	Post-Project Segment Freight Index	NA
	CLOSURE DURATION	Input current value from performance system (direction 1)	Orig Segment Directional Closure Duration (dir 1)	26.850
	CLOSURE DURATION	Input current value from performance system (direction 2)	Orig Segment Directional Closure Duration (dir 2)	6.860
	CLOSURE DURATION	Calculated Value	Segment Closures with fatalities	0
	CLOSURE DURATION	Calculated Value	Total Segment Closures	7
	CLOSURE DURATION	Calculated Value	% Closures with Fatality	0.00
	CLOSURE DURATION	Calculated Value	Closure Reduction	0.000
	CLOSURE DURATION	Calculated Value	Closure Reduction Factor	1.000
	CLOSURE DURATION	Enter in Freight Needs spreadsheet to update segment level Freight Need (direction 1)	Post-Project Segment Directional Closure Duration (NB)	26.850
	CLOSURE DURATION	Enter in Freight Needs spreadsheet to update segment level Freight Need (direction 2)	Post-Project Segment Directional Closure Duration (SB)	6.860
	VERT CLR	Input current value from performance system	Original Segment Vertical Clearance	NA
	VERT CLR	Input current value from performance system	Original vertical clearance for specific bridge	NA
	VERT CLR	Input post-project value (depends on solution)	Post-Project vertical clearance for specific bridge	NA
	VERT CLR	Input post-project value (depends on solution)(force segment clearance to equal this specific bridge)	Post-Project Segment Vertical Clearance	NA
	VERT CLR	Enter in Freight Needs spreadsheet to update segment level Freight Need	Post-Project Segment Vertical Clearance	NA
	Needs	User entered value from Freight Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Freight Need	**0.000**
	Needs	User entered value from Freight Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Freight Need	**0**

Solution #	**CS347.1**
Description	West Stanfield Area Safety Improvements
Project Beg MP	155
Project End MP	162
Project Length (miles)	7
Segment Beg MP	155
Segment End MP	162
Segment Length (miles)	7
Segment #	1
Current # of Lanes (both directions)	2
Project Type (one-way or two-way)	two-way
Additional Lanes (one-way)	0
Pro-Rated # of Lanes	2.00

LEGEND:

- user entered value
- calculated value for reference only
- calculated value for entry/use in other spreadsheet
- for input into Performance Effectiveness Score spreadsheet
- assumed values (do not modify)

		Notes and Directions	Description	
BRIDGE	BRIDGEINDEX	Input current value from performance system	Original Segment Bridge Index	No Change
		Input current value from performance system	Original lowest rating for specific bridge	No Change
		Input post-project value (For repair +1, rehab +2, replace=8)	Post-Project lowest rating for specific bridge	No Change
		Enter in Bridge Index spreadsheet to calculate new Bridge Index	Post-Project lowest rating for specific bridge	No Change
		Input updated segment value from updated Bridge Index spreadsheet	Post-Project Segment Bridge Index	No Change
		Enter in Bridge Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Bridge Index	No Change
	SUFF RATING	Input current value from performance system	Original Segment Sufficiency Rating	No Change
		Input current value from performance system	Original Sufficiency Rating for specific bridge	No Change
		Input post-project value (For repair +10, rehab +20, replace=98)	Post-Project Sufficiency Rating for specific bridge	No Change
		Enter in Bridge Index spreadsheet to calculate new Bridge Index	Post-Project Sufficiency Rating for specific bridge	No Change
		Input updated segment value from updated Bridge Index spreadsheet	Post-Project Segment Sufficiency Rating	No Change
		Enter in Bridge Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Sufficiency Rating	No Change
	BR RTNG	Input current value from performance system	Original Segment Bridge Rating	
		Input updated segment value from updated Bridge Index spreadsheet	Post-Project Segment Bridge Rating	No Change
		Enter in Bridge Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Bridge Rating	No Change
	Needs	User entered value from Bridge Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Bridge Need	**0**
		User entered value from Bridge Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Bridge Need	**0**

