MARICOPA
ASSOCIATION of
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2018
REGIONAL
COMMUTER
RAIL SYSTEM
STUDY UPDATE
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MARICOPA ASSOCIATION OF GOVERNMENTS

REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

May 2018

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Table of Contents

ES Executive Summary ES-1
1.0 Study Overview 1-1
1.1 Introduction 1-1
1.2 Background 1-1
1.3 Purpose of the System Study 1-2
1.4 Need for a Commuter Rail System 1-2
1.5 Potential Benefits and Goals of Commuter Rail 1-5
1.6 System Study Update Process 1-6
1.7 Organization of the System Study Update 1-6
2.0 Existing and Future Conditions 2-1
2.1 Introduction and Methodology 2-1
2.2 New Information Included in Update 2-5
2.3 Major Changes Since the 2010 Study 2-8
2.4 Summary of Findings 2-11
2.5 Grand Line Corridor 2-13
2.6 Estrella Line Corridor 2-37
2.7 San Tan Line Corridor 2-61
2.8 Kyrene Line Corridor 2-87
2.9 Future Extensions 2-110
3.0 Development of the Commuter Rail Program 3-1
3.1 Introduction 3-1
3.2 Development of Commuter Rail Corridors 3-1
3.3 Description of Proposed Commuter Rail System 3-13
3.4 Commuter Rail Operations 3-13
3.5 Summary of Commuter Rail System Assumptions 3-14
3.6 Ridership Forecasting Results 3-15
3.7 Cost Estimates 3-20
4.0 Recommendations and Implementation Strategy 4-1
4.1 Introduction 4-1
4.2 Peer City Comparison 4-1
4.3 Phasing Recommendations 4-5
4.4 Integration with other Transit Modes 4-5

4.5 Siting of Layover and Maintenance Facilities 4-8
4.6 Operations Models 4-12
4.7 Governance Options 4-16
4.8 Funding Options 4-22
4.9 Liability, Insurance, and Indemnification 4-35
4.10 Implementation Steps 4-43
5.0 References 5-1

Appendix A: Methodology for Cost Estimating
Appendix B: Evaluation of Potential Commuter Rail Corridor Extensions
Appendix C: System Study Station Target Area Evaluation
Appendix D: Commuter Rail Design Concepts
Appendix E: Railroad Conditions and Issues
Appendix F: Commuter Rail Vehicle Technology
Appendix G: Commuter Rail Operations Plan
Appendix H: Commuter Rail Maintenance Facility Description and Evaluation
Appendix I: Commuter Rail Governance and Operating Structures
Appendix J: Conceptual Memorandum of Understanding
Appendix K: Insurance and Indemnity Language
Appendix L: Potential Grade Separation Locations
Appendix M: One-on-One Meetings with Participating Jurisdictions
Appendix N: BNSF Operations Report (Included Separately)

List of Figures

Figure 1-1: MAG Regional Commuter Rail System Corridors 1-4
Figure 1-2: Commuter Rail Train Examples 1-5
Figure 2-1: Arizona Passenger Rail Corridor Study Preferred Alterative 2-10
Figure 2-2: Grand Line Corridor – Land Use 2-17
Figure 2-3: Grand Line Corridor – Railroad Facilities 2-23
Figure 2-4: Grand Line Corridor – Peak Period Travel Characteristics 2-29
Figure 2-5: Grand Line Corridor – Transit Services 2-33
Figure 2-6: Estrella Line Corridor – Land Use 2-41
Figure 2-7: Estrella Line Corridor – Railroad Facilities 2-47
Figure 2-8: Estrella Line Corridor – Peak Period Travel Characteristics 2-53
Figure 2-9: Estrella Line Corridor – Transit Services 2-57
Figure 2-10: San Tan Line Corridor – Land Use 2-65
Figure 2-11: San Tan Line Corridor – Railroad Facilities 2-73
Figure 2-12: San Tan Line Corridor – Peak Period Travel Characteristics 2-79
Figure 2-13: San Tan Line Corridor – Transit Services 2-83
Figure 2-14: Kyrene Line Corridor – Land Use 2-91
Figure 2-15: Kyrene Line Corridor – Railroad Facilities 2-97
Figure 2-16: Kyrene Line Corridor – Peak Period Travel Characteristics 2-103
Figure 2-17: Kyrene Line Corridor – Transit Services 2-107
Figure 2-18: Future Commuter Rail Extensions and Conceptual Station Area Locations 2-111
Figure 3-1: MAG Regional Commuter Rail System Corridors 3-2
Figure 3-2: MAG Commuter Rail System Study Update Station Areas 3-7
Figure 3-3: MAG Commuter Rail System 2040 Daily Boardings by Station 3-17
Figure 3-4: MAG Commuter Rail System Potential Ridership to Extension Areas of Wickenburg and San Tan Valley 3-18
Figure 3-5: Tempe Elevated Bypass and Trench Options 3-21
Figure 3-6: Gilbert Trench Option 3-22
Figure 3-7: Phoenix Union Station Track Layout from 2010 Study 3-27
Figure 4-1: Capital Cost per Mile (in 2017 Dollars) 4-3
Figure 4-2: Boardings per Revenue Mile Comparison 4-4
Figure 4-3: Annual O&M Cost per Passenger Trip 4-4
Figure 4-4: Existing and Planned Transit Modes in Downtown Phoenix 4-6
Figure 4-5: Typical Layover/Trail Track Facility 4-10
Figure 4-6: Typical CRMF Site Layout 4-10
Figure 4-7: Potential Commuter Rail Maintenance and/or Layover Facility Locations 4-11
Figure 4-8: Limitations on Passenger Transportation Liability 4-39

List of Tables

Table 2-1: Grand Line Corridor Population Change (2015 – 2040) 2-14
Table 2-2: Grand Line Corridor Employment Change (2015 – 2040) 2-14
Table 2-3: Grand Line Corridor Existing and Future Land Use 2-15
Table 2-4: Grand Line Corridor Recent and Future Roadway Improvements 2-25
Table 2-5: Grand Line AM Peak Period Travel Characteristics (2015 – 2040) 2-26
Table 2-6: Grand Line PM Peak Period Travel Characteristics (2015 – 2040) 2-27
Table 2-7: Home-Based Work Trips Originating within the Grand Line Corridor 2-35
Table 2-8: Estrella Line Corridor Population Change (2015 – 2040) 2-37
Table 2-9: Estrella Line Corridor Employment Change (2015 – 2040) 2-38
Table 2-10: Estrella Line Corridor Existing and Future Land Use 2-38
Table 2-11: Estrella Line Corridor Recent and Future Roadway Improvements 2-49
Table 2-12: Estrella Line AM Peak Period Travel Characteristics (2015 – 2040) 2-50
Table 2-13: Estrella Line PM Peak Period Travel Characteristics (2015 – 2040) 2-51
Table 2-14: Home-Based Work Trips Originating within the Estrella Line Corridor 2-59
Table 2-15: San Tan Line Corridor Population Change (2015 – 2040) 2-62
Table 2-16: San Tan Line Corridor Employment Change (2015 – 2040) 2-62
Table 2-17: San Tan Line Corridor Existing and Future Land Use 2-63
Table 2-18: San Tan Line Corridor Recent and Future Roadway Improvements 2-75
Table 2-19: San Tan Line Corridor AM Peak Period Travel Characteristics (2015 – 2040) 2-76
Table 2-20: San Tan Line Corridor PM Peak Period Travel Characteristics (2015 – 2040) 2-77
Table 2-21: Home-Based Work Trips Originating within the San Tan Line Corridor 2-85
Table 2-22: Kyrene Line Corridor Population Change (2015 – 2040) 2-87
Table 2-23: Kyrene Line Corridor Employment Change (2015 – 2040) 2-88
Table 2-24: Kyrene Line Corridor Existing and Future Land Use 2-88
Table 2-25: Kyrene Line Corridor Recent and Future Roadway Improvements 2-99
Table 2-26: Kyrene Line Corridor AM Peak Period Travel Characteristics (2015 – 2040) 2-100
Table 2-27: Kyrene Line Corridor PM Peak Period Travel Characteristics (2015 – 2040) 2-101
Table 2-28: Home-Based Work Trips Originating within the Kyrene Line Corridor 2-109
Table 3-1: Distance between Station Target Areas for Each Corridor 3-6
Table 3-2: Estimated Station to Station Travel Times – Grand/Kyrene Corridor (LHC) 3-11
Table 3-3: Estimated Station to Station Travel Times – Grand/Kyrene Corridor (DMU) 3-11
Table 3-4: Estimated Station to Station Travel Times – Estrella/San Tan Corridor (LHC) 3-12
Table 3-5: Estimated Station to Station Travel Times – Estrella/San Tan Corridor (DMU) 3-12
Table 3-6: Characteristics of Proposed Commuter Rail System 3-13
Table 3-7: Summary of Commuter Rail System Assumptions 3-14
Table 3-8: Comparison of Projected Boardings by Station 3-16

Table 3-9: Estimated Major Special Events Attendance 3-19
Table 3-10: Capital Costs of Proposed Commuter Rail System 3-23
Table 3-11: Annual O&M Costs of Proposed Commuter Rail System 3-24
Table 3-12: Annual Farebox Recovery 3-25
Table 4-1: Peer City Commuter Rail Systems 4-2
Table 4-2: Summary of Considerations for Passenger Rail Agency when Entering into Agreements to Operate Commuter Rail 4-15
Table 4-3: Existing Governance Models 4-18
Table 4-4: Potential Governance Structures 4-21
Table 4-5: Potential Commuter Rail Funding Source (Federal) 4-31
Table 4-6: Potential Commuter Rail Funding Source (State) 4-32
Table 4-7: Potential Commuter Rail Funding Source (Local or Regional) 4-33
Table 4-8: Potential Commuter Rail Funding Source (Private) 4-34
Table 4-9: Comparison of Commuter Rail Facilities and Transit Funding 4-35
Table 4-10: Potential Cost-Sharing Approach to Commuter Rail Implementation 4-45
Table 4-11: Summary of Near-Term Implementation Steps 4-47

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List of Acronyms

ABS	Automatic Block Signaling
ACE	Altamont Commuter Express
ADOT	Arizona Department of Transportation
APRCS	ADOT's Arizona Passenger Rail Corridor Study: Tucson to Phoenix
ASU	Arizona State University
ARZC	Arizona & California Railroad
BRT	Bus Rapid Transit
CMAQ	Congestion Mitigation and Air Quality
COASTER	The San Diego Coast Express Rail
CWT	Continuous Welded Rail
DASH	Downtown (Phoenix) Area Shuttle
DBFOM	Design Build Finance Operate and Maintain
DMU	Diesel Multiple Unit
DTC	Direct Traffic Control
EIS	Environmental Impact Statement
FAST	Fixing America's Surface Transportation
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FY	Fiscal Year
GUS	Glendale Urban Shuttle
HBW	Home-Based Work
HCT	High Capacity Transit
HOV	High Occupancy Vehicle
HSIPR	High-Speed Intercity Passenger Rail
HURF	Highway Users Revenue Fund
I-10	Interstate 10
JPA	Joint Powers Authority
LHC	Locomotive Hauled Coaches
LRT	Light Rail Transit
MARC	Maryland Area Regional Commuter (Commuter Rail Service)
MAG	Maricopa Association of Governments
MARY	Maryvale Area Ride for You
MAX	Maricopa Xpress
METRO	Valley Metro Rail, Inc.
MnDOT	Minnesota Department of Transportation
MOU	Memorandum of Understanding
MOW	Maintenance of Way
mph	Miles per Hour
MP	Milepost
MPO	Metropolitan Planning Organization
NEPA	National Environmental Policy Act
NTD	National Transit Database
O&M	Operating and Maintenance
P3	Public-Private Partnerships
PAG	Pima Association of Governments
PCJPB	Peninsula Corridor Joint Powers Board
Penta-P	Public-Private Partnership Pilot Program

PMT	Project Management Team
PRIIA	Passenger Rail Investment and Improvement Act of 2008
PTC	Positive Train Control
RPTA	Regional Public Transportation Authority
RTD	Regional Transportation District (Denver, Colorado)
RTP	Regional Transportation Plan
SCMPO	Sun Corridor Metropolitan Planning Organization
SHF	State Highway Fund
SMART	Sonoma-Marin Area Rail Transit (Bay Area, California)
SRT	System Review Team
STAN	Statewide Transportation Acceleration Needs
STB	Surface Transportation Board
STBGP	Surface Transportation Block Grant Program
ST-LUIS	Sustainable Transportation and Land Use Integration Stud
STP	Surface Transportation Program
SVMPO	Sierra Vista Metropolitan Planning Organization
TAZ	Transportation Analysis Zone
TIF	Tax Increment Financing
The T	The Fort Worth Transportation Authority
TOD	Transit Oriented Development
TRE	Trinity Railway Express (Dallas/Fort Worth, Texas)
TRID	Transit Revitalization Investment District (Portland, Oregon)
TWC	Track Warrant Control
UPRR	Union Pacific Railroad
USDOT	United States Department of Transportation
VLT	Vehicle License Tax
VMT	Vehicle Miles Traveled
VRE	Virginia Railway Express
WES	Westside Express Service (Portland, Oregon)

ES.1 COMMUTER RAIL SYSTEM STUDY OVERVIEW

The purpose of the Regional Commuter Rail System Study Update is to revise the results of the original study that took place in 2010. The 2010 Study evaluated a network of existing railroad corridors and the necessary elements needed to implement a regional commuter rail system.

This System Study Update further analyzes a set of two cross-region commuter rail corridors that were initially evaluated in the 2010 Study. The documentation in the System Study Update considered various factors, including demographic forecasts, ridership forecasts, operations, governance, and implementation requirements. The System Study Update concludes with recommendations for the implementation of a regional commuter rail system.

ES.1.1 How does this Study Relate to Previous Studies?

This Study updates the 2010 Commuter Rail System Study, which built on previous local and regional planning work to consider the feasibility of operating commuter rail service on existing freight rail lines. In 2003, the Maricopa Association of Governments (MAG) completed the High Capacity Transit (HCT) Study. The study recommended a transit network designed to meet the travel needs of the region in the forecast year (now 2040). In 2008, following the HCT Study, MAG developed the Commuter Rail Strategic Plan to provide a framework and specific steps for implementing commuter rail in the MAG region. The Strategic Plan developed a commuter rail system concept that would radiate from downtown Phoenix and be oriented around the existing freight rail lines in the study area. These corridors include:

- Grand Line (formerly Grand Avenue) Corridor (BNSF Railway)
- Estrella Line (formerly Yuma West) Corridor (Union Pacific Railroad)
- San Tan Line (formerly Southeast or SE) Corridor (Union Pacific Railroad)
- Kyrene Line (formerly Tempe) Corridor (Union Pacific Railroad)
- Chandler Corridor (Union Pacific Railroad) (Subsequently removed from consideration)

These five corridors were evaluated in the MAG Regional Commuter Rail System Study completed in 2010.

Since the completion of the 2010 Study, demographic and land use projections changed throughout the MAG region due in part to the economic downturn in the late 2000's. This helped to change where development has occurred over the past decade and where growth is now expected to occur in the future. Further, light rail transit (LRT) was relatively new to the Phoenix area at the time of the 2010 Study and has been expanded several times due to its success.

ES.2 WHAT HAS CHANGED SINCE THE 2010 STUDY?

Since the 2010 Study, several important changes have occurred in the MAG region that may affect the timing, coverage, operations, and the implementation of a potential commuter rail system.

ES.2.2 What Happened with Demographics and Land Use Assumptions?

Socioeconomic and land use projections have changed throughout the MAG region since 2010. This Systems Study Update included updated existing and future year (now 2040) data for population, employment, and land uses. These projections will fold directly in and result in updated regional travel patterns, travel times, and ridership forecasting for the proposed commuter rail system.

ES.2.3 What Happened to the Chandler Corridor?

The Union Pacific Railroad Chandler Branch was removed from consideration for commuter rail service for a variety of reasons. Based on details from the 2010 Study analysis, the Chandler Branch and San Tan Line were found to compete with each other for ridership in the regional travel model. It also competed with ridership on the adjacent Kyrene Line to a lesser extent. In addition, the Chandler Branch also became difficult to interline and model as it is an 'Odd 5th line' with no corollary line in West Valley. Lastly, the City of Chandler requested in 2010 that the Chandler Branch not be included in System Plan final recommendations as they envisioned High Capacity Transit (HCT) on the parallel Arizona Avenue.

ES.2.4 What Changed in Terms of Corridor Extents?

In 2010, the Grand Line Corridor was evaluated between downtown Phoenix and Wickenburg. However, it was only modeled to Wittmann. Similarly, the Estrella Line was evaluated to Arlington, but was only modeled to Buckeye. Based on additional ridership analysis, both are still only proposed to Wittmann and Buckeye, respectively. The San Tan Line was originally proposed to terminate in downtown Queen Creek and that remains unchanged.

In the 2010 Study, the Kyrene Line Corridor was proposed to terminate at West Chandler Boulevard just northeast of the I-10/SR 202 interchange. This line is now proposed to terminate near the Wild Horse Pass Hotel and Casino just southwest of the I-10/SR 202 interchange on Gila River Indian Reservation land, an increase of approximately 2 miles.

ES.2.5 How Does the Arizona Passenger Rail Corridor Study: Tucson-Phoenix Fit with Commuter Rail?

One of the most important changes that have occurred in the MAG region since the 2010 Study has been the ADOT Arizona Passenger Rail Corridor Study: Tucson to Phoenix (APRCS). This is especially important to the San Tan Line Corridor where commuter and intercity rail could both operate within the same corridor.

The APRCS could link Arizona's largest metro areas of Tucson and Phoenix with passenger rail service. The concept for rail service between Tucson and Phoenix assumes train operation at speeds between 80 and 125 mph using a blend of intercity and commuter operations.

ES.3 DESCRIPTION OF PROPOSED COMMUTER RAIL SYSTEM

ES.3.1 What is the Need for a Commuter Rail System?

Demands on the Phoenix region's highway system have resulted in increased travel time for commuters, as well as less predictable travel times that vary with congestion levels. These problems will only worsen in the future as the region continues to grow. Recent and planned public transportation investments in bus and LRT will help to mitigate these impacts, but cannot do so alone. Commuter rail service in the Phoenix region would complement and build upon existing and planned bus and LRT service. Specifically, commuter rail service would (1) offer an alternative transit mode that has the advantage of using existing rail corridors, (2) use a transit technology that is appropriate for longer distance travel, and (3) allow for transfers to other transit systems.

Commuter rail systems are generally used in congested urban areas to improve travel time, mitigate congestion, add convenience, and provide an alternative means of travel – particularly in times of increasing energy prices. Commuter rail trains typically provide service between suburbs to urban centers for the purpose of reaching activity centers, such as employment, special events, and intermodal connections. Commuter rail trains are optimized for maximum passenger capacity, allowing for approximately 140 passengers per car, and are equipped with comfortable seating and passenger amenities. Designed to primarily meet the needs of regional commuters in the AM and PM peak travel times, commuter rail service typically occurs at lower frequency than LRT. The distance of a typical commuter rail corridor is also longer than that of LRT, ranging from 30 to 50 miles, with passenger stations generally spaced 5 to 10 miles apart.

ES.3.2 What Type of Rail Vehicles would be Used?

The Project Team evaluated Locomotive Hauled Coaches (LHC) and Diesel Multiple Unit (DMU) technologies to determine which type of commuter rail vehicles would be most appropriate for the MAG commuter rail system. An "off-the-shelf" Federal Railroad Administration (FRA)-compliant DMU was not widely available in 2010. However, U.S. Railcar (formerly Colorado Railcar), Nippon Sharyo, and Stadler Rail Group now manufacture DMUs for the U.S. market. U.S. Railcar supplied vehicles to TriMet for its Westside Express Service (WES) in Portland; Nippon Sharyo supplied vehicles for Sonoma-Marin Area rail Transit (SMART) commuter rail corridor between the Sonoma County Airport and San Rafael California; and Stadler Rail Group is supplying vehicles to Trinity Metro (Fort Worth) for its TEX Rail corridor between downtown Fort Worth and Dallas-Fort Worth International Airport (DFW Airport). These vehicles now meet structural requirements of the FRA and are able to operate in mixed traffic with freight trains.

> The FRA has very stringent requirements for passenger and commuter vehicles, which can be found in the Code of Federal Regulations (CFR), specifically 49 CFR Part 238 – Passenger Equipment Safety Standards. Many of these standards relate to the crashworthiness of rail vehicles. If they meet certain criteria, these vehicles may operate in mixed traffic with freight trains. LHC vehicles are built to these standards, and in recent years, some DMU vehicles have also been built to these standards and can therefore operate on the same tracks as freight trains.

Both LHCs and DMUs are being evaluated for commuter rail service in Phoenix. For a complete description of the vehicle technology evaluation, see Appendix F: Commuter Rail Vehicle Technology.

The San Diego Coaster (left) LHCs connect downtown San Diego to Oceanside, CA. Seattle's Sounder (right) connects Everett and Lakewood to downtown Seattle. Both lines use a locomotive (left) for power in both directions and a cab control car (right) for operations in the reverse direction. Source: NCTD (left), Sound Transit (right).

The SMART DMUs connecting Santa Rosa and downtown San Rafael, CA (left) operate two-car trainsets, which can be expanded. The TEX Rail DMUs (right) will be operated in four-car consists between downtown Fort Worth and Dallas/Fort Worth International Airport. Source: SMART (left), TEX Rail (right)

ES.3.1 What Corridors are being Considered?

For the System Study Update, the Project Team further developed two cross-region corridors that were first evaluated in the 2010 Study. Based on the results of the 2010 Study, the Grand Line was interlined with the Kyrene Line and the Estrella Line was interlined with the San Tan Line. Interlined alternatives would provide a one-seat ride throughout the corridor. Both of lines are proposed to operate with 30-minute peak headways and 120-minute off-peak headways. Table ES-1 shows the characteristics of the proposed commuter rail system.