Solution #	**CS347.1**
Description	West Stanfield Area Safety Improvements
Project Beg MP	155
Project End MP	162
Project Length (miles)	7
Segment Beg MP	155
Segment End MP	162
Segment Length (miles)	7
Segment #	1
Current # of Lanes (both directions)	2
Project Type (one-way or two-way)	two-way
Additional Lanes (one-way)	0
Pro-Rated # of Lanes	2.00

LEGEND:

- user entered value
- calculated value for reference only
- calculated value for entry/use in other spreadsheet
- for input into Performance Effectiveness Score spreadsheet
- assumed values (do not modify)

		Notes and Directions	Description	
PAVEMENT	PAVEMENT INDEX	Input current value from performance system	Original Segment Pavement Index	3.08
		Input current value from performance system	Original Segment IRI in project limits	52.53
		Input current value from performance system	Original Segment Cracking in project limits	15.59
		Input current value from performance system	Original Segment Rutting in project limits	0.12
		Input post-project value (For rehab, increase to 45; for replace increase to 30)	Post-Project IRI in project limits	52.53
		Enter in Pavement Index spreadsheet to calculate new Pavement Index	Post-Project IRI in project limits	52.53
		Input post-project value (Lower to 0 for rehab or replace)	Post-Project Cracking in project limits	15.59
		Enter in Pavement Index spreadsheet to calculate new Pavement Index	Post-Project Cracking in project limits	15.59
		Input post-project value (Lower to 0 for rehab or replace)	Post-Project Rutting in project limits	0.12
		Enter in Pavement Index spreadsheet to calculate new Pavement Index	Post-Project Rutting in project limits	0.12
		Input updated segment value from updated Pavement Index spreadsheet	Post-Project Segment Pavement Index	3.08
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment Pavement Index	3.08
	DIRECTION PSR	Input current value from performance system (direction 1)	Original Segment Directional PSR (NB)	
		Input current value from performance system (direction 2)	Original Segment Directional PSR (SB)	
		Value from above	Original Segment IRI in project limits	52.53
		Value from above	Post-Project directional IRI in project limits	52.53

		Input updated segment value from updated Pavement Index spreadsheet (direction 1)	Post-Project Segment Directional PSR (NB)	3.98
		Input updated segment value from updated Pavement Index spreadsheet (direction 2)	Post-Project Segment Directional PSR (SB)	4.09
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment Directional PSR (NB)	3.98
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment Directional PSR (SB)	4.09
	% FAIL	Input current value from performance system	Original Segment % Failure	69.0%
		Input value from updated Pavement Index spreadsheet	Post-Project Segment % Failure	69.0%
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment % Failure	69.0%
	Needs	User entered value from Pavement Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Pavement Need	**2.828**
		User entered value from Pavement Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Pavement Need	**2.828**

CMF Application

SR 347-84 Corridor Profile Study

CMF Application

=user input

CS347.1 (MP 155-162) Northbound

BMP	EMP	CMF1	CMF2	CMF3	CMF4	Dir	Effective CMF	Crashes in Segment Limits Fatal	Crashes in Segment Limits Incap	Crashes in Solution Limits Fatal	Crashes in Solution Limits Incap	Post-Solution Crashes Fatal	Post-Solution Crashes Incap	Total Crash Reduction Fatal	Total Crash Reduction Incap
155	162.00	0.72	1.00	1	1	NB	0.720			1	1	0.720	0.720	0.280	0.280
								1	1			**0.720**	**0.720**	0.280	0.280

CS347.1 (MP 155-162) Southbound

BMP	EMP	CMF1	CMF2	CMF3	CMF4	Dir	Effective CMF	Crashes in Segment Limits Fatal	Crashes in Segment Limits Incap	Crashes in Solution Limits Fatal	Crashes in Solution Limits Incap	Post-Solution Crashes Fatal	Post-Solution Crashes Incap	Total Crash Reduction Fatal	Total Crash Reduction Incap
155	162	0.72	1.00	1	1	SB	0.720			2	0	1.440	0.000	0.560	0.000
								2	0			**1.440**	**0.000**	0.560	0.000