Table ES-1: Characteristics of Proposed Commuter Rail System

Line	Description	Distance	Peak Service	Off-Peak Service	No. of Stations	Travel Time
Individual Corridors						
Grand Line	Service between Wittmann and downtown Phoenix	35.8 miles	30 min.	120 min.	8	38-42 min.
Kyrene Line	Service between Wild Horse Pass/I-10 and downtown Phoenix	18.0 miles	30 min.	120 min.	7	26-29 min.
Estrella Line	Service between Buckeye and downtown Phoenix	30.4 miles	30 min.	120 min.	9	34-39 min.
San Tan Line	Service between Queen Creek and downtown Phoenix	31.0 miles	30 min.	120 min.	8	37-41 min.
Combined Corridors						
Grand/Kyrene Line	Service between Wittmann and Wild Horse Pass/I-10 with a stop in Phoenix	53.8 miles	30 min.	120 min.	14	66-73 min.
Estrella/San Tan Line	Service between Buckeye and Queen Creek with a stop in Phoenix	61.4 miles	30 min.	120 min.	16	74-82 min.

Source: AECOM, 2018.

ES.3.2 How would the Service be Operated?

Commuter rail service differs from LRT service, which focuses on shorter corridors and more frequent service throughout the day. Commuter rail corridors are typically longer than LRT lines, which traditionally are fewer than 20 miles in length. In the Phoenix region, the two commuter rail cross-region corridors have total distances of 53.7 miles (Grand/Kyrene Line) and 61.4 miles (Estrella/San Tan Line).

Another difference is that commuter rail focuses on peak-period service. The commuter rail program proposed for the MAG region would have trains departing every 30-minutes during peak periods (5:00-7:30 AM and 3:30-6:30 PM) with three mid-day trains (at 10:00 AM, 12:00 PM, and 2:00 PM) and one evening train (8:00 PM). It is assumed that trains would leave from both ends of both corridors at these times, with the focus of providing service from the suburban stations to downtown Phoenix during the morning commute and from downtown Phoenix back to the suburbs during the evening commute.

Conceptual illustration of diesel locomotive for proposed regional commuter rail system.
Source: MAG

It should be noted that schedules will be refined in future phases of the study, as scheduling at this level of analysis is used to determine the number of trains that are required to operate the

service, and to begin to understand how passenger traffic would fit in with freight traffic on the proposed alignments.

ES.3.3 How Many Riders Would the Proposed Commuter Rail System Carry in 2040?

Ridership results in 2017 for the two cross-region lines forecast approximately 10,830 riders in 2040 for the Grand/Kyrene Line and 10,100 riders in 2040 for the Estrella/San Tan Line. The total system ridership is projected to be approximately 20,930 for both lines in 2040, as shown in Figure ES-1. Figure ES-2 shows potential ridership to extension areas of Wickenburg and San Tan Valley. Ridership projections are based on the level of service described in Section ES.3.2.

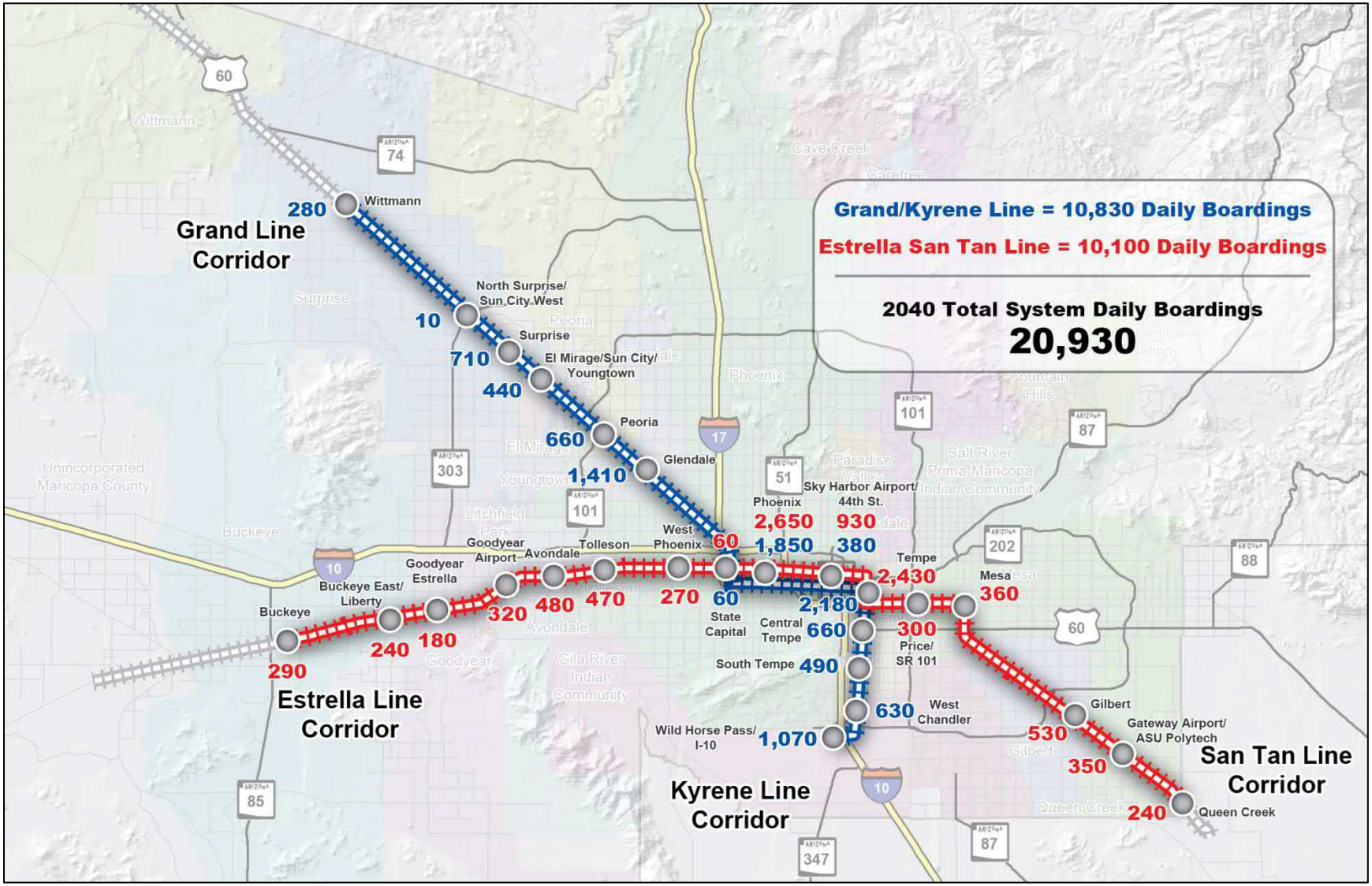
ES.3.4 What is the Cost of the Proposed Commuter Rail System?

This section presents the cost estimates for both cross-region lines of the proposed commuter rail system. It provides capital cost estimates, which include the cost to construct the commuter rail tracks and stations, procure vehicles, and make needed infrastructure improvements.

This section also presents the operations and maintenance (O&M) costs, which include the annual cost to operate commuter rail service in each of the two cross-region corridors based on the service plans developed for the project. Costs are based on the hours and miles of service developed in the operating plan, and the average costs of similar systems.

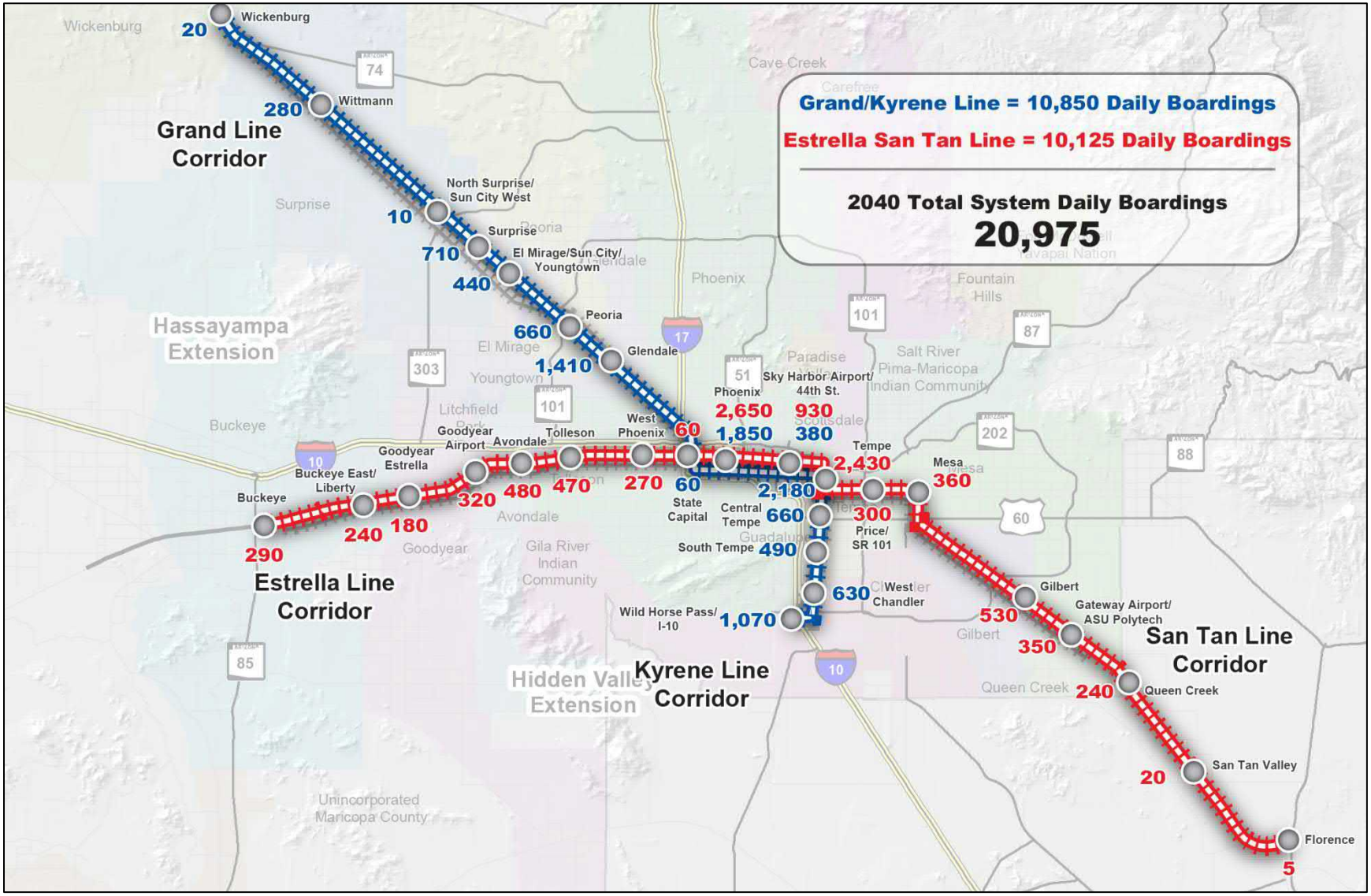
Three design options related to commuter rail service traversing Tempe and Gilbert have recently been discussed. Discussions have centered around an elevated bypass that would follow SR 202 and SR 101 around Tempe to the north or a trench along the existing alignment on the south side of Tempe, as well as a trench option in Gilbert. Table ES-2 shows the projected capital costs for the proposed commuter rail system, while Table ES-3 presents the annual O&M costs.

Figure ES-1: MAG Commuter Rail System 2040 Daily Boardings by Station



Source: AECOM, 2018.

Figure ES-2: MAG Commuter Rail System Potential Ridership to Extension Areas of Wickenburg and San Tan Valley



Source: AECOM, 2018.

Table ES-2: Capital Costs of Proposed Commuter Rail System

Interlined Alternative	Capital Cost	
	DMU	LHC
Grand/Kyrene Line Corridor (same for both vehicle types) (does not include Union Station, Commuter Rail Maintenance Facility, or vehicles)	$1.075 B ($23.4 Million/mile)	$1.075 B ($23.4 Million/mile)
Estrella/San Tan Line Corridor (same for both vehicle types) (does not include Union Station, Commuter Rail Maintenance Facility, or vehicles)	$1.160 B ($16.2 Million/mile)	$1.160 B ($16.2 Million/mile)
System Elements (includes Union Station and Commuter Rail Maintenance Facility)	$152 M	$152 M
Vehicles (15 trainsets)	$180 M	$135 M
System Total	**$2.566 B**	**$2.521 B**
Tempe Elevated Bypass Option (shows additional cost (4.5 miles at $100 million/mile), not vehicle dependent)	$450 Million	
Tempe Trench Option (shows additional cost (2.7 miles at $120 million/mile), not vehicle dependent)	$324 Million	
Gilbert Trench Option (shows additional cost (3.5 miles at $120 million/mile), not vehicle dependent)	$420 Million	

Source: AECOM, 2018.

Table ES-3: Annual O&M Costs of Proposed Commuter Rail System

Interlined Alternative	DMU		LHC	
	Train Miles	Train Hours	Train Miles	Train Hours
Annual Weekday Train Miles and Hours	465,579	20,910	465,579	20,910
Annual Weekend Train Miles and Hours	35,442	1,210	35,442	1,210
Total Annual Train Miles and Hours	501,021	22,120	501,021	22,120
Average Peer City Cost per Mile and Hour	$38.72	$901.54	$20.93	$683.54
Grand/Kyrene Line Corridor Total Cost	**$19.4 M**	**$19.9 M**	**$10.5 M**	**$15.1 M**
Annual Weekday Train Miles and Hours	532,338	20,910	532,338	20,910
Annual Weekend Train Miles and Hours	40,524	1,210	40,524	1,210
Total Annual Train Miles and Hours	572,862	22,120	572,862	22,120
Average Peer City Cost per Mile and Hour	$38.72	$901.54	$20.93	$683.54
Estrella/San Tan Line Corridor	**$22.2 M**	**$19.9 M**	**$12.0 M**	**$15.1 M**

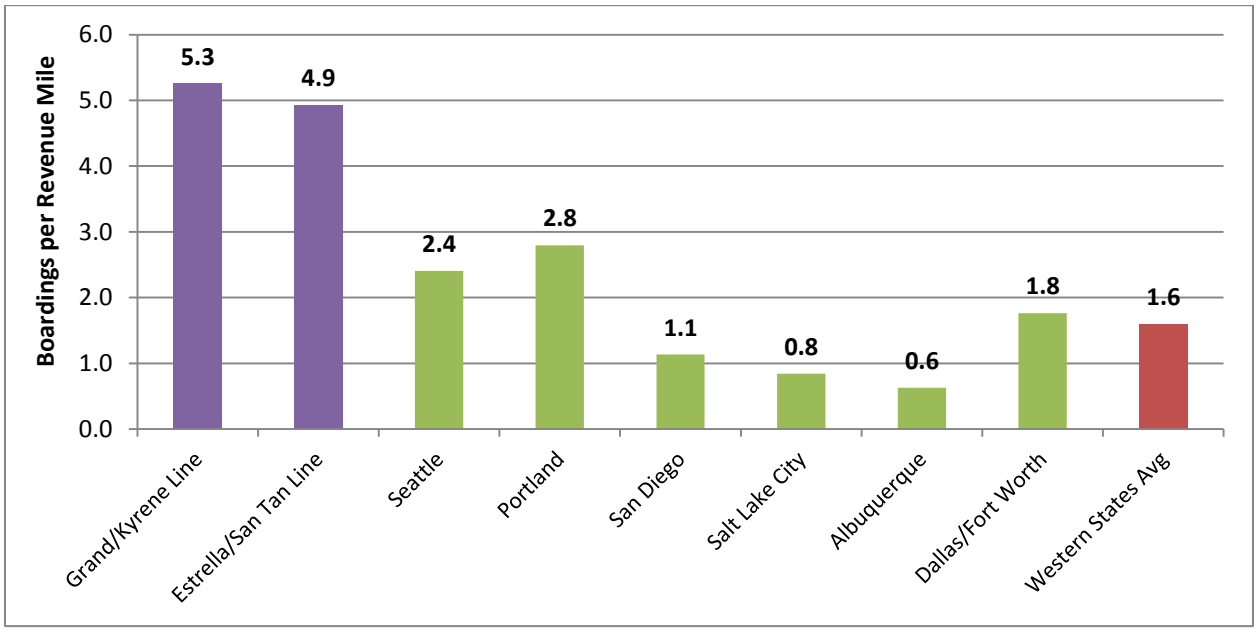
Source: AECOM, 2018.

ES.4 COMPARISON OF SYSTEM STUDY ALTERNATIVES

ES.4.5 Boardings per Revenue Mile

With approximately 10,100 daily riders forecast for 2040, the Grand/Kyrene Line would have approximately 5.3 weekday boardings per revenue mile while the Estrella/San Tan Line is expected see approximately 10,830 riders per day or approximately 4.9 weekday boardings per revenue mile. As shown in Figure ES-3, these figures are higher than other Western U.S. cities based on statistics from 2016. However, it should be noted that these represent 2040 ridership projections. These numbers would likely be similar to the other systems for the first few years of service. Additionally, as the other systems continue to grow, respective ridership numbers would likely increase as well.

Figure ES-3: Boardings per Revenue Mile Comparison



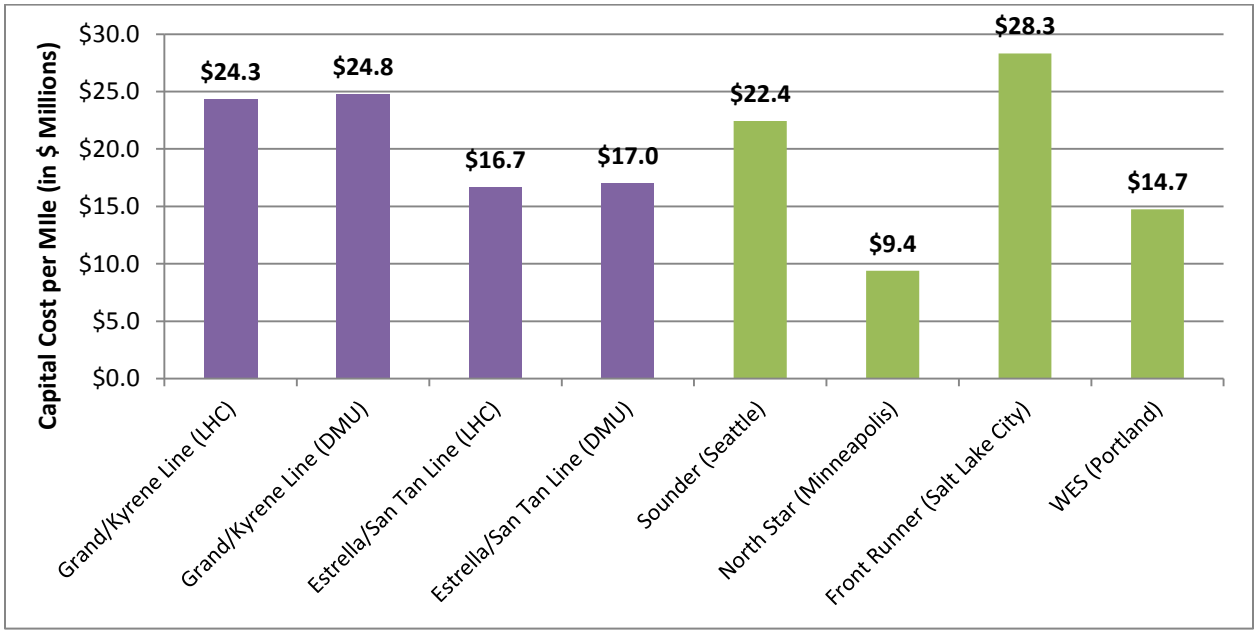
Source: AECOM, 2018; National Transit Database, Transit Profiles 2016.

ES.4.1 Capital Costs per Mile

The capital cost per mile for the proposed MAG commuter rail system is projected to be $24.8 million per mile using DMU vehicles or $24.3 million per mile using LHC vehicles for the Grand/Kyrene Line. The Estrella/San Tan Line is projected to cost $17.0 million per mile using DMU vehicles or $16.7 million per mile using LHC vehicles,

As shown in Figure ES-4, total capital cost per mile for the proposed MAG commuter rail system range from approximately $16.7 million per mile for the Estrella/San Tan Line to $24.8 million per mile for the Grand/Kyrene Line. The cost to build either line is comparable to other commuter rail systems built throughout the country in the last 15 years.

Figure ES-4: Capital Cost per Mile (in 2017 Dollars)



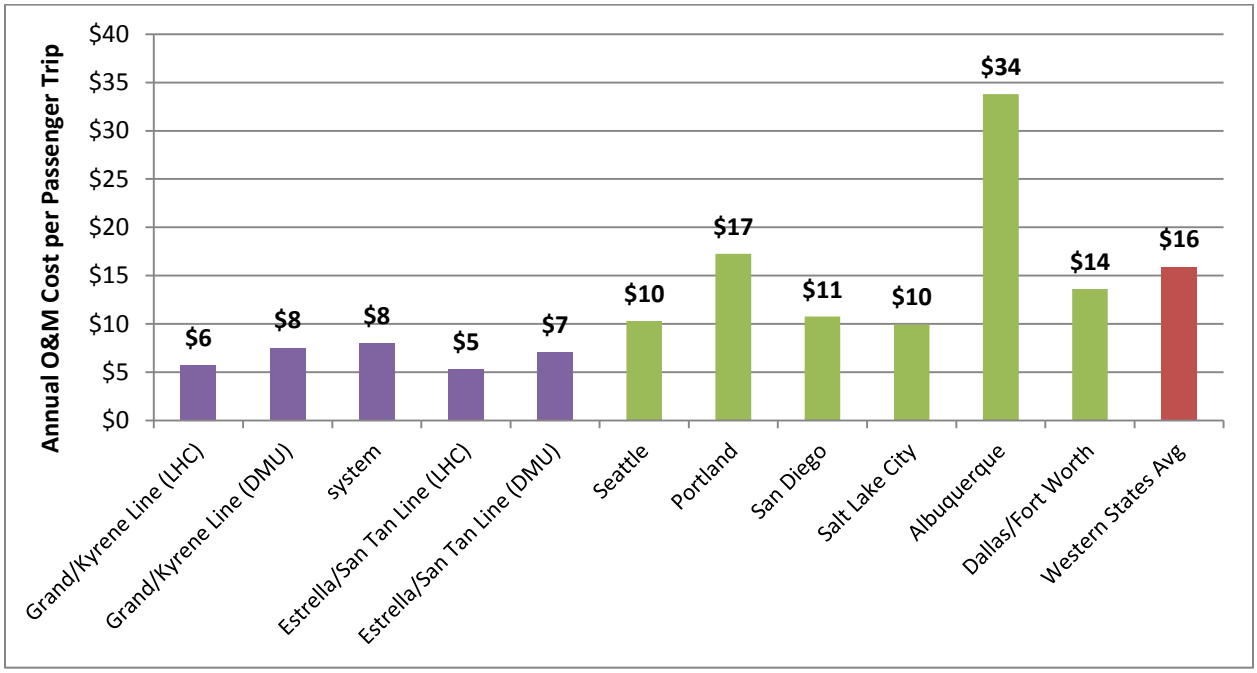
Source: AECOM, 2018.