Performance Area Scoring

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement					Bridge					Safety					Mobility					Freight					Total Risk Factored Performance Area Benefit
				Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	
CS347/84.1	West Stanfield Area Safety Improvements	155-162	3.2	2.828	2.828	0.000	0.00	0.000	0.000	0.000	0.000	0.00	0.000	12.301	8.385	3.916	4.13	16.173	0.876	0.876	0.000	7.26	0.000	0.000	0.000	0.000	7.04	0.000	16.173

Performance Effectiveness Scoring

				Safety Emphasis Area						Mobility Emphasis Area						Freight Emphasis Area									
Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Total Factored Benefit	VMT Factor	NPV Factor	Performance Effectiveness Score
CS347/84.1	West Stanfield Area Safety Improvements	155-162	3.2	4.291	2.686	1.605	4.13	1.50	9.943	0.151	0.151	0.000	7.26	1.50	0.000	0.000	0.000	0.000	7.04	1.50	0.000	26.116	0.99	15.3	123.6

miles	2020 ADT	1-way or 2-way	VMT
7.00	2268	2	15876

Appendix J: Solution Prioritization Scores

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement		Bridge		Safety		Mobility		Freight		Total Factored Score	Risk Factors					Weighted Risk Factor	Segment Need	Prioritization Score
				Score	%	Score	%	Score	%	Score	%	Score	%		Pavement	Bridge	Safety	Mobility	Freight			
CS347/84.1	West Stanfield Area Safety Improvements	155-162	3.2	0.000	0.0%	0.000	0.0%	26.116	100.0%	0.000	0.0%	0.000	0.0%	26.116	1.14	1.51	1.78	1.36	1.36	1.780	1.23	**271**

Appendix K: Preliminary Scoping Reports for Prioritized Solutions

ADOT

PRELIMINARY SCOPING REPORT

GENERAL PROJECT INFORMATION	
Date: February 14, 2023	**ADOT Project Manager:**
Project Name: West Stanfield Area Safety Improvements (CS347.1)	
City/Town: N/A	**County:** Pinal
COG/MPO: CAG	**ADOT District:** Southcentral
Primary Route/Street: SR 84 and SR 347	
Beginning Limit: MP 155	
End Limit: MP 162	
Project Length: 7 miles	
Right-of-Way Ownership(s) (where proposed project construction would occur): *(Check all that apply)* ☐ City/Town; ☐ County; ☒ ADOT; ☐ Private; ☐ Federal; ☐ Tribal; ☐ Other:	
Adjacent Land Ownership(s): *(Check all that apply)* ☐ City/Town; ☐ County; ☐ ADOT; ☒ Private; ☐ Federal; ☐ Tribal; ☒ Other: *http://gis.azland.gov/webapps/parcel/*	

LOCAL PUBLIC AGENCY (LPA) or TRIBAL GOVERNMENT INFORMATION *(If applicable)*	
LPA/Tribal Name:	
LPA/Tribal Contact:	
Email Address:	**Phone Number:**
Administration: ☐ ADOT Administered ☐ Self-Administered ☐ Certification Acceptance	

PROJECT NEED
Safety Need: From MP 155 to MP 162, there is a High level of need based on the overall Safety Index and both Directional Safety Indexes above statewide averages.

PROJECT PURPOSE			
What is the Primary Purpose of the Project?	Preservation ☐	Modernization ☒	Expansion ☐
Address Safety Need by rehabilitating shoulders in both directions.			