The primary variable on per-mile capital costs for commuter rail systems is the quality of existing track and infrastructure and improvements needed to accommodate both commuter rail and freight rail traffic. For example, the North Star Commuter Rail system in Minneapolis is the least expensive of the peer city systems because that system is using an existing high-quality, double-track alignment. The FrontRunner system in Utah has a relatively high cost per mile because it was required to install a significant amount of new track.

ES.4.2 O&M Cost per Passenger Trip

According the National Transit Database, Transit Profiles 2016, the average annual O&M cost per passenger trip for commuter rail systems in the Western states is approximately $16 per passenger trip. Strong ridership forecasted for the MAG commuter rail system would result in lower O&M cost per passenger trip as compared to peer cities, as shown in Figure ES-5.

Figure ES-5: Annual O&M Cost per Passenger Trip



Source: AECOM, 2018; National Transit Database, Transit Profiles 2016.

ES.5 IMPLEMENTATION STEPS

For implementation of the commuter rail corridors recommended for the MAG region, a number of action items related to future coordination with the railroads, system governance and funding acquisition are required.

ES.5.3 What Agreements with the Railroads Would be Required to Operate Commuter Rail Service?

As envisioned, commuter rail service in the MAG region would share right of way currently owned by the Union Pacific Railroad and BNSF Railway, utilizing the same track where possible. To enable this, a rail access agreement of some type would be required. Unless conditions change, a Capacity Rights Agreement is expected to be the likely avenue for implementing commuter rail service along the System Study Update corridors. Capacity Rights Agreements may be a real estate interest such as a lease or easement, or a contractual or license right. The purchaser is not acquiring the line, but rather is only acquiring the right to operate a specified number of trains. Further coordination with the Union Pacific Railroad and BNSF Railway is critical to determining the appropriate approach to contractual relationships to operate commuter rail. The railroads' projections of future freight activity along the corridors would need to be integrated into the overall agreement.

ES.5.4 Who Would Operate the Commuter Rail Service?

One option for the operation of commuter rail service would be to contract with a private operator. Operations could be contracted to an independent contractor, such as Amtrak or a private contractor like Herzog, which operates several commuter rail systems throughout the U.S., including the New Mexico Railrunner, TRE in Dallas/Fort Worth, and the San Diego

Coaster. An owner railroad – the BNSF Railway or Union Pacific Railroad – could also operate passenger rail service under the terms of a Capacity Rights or other agreement. As of 2017, BNSF Railway operates passenger service for three commuter rail systems, including the Metra Chicago-Aurora Line in Illinois, the Sounder in Seattle, and the Northstar in Minnesota.

ES.5.5 How Would Regional Commuter Rail Service be Governed?

One of the most significant issues to be resolved for the implementation of commuter rail in the MAG region is the question of who would be the responsible party for managing, designing, constructing, and operating the system. Implementation of a commuter rail system will require a governance structure that reflects the financial, political, and representational patterns of the areas served by commuter rail.

Conceptual illustration of DMU locomotive for proposed regional commuter rail system. Source: MAG

Table ES-4 summarizes the potential advantages and disadvantages of each type of governance structures under consideration.

Table ES-4: Summary of Advantages and Disadvantages of Governance Structures

Governance Structure Option	Potential Advantages	Potential Disadvantages
Regional Transit Authority/ District (Multi-Modal)	• One transit service provider would create greater efficiencies and coordination between all transit modes to help ensure integrated regional system.	• May lack focus. • May be cumbersome political process to expand taxing authority to outlying areas. • Would present a learning curve for Valley Metro to manage a rail program.
Regional Rail Authority/ District (Single-Purpose)	• Single focus on commuter rail and FRA. • With creation of new taxing district, all funding partners would be equally represented. • Could be added to Valley Metro organizational responsibilities.	• Would require close coordination with Valley Metro to ensure integrated regional transit system. • Adds another entity to the mix. • If formed by popular vote, would be unable to serve jurisdictions which do not vote to join. • Cost and start-up time may be greater.
Joint Powers Authority	• Would provide flexibility in the formation of governing body. • Does not require legislative authority. • If Valley Metro mission is expanded, JPA will benefit from similar rail expertise with LRT.	• May result in potential overlapping responsibilities. • Each participating entity would be required to secure its own funding source. • May start “turf war” between entities. • Would present a learning curve as LRT and commuter rail are very different. • Would require “unwinding provisions” if one or more forming entities desire to withdraw.

Table ES-4: Summary of Advantages and Disadvantages of Governance Structures

Governance Structure Option	Potential Advantages	Potential Disadvantages
Division of State Department of Transportation	• A state agency could apply for funding that a local entity may not be able to obtain. • Could empower single railroad negotiator and greater coordination for unified statewide passenger rail service.	• ADOT has not been an operator of systems. • May rely on state appropriations. • May bring into question equity. • Increases state influence over local/regional decisions. • Typically State DOTs are focused on Highway projects and issues.
Division of Metropolitan Planning Organization	• MAG could continue its role as lead implementation agency and pass-through funding entity.	• Could require greater coordination among existing transit authorities. • Northern Pinal County is part of CAAG (not within MAG). Unless limited to commuter rail operations, Pinal County jurisdictions would be involved in other modal planning for the region. • Would require expansion of MAG charter. • Would require establishment of new operational division within MAG.

Source: AECOM, 2018.

ES.5.6 What Funding Options are Available to Implement Commuter Rail?

The initial step to develop a funding implementation strategy is to gauge possible or probable funding options at the federal, state and local levels. The policy positions of the involved agencies and possible implementation responsibilities should be thoroughly considered, as should those of other partners included in the project area. Frequently, the focus is on funding sources for the capital investment to implement service. Ultimately, however, the more critical financial issue at the local level is the annual requirement for ongoing O&M costs.

Table ES-5 lists the federal, state, local and private funding sources and their relative viability for use in the System Study corridors.

Table ES-5: Federal, State, Local and Private Funding Sources

Fund Source	Capital and/or Operations
Federal Transit Administration Section 5307	Supports transportation capital costs including preventive maintenance
Federal Transit Administration Section 5309 New Starts	Supports transportation capital
Congestion Mitigation and Air Quality (CMAQ) Funds	Supports transportation capital uses only
Surface Transportation Block Grant Program (STBG, formerly Surface Transportation Program) Funds	Supports transportation capital uses only
Federal Railroad Administration Section 130	Supports transportation capital uses only, primarily for the use of improving grade crossings.

Federal Railroad Administration High Speed Intercity Passenger Rail (HSIPR) Program	Supports Consolidated Rail Infrastructure and Safety Improvements, Federal-State Partnership for State of Good Repair, and Restoration and Enhancement Grants uses
Federal Railroad Administration Positive Train Control Funding	Supports commuter railroads with positive train control (PTC) implementation
Highway User Revenue Fund (HURF) (including Vehicle License Tax or VLT)	Supports transportation capital uses only
Statewide Transportation Acceleration Needs (STAN) Account	Supports transportation capital and/or operations
New Dedicated Statewide Transportation Funding (e.g. statewide tax)	Supports transportation capital and/or operations
Vehicle Miles Travelled (VMT) tax	Supports capital and/or operations
Maricopa County Transportation Excise Tax (Sales Tax)	Supports capital and/or operations
Payroll Tax	Potentially support capital and/or operations
Motor Vehicle Sales Tax	Potentially support capital and/or operations
Vehicle Rental Tax	Supports capital and/or operations
Local Gas Tax	Potentially supports capital and/or operations
Vehicle License Tax (VLT) by District	Supports capital and/or operations
Property Taxes	Supports capital and/or operations
Tax Increment Financing (TIF)	Supports capital and/or operations
Public Value Capture: Benefits Assessment Districts	Potentially support capital and/or operating uses
Public Value Capture: Tax Increment Financing	Potentially support capital and/or operating uses
Public-private partnerships (P3)	Potentially support capital and/or operating uses

Source: AECOM 2018.

ES.5.7 What Near-Term Implementation Steps are Needed?

Table ES-6 summarizes the near-term implementation steps, including potential responsible parties, partners, and timeframe.

Table ES-6: Summary of Near-Term Implementation Steps

Item	Responsible Party	Partners	Timeframe
1) Periodic Ridership Forecasting Updates	• MAG	• Local Jurisdictions	Ongoing
2) Coordination with Railroads	• ADOT • MAG • Railroad(s)	• Local Jurisdictions • Valley Metro	Ongoing
3) Local Planning Efforts	• Local Jurisdictions	• MAG • ADOT	Ongoing
4) Address Enabling Legislation regarding Liability and Indemnification	• ADOT • MAG	• MAG • Railroad(s)	2018-2022
5) Coordination of Infrastructure Improvements with the Railroads, ADOT and Local Jurisdictions	• MAG • Local • ADOT	• Railroads • Valley Metro	Ongoing

Table ES-6: Summary of Near-Term Implementation Steps

Item	Responsible Party	Partners	Timeframe
6) Identify Funding Commitments	• MAG • ADOT • Legislature	• Local Jurisdictions	2018-2022
7) Develop and Implement Governance Plan	• MAG • ADOT	• Valley Metro • Local Jurisdictions	Following identification of local funding commitments
8) Initiate Process for Federal Funding	• MAG	• Local Jurisdictions	Following identification of local funding commitments
9) Preserve Future Options	• MAG • ADOT • Local Jurisdictions • Regional Joint Powers Authority	• Local Jurisdictions • Railroad(s) • MAG • CAG • ADOT	Ongoing

Source: AECOM, 2018.

ES.5.8 What Long Term Implementation Steps are Needed?

The identification of funding commitments and determination of the appropriate governance structure for commuter rail, which are likely to influence each other, will set the stage for moving into the next level of investment in commuter rail in the region. With progress on these key steps, the region will be in a position to move forward on other recommendations from the System Study Update, as described below.

- Formalize partnership with the railroads.
- Secure sources of funding including federal, state, regional and local public funding, as well as private sector participation.
- Design, construct, and operate initial commuter rail system.
- Continue planning to develop seamless transportation system and meet regional sustainability goals.

ES.6 BNSF COORDINATION

Subsequent to the completion of the System Study Update, BNSF evaluated the proposed commuter rail operations plan and provided capital requirements for the operation of passenger rail service within the existing BNSF freight railroad right-of-way. There do not appear to be any fatal flaws in terms of operating passenger rail service within the BNSF freight rail right-of-way at this time. Infrastructure needs, costs, and passenger rail operations (including travel times) will continue to be revisited at each subsequent stage in this planning process. Coordination with BSNF will also in subsequent stage of the planning process.

1.0 STUDY OVERVIEW

1.1 Introduction

The Phoenix metropolitan area has experienced unprecedented population growth over the last several decades, impacting all aspects of community development and straining the capacity of the Valley's transportation system. Today the regional population is 4.7 million (as of spring 2018), and that number is projected to be 6.0 million in 2040. As the population in the Maricopa County and northern Pinal County region continues to grow, more residents will be commuting along already congested roadway networks that are only expected to worsen in the years ahead. To address this future travel demand and provide faster and more reliable travel options for commuters, a system of commuter rail corridors radiating from downtown Phoenix to the northwest, west and south/southeast are being investigated. This potential network of commuter rail corridors, as shown in Figure 1-1, is the subject of this Regional Commuter Rail System Study Update.

This chapter provides an overview and background information on the need and potential benefits of commuter rail and the planning effort that was undertaken to produce this Study. The chapter is organized as follows:

- Section 1.2 provides the history of commuter rail planning in the region that led to the development of the original Commuter Rail System Study and this subsequent update.
- Section 1.3 summarizes the purpose of this System Study Update.
- Section 1.4 describes the need for a regional commuter rail system and provides information on commuter rail technology.
- Section 1.5 summarizes the potential benefits of implementing commuter rail, including proposed goals to guide further development of a commuter rail system in the region.
- Section 1.6 describes the planning process through which this Commuter Rail System Study Update was developed.

Current BNSF Railway Grand Avenue Line in downtown Glendale, AZ. Source: MAG.

- Section 1.7 describes the organization of the remainder of this report.

1.2 Background

In 2003, the Maricopa Association of Governments (MAG) completed the High Capacity Transit (HCT) Study that recommended a transit network designed to meet the travel demand needs of the region in the forecast year of 2040. A key finding of this study was that commuter rail corridors may potentially serve a critical function in addressing future travel needs in the region. In 2008, following the HCT Study, MAG developed the Commuter Rail Strategic Plan to provide a framework and specific steps for implementing commuter rail in the region. The Strategic Plan

developed a commuter rail system concept that would radiate from downtown Phoenix oriented around the five existing freight rail lines in the study area including:

- Grand Line (formerly Grand Avenue) Corridor (BNSF Railway)
- Estrella Line (formerly Yuma West) Corridor (Union Pacific Railroad)
- San Tan Line (formerly Southeast or SE) Corridor (Union Pacific Railroad)
- Kyrene Line (formerly Tempe) Corridor (Union Pacific Railroad)
- Chandler Corridor (Union Pacific Railroad)

These five corridors were evaluated in the MAG Regional Commuter Rail System Study completed in 2010.

Since the completion of the 2010 Study, demographic and land use projections changed throughout the MAG region due in part to the economic downturn in the late 2000's. This helped to change where development has occurred over the past decade and where growth is now expected to occur in the future. Further, light rail transit (LRT) was relatively new to the Phoenix area at the time of the 2010 Study and has since been further expanded due to its success.

Current Union Pacific Railroad Estrella Line over the Agua Fria Bridge in Avondale, AZ. Source: MAG.

Since 2010, each of the corridor names have changed to more accurately reflect the geographic areas/sub-regions, with the Grand Avenue Corridor becoming the Grand Line, the Yuma West Corridor becoming the Estrella Line, the Tempe Corridor becoming the Kyrene Line, and the Phoenix Subdivision SE Corridor becoming the San Tan Line. Finally, the Chandler Corridor has been removed from consideration for a variety of reasons. Based on details from the 2010 analysis, the Chandler Branch and San Tan Line were found to compete with each other for ridership in the regional travel model. It also competed with ridership on the adjacent Kyrene Line to a lesser extent. In addition, the Chandler Branch also became difficult to interline and model as it is an 'Odd 5th line' with no corollary line in West Valley. Lastly, the City of Chandler requested in 2010 that the Chandler Branch not be included in System Plan final recommendations as they envisioned HCT on the parallel Arizona Avenue

1.3 Purpose of the System Study Update

The System Study Update builds on the work of the 2010 Study by updating the corridor existing conditions, rail operations assumptions, capital cost considerations, and other necessary implementation elements required to initiate commuter rail service in the MAG region. The System Study Update concludes with recommendations for an optimized commuter rail system and potential future extensions.

1.4 Need for a Commuter Rail System

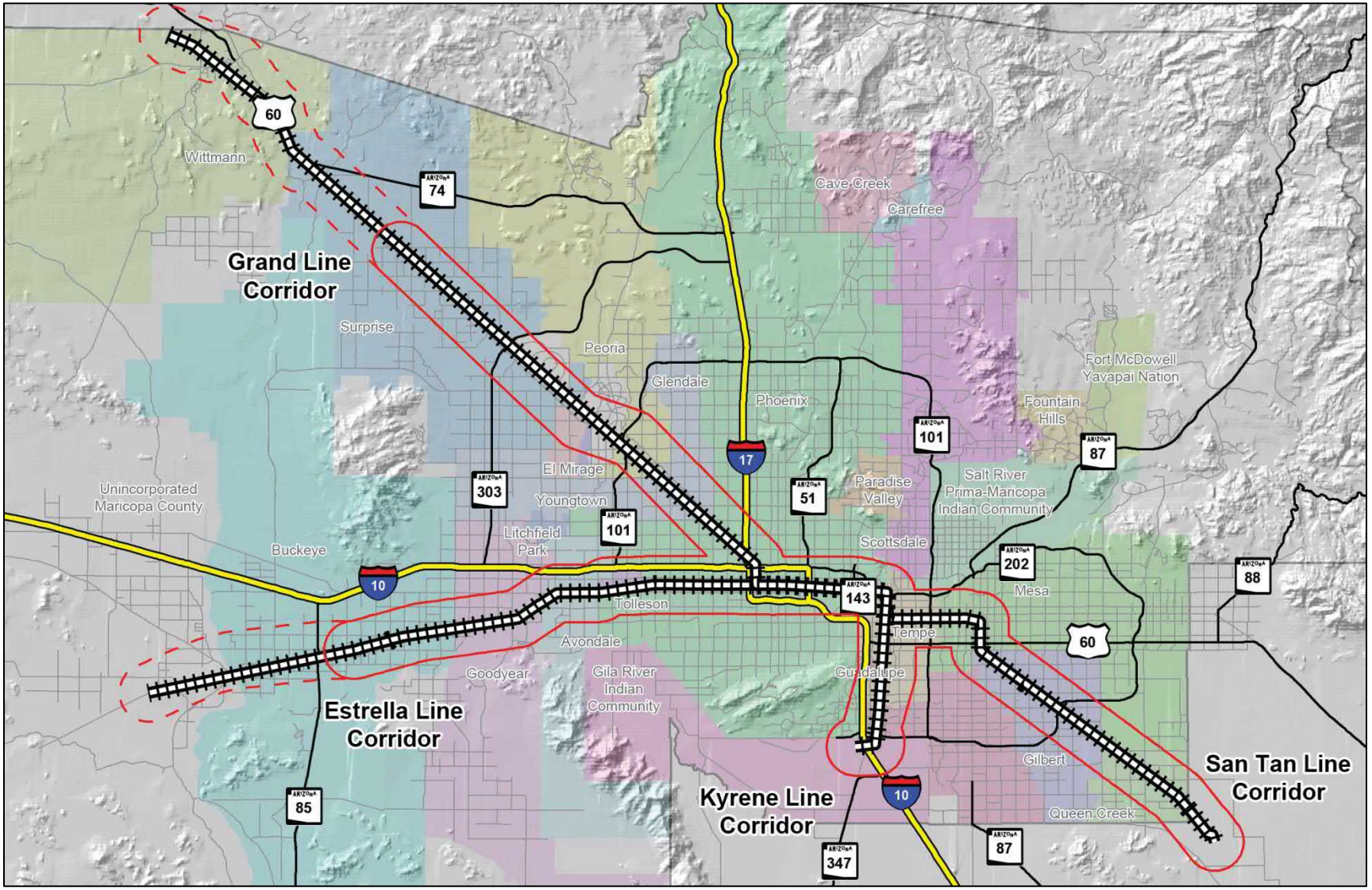
Demands on the MAG region's freeway system have resulted in increased travel time for commuters, as well as less predictable travel times that vary with congestion levels. These

problems will only worsen in the future as the region continues to grow. Recent and planned public transportation investments in bus and LRT will help to mitigate these impacts, but cannot do so alone. Commuter rail service in the MAG region would complement and build upon existing and planned bus and LRT service. Specifically, commuter rail service would (1) offer an alternative transit mode that has the advantage of using existing rail corridors, (2) use a transit technology that is appropriate for longer distance travel, and (3) allow for transfers to other transit systems.

Commuter rail systems are generally used in congested urban areas to improve travel time, mitigate congestion, add convenience, and provide an alternative means of travel – particularly in times of increasing energy prices. Commuter rail trains typically provide service between suburbs and urban cores for the purpose of reaching employment, special events, and intermodal connections. Commuter rail trains are optimized for maximum passenger capacity, allowing for approximately 140 passengers per car, and are equipped with comfortable seating and passenger amenities. Designed to primarily meet the needs of regional commuters in the AM and PM peak travel times, commuter rail service typically occurs at lower frequency than LRT. The distance of a typical commuter rail corridor is also longer than that of LRT, ranging from 30 to 50 miles, with passenger stations generally spaced 5 to 10 miles apart. See Figure 1-2 for examples of commuter rail trains.

Conceptual photo simulation of the tracks to the south of Phoenix Union Station where proposed commuter rail trains will pick up and drop off passengers destined for downtown Phoenix. Built in 1923, over 20 passenger trains per day used the depot as recently as the 1950s. In the above illustration, platforms have been added between tracks to better depict the station area. However, upon completion, there will be passenger amenities that will likely include shade canopies, bike racks or lockers, wind screens, schedule information, and ticket vending machines. Source: MAG.

Figure 1-1: MAG Regional Commuter Rail System Corridors



Source: AECOM, 2018.

Figure 1-2: Commuter Rail Train Examples

Locomotive Hauled Coach: Rail Runner Express Commuter Train; Albuquerque, NM
Source: MRCOG/HDR.

Diesel Multiple Unit: SMART line connecting Santa Rosa and downtown San Rafael, CA
Source: SMART.

1.5 Potential Benefits and Goals of Commuter Rail

There are a series of potential benefits associated with commuter rail service as described below.

Improved mobility, particularly reduced travel time for the commuters. The ability of a commuter rail system to improve mobility throughout the region, especially during peak hours of congestion, can result in shorter trips for commuters as compared with single-occupancy vehicles. In addition, commuter rail service can solidify connections between suburban population growth areas and key destinations by providing a faster and more efficient travel option. Improved travel options can allow families and individuals to choose more freely where to live, knowing that they can commute to work, special events, or other destinations reasonably. Proximity to commuter rail or other transit options may be a significant amenity for many residents and employers who would benefit from improved mobility and connectivity.

Higher quality commuter experience. As previously mentioned, a trip on a commuter rail train can reduce personal vehicle trips and daily commute times. Commuter rail service and stations can be designed to meet passenger needs, reduce individual carbon footprints, and provide a pleasant environment for travel during what is normally a time of peak congestion and delays.

Current Union Pacific Railroad San Tan Line in Gilbert, AZ.
Source: MAG.