1

ADOT

PRELIMINARY SCOPING REPORT

PROJECT RISKS	
Check any risks identified that may impact the project's scope, schedule, or budget:	
☐ Access / Traffic Control / Detour Issues	☐ Right-of-Way
☐ Constructability / Construction Window Issues	☐ Environmental
☐ Stakeholder Issues	☐ Utilities
☐ Structures & Geotech	☐ Other:
Risk Description: *(If a box is checked above, briefly explain the risk)*	

POTENTIAL FUNDING SOURCE(S)				
Anticipated Project Design/Construction Funding Type: *(Check all that apply)*	☐ STBG	☐ TAP	☐ HSIP	☐ State
	☐ Local	☐ Private	☐ Tribal	☐ Other:

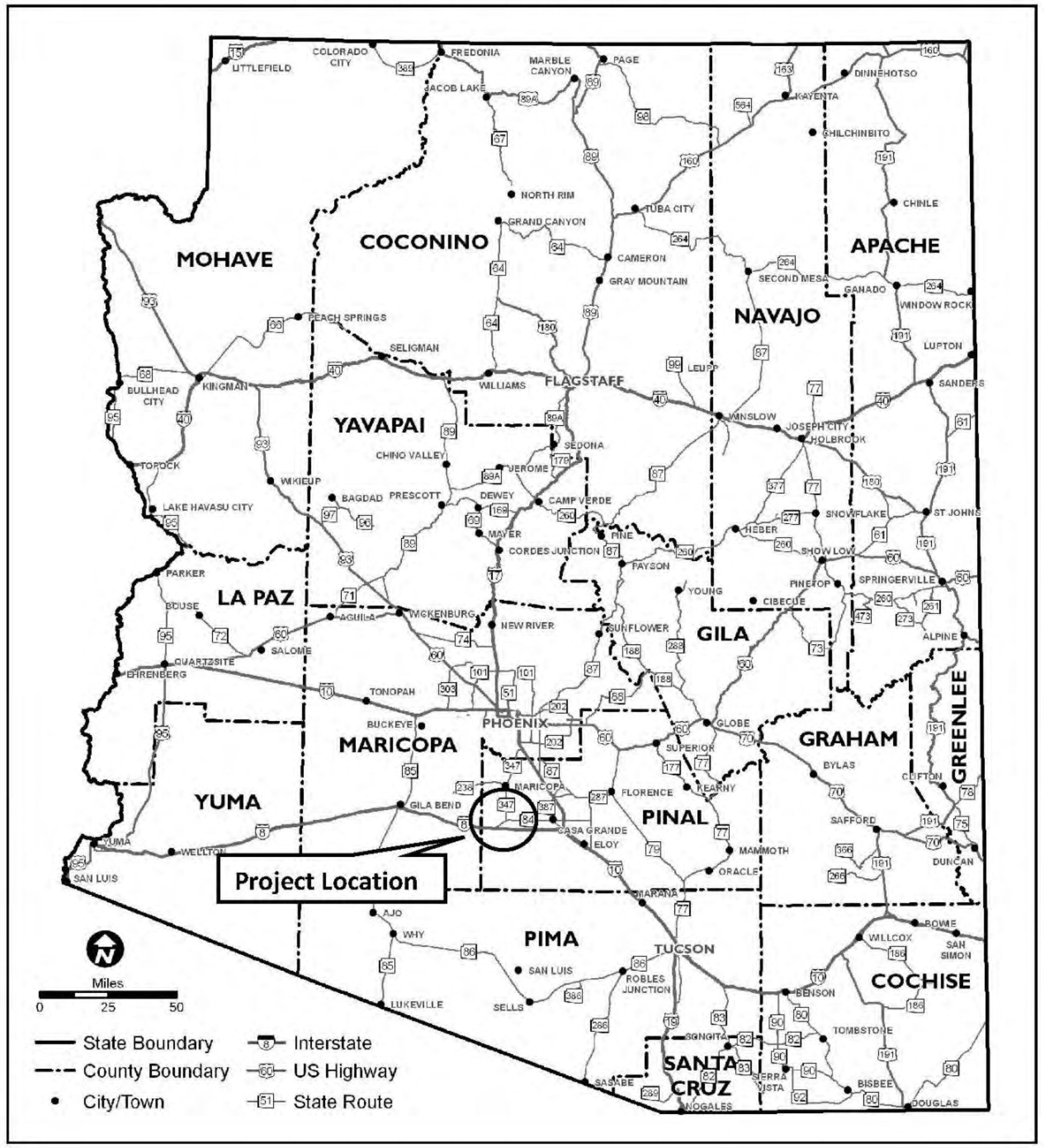
COST ESTIMATE				
Preliminary Engineering	Design	Right-of-Way	Construction	Total
$85,000	$283,200	$0	$2,831,900	$3,200,100