Connections to employment or activity centers for everyday life. Commuter rail service can efficiently connect passengers directly to employment or activity centers. Activity centers may include employment areas, medical facilities, educational institutions, shopping, or special events centers. In evaluating the feasibility of

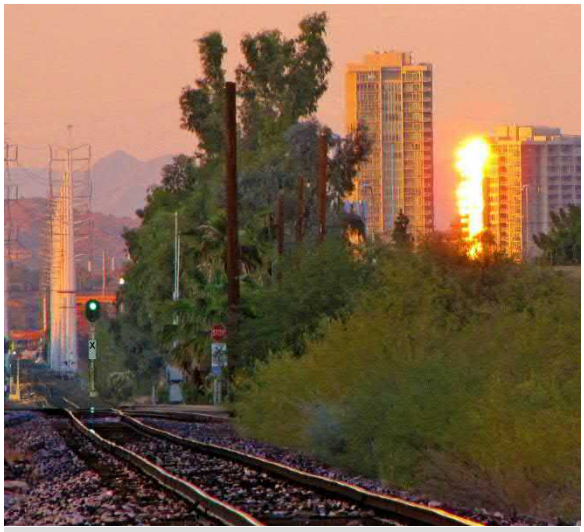
commuter rail corridors, MAG is considering the overall impacts on connectivity throughout the region, including linkages to other modes for travel. These links may include connectivity to other commuter rail service lines, park-and-ride facilities, and other transit modes such as local or regional bus service and LRT.

Opportunities to support local development in station areas. A well-designed approach to station development can assure that commuter rail is a neighborhood asset and supports local businesses throughout the corridor. Transit-oriented development may provide opportunities for mixed uses and public-private partnerships to support local economic development goals. Local jurisdictions may view commuter rail as an opportunity to facilitate the development of underutilized parcels located along commuter rail corridors.

The process of defining and evaluating commuter rail system corridors builds on previous work in the MAG Commuter Rail Strategic Plan that established the goals for commuter rail in the region. The Strategic Plan outlined a series of five goals to serve as a guiding framework for future commuter rail planning and implementation in the region:

- **Goal 1: Employ Commuter Rail to Shape Regional Growth**
- **Goal 2: Improve Transportation Mobility Opportunities by Implementing Commuter Rail**
- **Goal 3: Provide a Seamless and Cost Effective Commuter Rail Option**
- **Goal 4: Promote Sustainability through the Implementation of Commuter Rail**
- **Goal 5: Increase Public/Private Cooperation to Implement Commuter Rail**

This System Study Update continues to be guided by these five overall project goals and was used in the development of corridor evaluation criteria, as described in more detail in Chapter 3.



Current Union Pacific Railroad Kyrene Line in Tempe, AZ. Source: MAG.

1.6 System Study Update Process

This study was conducted to update existing conditions in the region and advance the discussion on some of the major implementation aspects of the project including operational information including service levels, geographies, and infrastructure requirements; potential governance structure; and potential funding mechanisms to construct and operate the system.

1.7 Organization of the System Study Update

The remaining chapters of the Regional Commuter Rail System Study Update are organized as follows:

Chapter 2: Existing and Future Conditions. Describes existing and future conditions along each of the four corridors. Includes a summary of demographics, land use, the relationship of commuter rail in existing planning documents, railroad conditions, highway characteristics, transit service and corridor travel patterns.

Chapter 3: Alternative Development and Evaluation. Presents commuter rail system alternatives, including service plans, ridership forecasts, and costs.

Chapter 4: Implementation Strategy. Presents the recommended commuter rail system prioritization and implementation phasing, reviews the necessary future coordination with the railroads, governance options, funding options, and implementation steps.

Chapter 5: Liability, Insurance, and Indemnification. Presents information related to liability, insurance, and indemnification issues surrounding the operation of passenger rail on freight railroad infrastructure.

Chapter 6: References. Provides a list of sources used in the System Study Update.

Appendix A: Methodology for Cost Estimating. Describes the assumptions used to develop capital and operating and maintenance (O&M) costs for each corridor.

Appendix B: Evaluation of Potential Commuter Rail Corridor Extensions. Presents existing and future conditions for potential future commuter rail corridor extensions. Evaluates ridership potential for each potential extension and compares results between extensions.

Appendix C: System Study Station Target Area Evaluation. Describes rationale for selection of station target areas and provides station target area screening results. The evaluation focuses on station target areas within the East Valley corridors.

Appendix D: Draft Commuter Rail Design Concepts. Illustrates potential design concepts and infrastructure requirements for commuter rail in each corridor. These conceptual designs have not been updated since the 2010 Study.

Appendix E: Railroad Conditions and Issues. Illustrates potential design concepts and infrastructure requirements for commuter rail in each corridor with consideration for freight operations, stations, passing sidings, at-grade crossings, bridges, and other physical characteristics of each corridor.

Appendix F: Commuter Rail Vehicle Technology. Summarizes characteristics of commuter rail transit technology, including vehicle features, technology used in other systems, potential acquisition options and average costs.

Appendix G: Commuter Rail Operations Plan. Describes service plans for each commuter rail corridor, including service levels, travel time, fleet size, and commuter rail maintenance philosophy.

Appendix H: Commuter Rail Maintenance Facility Description and Evaluation. Presents the requirements for commuter rail maintenance and layover facilities and summarizes considerations for advance planning of these facilities.

Appendix I: Commuter Rail Governance and Operating Structures. Describes and evaluates potential governance strategies for the MAG commuter rail system.

Appendix J: Conceptual Memorandum of Understanding. Illustrates a typical Memorandum of Understanding (MOU) for a railroad partnership that would address key points of negotiation such as compensation, capacity improvements, and level of service.

Appendix K: Insurance and Indemnity Language. Presents typical insurance and indemnity language.

Appendix L: Potential Grade Separation Locations. Provides a summary of potential grade separation locations along the four corridors under evaluation in the System Study Update.

Appendix M: One-on-One Meeting Summaries. Provides summaries of one-on-one meetings held between MAG Project Team and the local communities located along the proposed alignments of the System Study Update.

Appendix N: BNSF Railway Operations Report. Presents the BNSF freight rail operations report for the Grand Line Corridor.

2.0 EXISTING AND FUTURE CONDITIONS

2.1 Introduction and Methodology

2.1.1 Introdcution

The purpose of this chapter is to provide an updated overview of current and projected demographic and travel characteristics within the commuter rail corridors evaluated in the 2010 MAG Commuter Rail System Study (2010 Study). The focus is on how the communities along the corridors are expected to evolve over the next several decades, the implications for transportation demand and mobility, and the multimodal options for meeting demand and improving service in the region.

The corridors being evaluated include railroads operated by both BNSF Railway (BNSF) and the Union Pacific Railroad (UPRR). The four corridors analyzed include Grand Line (formerly Grand Avenue) (BNSF); Estrella Line (formerly Yuma West) (UPRR); San Tan Line (formerly Phoenix Subdivision Southeast) (UPRR); and Kyrene (formerly Tempe) (UPRR). The System Study Update Planning Area is defined as a two mile buffer surrounding each of the four existing railroad lines, as shown on Figure 2-1.

This chapter is organized as follows:

- Section 2.2 provides new land use and transportation plans that are regional in nature or that would apply to each of the corridors that are being evaluated in the System Study Update.
- Section 2.3 provides a summary of the major changes that have occurred in the region since the 2010 Study. These changes lead the project team to the updates shown throughout the remainder of Chapter 2.
- Section 2.4 provides a summary of the findings related to existing and future conditions within each potential commuter rail corridor in order to compare results between corridors.
- Sections 2.5 through 2.8 summarize existing and future conditions for the Grand Line Corridor (Section 2.5), Estrella Line Corridor (Section 2.6), San Tan Line Corridor (Section 2.7), and Kyrene Line Corridor (Section 2.8). The following elements are described for each of the corridors:
  - Demographics;
  - Land Use;
  - Planning Context;
  - Railroad Characteristics;
  - Highway Characteristics;
  - Transit Service; and
  - Travel Patterns.
- Section 2.9 presents potential future short- and long-term corridor extensions to the four current commuter rail corridors. Appendix B: Evaluation of Potential System Study Commuter Rail Corridor Extensions, provides greater detail on each extension.

2.1.2 Methodology

Demographics

Understanding historic and projected population and employment growth patterns is critical to designing a regional commuter rail system that meets existing and future travel demands. The demographic evaluation reviews regional population and employment characteristics associated with each of the four commuter rail corridors. Both existing and future population and employment data (collected and disceminated by MAG) is analyzed based on Transportation Analysis Zones (TAZs) found in each corridor. Corridor limits are defined by a two-mile buffer extending from each rail line and includes TAZs within the buffer. TAZs were grouped together based on jurisdictional boundaries in order to understand the growth trends in each corridor.

Land Use

Land use characteristics contribute to the success or failure of transportation systems and are necessary to evaluate as part of this system study. It is important to identify land uses that are compatible with transit service, such as mixed-use development, as they will assist in the success of commuter rail service. The land use evaluation identifies existing and planned land uses (as provided by MAG) within two-miles of each rail line, as well as regional activity centers that could be considered destination points.

Planning Context

The evaluation of the planning context through the summary of local General Plans and Transportation Plans is also an important aspect of the system study. It is important to understand the relationship between the local municipalities and the regional transit network, and how these communities are planning to deveop around potential future station locations.

Railroad Characteristics

The characteristics and existing conditions of the railroads are significant in understanding the feasibility of implementing commuter rail service on the existing tracks located in each of the four corridors. This section summarizes the existing conditions of the tracks and provides an inventory of major railroad facilities, identified by milepost (MP), located throughout each corridor. This evaluation will also identify any Quiet Zones located in each corridor. The Federal Railroad Administration (FRA) defines Quiet Zones as a section of rail line that contains one or more consecutive public crossings at which locomotive horns are not routinely sounded.

The Operations Plan, further described in Appendix G, for each respective corridor will further analyze the existing conditions of each railroad as they relate to improvements needed to implement commuter rail service.

Highway Characteristics

Each potential commuter rail corridor identified in this study corresponds to an adjacent or parallel highway corridor that offers a roadway travel alternative for commuters. This section describes the existing characteristics of each highway corridor as well as any future planned improvements.

It is also important to understand the travel time, level of congestion and expected increase of congestion on these roadways over time to determine the potential passenger demand of and ultimate need for future commuter rail service in corresponding travel corridors. To provide a

general indicator of highway congestion throughout each corridor, current travel characteristics between downtown Phoenix and each respective corridor end-of-line were calculated using the MAG Regional Travel Demand Model using TransCAD. Levels of service indicate the amount of traffic congestion on a given section of road at a given time. This is fundamentally related to the amount of traffic that a roadway serves compared to the roadway's capacity; the closer the volume is to the roadway's capacity, the more congested the segment will be. For the purposes of categorizing congestion levels, this model can assign volumes greater than capacity which is measured by volume over capacity, or V/C. Congestion levels are assigned as follows:

- Little to No Congestion – V/C < 1;
- Moderate Congestion – V/C = 1 – 1.2; and
- Severe Congestion – V/C > 1.2.

Travel times were also determined for the years 2015 and 2040 for both the AM and PM peak periods. Typically detailed traffic operations analysis relies on peak hour data; however, the MAG model only provides information for the more aggregate AM and PM peak periods (6:00-9:00 AM and 3:00-6:00 PM, respectively). The peak hour within those peak periods is likely to have the same or worse congestion levels than this evaluation will show. Each set of travel times represent the peak direction for that time period (e.g., inbound to downtown Phoenix in the AM and outbound in the PM).

Travel times were also shown for both High-Occupancy Vehicle (HOV) lanes where they currently exist or where they are planned (2040) and for the off-peak to provide a comparison. Off-peak is not included in the model, so these were derived using posted speed limits for each of the segments to derive a free-flow speed.