RECOMMENDED PROJECT DELIVERY
Delivery: ☐ Design-Bid-Build ☐ Design-Build ☐ Other:
Design Program Year: FY
Construction Program Year: FY

ATTACHMENTS
1) State Location Map **2) Project Vicinity Map** **3) Project Scope of Work**

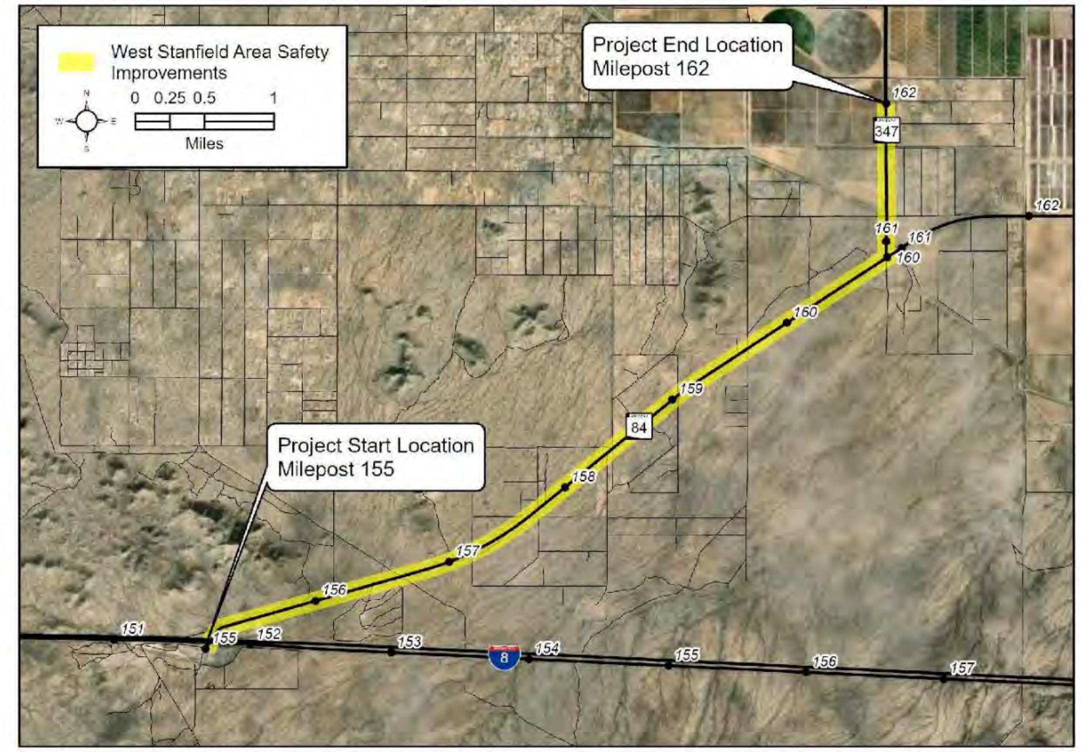
2

ATTACHMENT 1 – STATE LOCATION MAP



3

ATTACHMENT 2 – PROJECT VICINITY MAP



4

ATTACHMENT 3 – SCOPE OF WORK

SCOPE OF WORK
• Rehabilitate shoulders in both directions (striping, delineators, RPMs, safety edge, and rumble strips for both shoulders)

SCOPE ITEMS CONSIDERED, BUT NOT INCLUDED
• N/A

Pursuant to 23 USC 409: Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or rail-way-highway crossings, pursuant to sections 130, 144, and 148 [152] of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

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