Transit Service

This section provides a summary of existing and planned transit services that are included in the fiscally constrained Regional Transportation Plan (RTP). The types transit services that are currently provided or are planned for future implementation in each corridor are described below and include:

- Fixed Route Bus;
- High Capacity Transit; and
- Transit Passenger Facilities.

Fixed Route Bus

Fixed route bus service is comprised of local bus, circulators, regional connectors, and express bus service, as described below:

- Local Bus: Local bus service provides mainline transit service on the region's one-mile street network.
- Circulator: Circulators are run by individual cities and provide residents with access to activity centers within the community.
- Regional Connector: Regional connectors provide both fixed stop as well as flexible stop service from the rural areas of Maricopa County to the urban areas.

- Express Bus: Express bus service provides weekday peak period commuter service between cities in the MAG region and downtown Phoenix via the freeway network and existing and proposed high occupancy vehicle (HOV) facilities.

High Capacity Transit

High capacity transit (HCT), including light rail transit (LRT), refers to service that can carry large numbers of passengers per mile, per hour, typically at higher travel speeds than local buses. HCT service generally avoids congestion by operating in a fixed guideway that is separate from on-street traffic. The MAG region opened its 20-mile starter LRT line in 2008. Today, after two extensions, the 26.3-mile system serves 35 stations. The line begins in Phoenix at the 19th Avenue/Dunlap station before turning south on 19th Avenue and east on Camelback Road. The line then turns south onto Central Avenue into Downtown Phoenix. At Roosevelt, the line splits into two one-way segments on First Avenue south before turning east on Jefferson Street, and north on central after traveling west on Washington Street. After the one-way tracks rejoin east of 24th Street, it continues past Sky Harbor Airport, then turns southeast crossing into Tempe. The line crosses Tempe Town Lake, turns east along Mill Avenue where it then joins Apache Boulevard to Main Street in Mesa where it ends at Mesa Drive. There area several additional expansions planned in the coming years.

Bus Rapid Transit (BRT) is enhanced bus service that offers many of the same amenties as rail service to provide faster travel times and improved travel time reliability and enhanced passenger comfort at stations, but at a lower cost than rail service. There is currently no BRT service in the MAG region, but the City of Phoenix is evaluating it in several corridors.

Transit Passenger Facilities

Transit passenger facilities refer to both transit centers and park-and-ride facilities. While both facilities are identified as stops along specific bus routes, transit centers serve multiple routes acting as a transfer point between them. Park-and-ride facilities are stops along specific routes where passengers can park automobiles for an extended period of time while accessing the regional transit network.

Travel Patterns

Travel patterns are largely based on the demographics growth trends of each corridor and are important for understanding how commuter rail can serve existing and future travel markets. To assess travel patterns, home-based work (HBW) trips were analyzed from the MAG TransCAD Model for 2015 and 2040. Home-based work trips were chosen because they take place regularly and typically occur during congested periods of the day. HBW trips originating within each corridor were analyzed by overall destinations within the MAG region. Destinations that were identified as a part of this analysis include:

- Within each corridor;
- Within the System Study Planning Area; and
- Outside the limits of the System Study.

The System Study Planning Area is defined as the two mile buffer surrounding each of the four existing railroad lines defined as part of this analysis.

2.2 New Information Included in the Update

This chapter is an update to the existing conditions analysis that was originally authored for the 2010 MAG Commuter Rail System Study. This effort will document existing conditions and future demographic, land use, and transportation system projections. Many communities throughout the region have updated their general plans and/or transportation plans since the 2010 Study was completed.

2.2.1 Planning Context

A new subsection has been added to each corridor evaluation, titled Planning Context. The project team reviewed General Plans and transportation plans that have been updated since the 2010 Study for municipalities that are located along each corridor. Many of these plans include the Commuter Rail line that traverses the municipality, and in general these municipalites have begun to plan for it by adding transit oriented development (TOD) land use zones around future station locations and other transit supportive policies. Several plans that are more regional in nature are described below. These plans focus on regional issues that relate to all of the corridors, or relate to downtown Phoenix where the corridors converge.

Plan PHX: 2015 General Plan

The Plan PHX document has four primary parts. It starts with a single vision, then moves into the three community benefits, then its five core values, and concludes with its seven strategic tools. The vision is “The Connected Oasis”. The plan then describes its three benefits, which include “Prosperity, Health, and Environment”. Under “Prosperity”, the plan describes how ridership on LRT has increased each year, but even more importantly the initial 20-mile segment has resulted in $6.9 billion in capital investment ($5.3 billion of which is from the private sector).

The land use plan has areas of preservation and areas of growth, as well as cores, centers, and corridors. The plan looks at both land use and infrastructure together to better facilitate the movement of people and goods. As noted above, the LRT system has resulted in a great deal of development around its stations. The “Transit Oriented Development” section of the plan states the region’s LRT system not only transports thousands of riders, it also provides an array of benefits and opportunities for the land around transit hubs. One such opportunity is to create a new development pattern for communities near planned or existing stations, in many cases revitalizing some of Phoenix’s neighborhoods with the greatest need for redevelopment. The goal is to design areas surrounding LRT and major transit corridors to create a walkable environment and increase activity levels.

The ”Public Transit” section states that many Phoenix and surrounding community’s residents rely on Phoenix’s mass transit system as their primary source of transportation for work, school and other purposes. The mass transit system is made up of buses and rail, but also includes airport infrastructure, a crucial transportation link to the rest of the world. The system should be efficient, reliable, frequent, and comprehensive. While the Phoenix system has and continues to provide a high level of service, improvements should be made to encourage ridership and provide relief to the local street and freeway systems. The goal is to develop the Phoenix transit system into an efficient multi-modal transportation system which will allow for the movement of people safely, connecting the many activity and employment centers and neighborhoods throughout the city. While the public transit focus in the plan was LRT, the city has developed the plans and codes that will help it implement new transit modes and allow the land uses

surrounding stations to be successful both financially and to fit within the fabric of the community.

ADOT State Rail Plan (2011)

Arizona's rail system provides a network over which freight and passengers are transported. As the population of the state grows, rail will become an even more important mode. The State Rail Plan detailed issues and opportunities for the state to develop and improve both freight and passenger service. Increasing the safety of Arizona's citizens is a guiding principle, along with preserving the State's environment and quality of life. Four corridors of opportunity included the Arizona Spine, the CANAMEX Corridor, the Route 66 Corridor, and the Sunset Corridor.

The Arizona Spine Corridor would use the Grand Line Corridor between Phoenix and Wickenburg. As population grows, there will continue to be a need to move freight as well as more need for passenger service (particularly within the Phoenix area). One of the recommendations important to the Grand Line Corridor is to partner with BNSF to implement operational improvements along the Phoenix Subdivision, as this is an important freight corridor, and will become even more important if passenger service is added to the corridor. The plan will be updated by ADOT in 2018.

ADOT Transportation in AZ (2016)

The ADOT Transportation in AZ report discusses both commuter rail and passenger rail among other modes. The report shows the MAG system plan in the commuter rail section and shows the Tucson to Phoenix route in the "Passenger Rail" section. The report also describes transportation funding in the state. Several observations were made about transportation in Arizona:

- Long range transportation planning is complex; it brings together a combination of technical, policy, process and political requirements and considerations.
- Tough decisions will need to be made; it is clear that Arizona will likely not have the funding needed to fully achieve the Building a Quality Arizona vision. This places importance on establishing and maintaining clear and meaningful processes for prioritizing goals and objectives and making tradeoff decisions.
- The transportation landscape is changing; emerging forces and trends associated with demographics, the political climate, culture and attitudes, technology, energy, the environment, and the workforce will change the way people and goods move, the challenges transportation agencies face, and the way programs and projects need to be delivered.
- The Great Recession had a profound impact on Arizona; while population and economic growth is returning to Arizona, the State was one of the hardest hit by the economic downturn. For transportation, this created the dual challenge of lagging revenues for spending, but increased demand for investment to spur economic growth and help diversify the State's economy.
- The asset management challenge; from a national perspective, Arizona's transportation assets are generally in good condition, but due to both financial constraints and the age of the system, ADOT and its stakeholders will face increasing investment demands to maintain existing asset conditions.

MAG Sustainable Transportation and Land Use Integration Study (2013)

The Sustainable Transportation and Land Use Integration Study (ST-LUIS) highlights the potential to move the region towards greater use of sustainable transportation modes including transit, walking, and biking. Based on the investigation of market realities and research findings, and the study's testing of HCT scenarios in the MAG region, the overarching recommendation is to provide a high quality, productive transit system supported by compact walkable and transit-oriented places.

The ST-LUIS place types describe and illustrate three kinds of places that offer the best opportunities for supporting sustainable transportation in the MAG region, based on the study's investigation of research findings, best practices and local precedents. The place types can be used to characterize existing conditions, to describe an ideal condition, and to communicate a future vision as a basis for actions.

Some characteristics are common to all three place types, but depends on an appropriate density and land use mix to support walkability and a high level of street network connectivity. In successful walkable communities, these measurable characteristics are paired with the less-tangible qualities of authentic character, attractive public realm, and placemaking that contribute to identity and value. MAG and the local municipalities are already involved in many supportive activities that move the recommendations and strategies of the ST-LUIS forward. The region will need to continue to move forward and answer questions not resolved through this project. These will include the completion of more detailed planning activities, the continued emphasis on implementation activities supporting the transition to walkable communities and TOD, and the implementation of a multi-modal system that supports transitions to walkable communities and sustainable transportation.

City of Phoenix Transportation 2050 (T2050)

Phoenix voters approved the T2050 plan in 2015. The $31.5 billion 25-year plan proposes to implement expanded bus service hours and frequencies, 42 miles of new LRT, 75 miles of BRT, and a 5-mile urban circulator. The plan also will add 680 miles of new asphalt on major arterials, 1,080 miles of bike lanes, as well as numerous street modernization projects. Funding for T2050 is being generated by the voter-approved sales tax associated with Proposition 104, which went into effect on January 1, 2016. While the plan does not fund commuter rail, it does bring significant new transportation funding into the region.

2.2.2 Future Roadway Projects

The 2010 Study showed projects that were planned along the Grand Avenue Corridor based on the MAG Regional Transportation Plan (RTP) 2007 Update. Since 2010, the RTP has been updated in 2014 (2035 RTP) and in September 2017 (2040 RTP). With that in mind, this document shows the major freeway improvements that are planned in each corridor (generally highway widening or interchange projects).

2.3 Major Changes since the 2010 Study

Since the 2010 Study, several important changes have occurred in the MAG region that may affect the timing, coverage, operations, and the implementation of a potential commuter rail system. These key changes are described in more detail below.

2.3.1 Updated Demographic and Land Use Information

Socioeconomic and land use projections have significantly changed since 2010. This update will include new existing and future year (now 2040) data for population, employment, and land uses. These projections will fold directly in and result in updated regional travel patterns, travel times, and ridership forecasting for the proposed commuter rail system.

2.3.2 Chandler Corridor Removed

As described in Chapter 1, the Union Pacific Railroad Chandler Branch was removed from consideration for commuter rail service.

2.3.3 Corridor Extents

In 2010, the Grand Line Corridor was evaluated between downtown Phoenix and Wickenburg. However, it was only modeled to the Town of Wittmann. Similarly, the Estrella Line was evaluated to Arlington, but was only modeled to the City of Buckeye. Based on additional ridership analysis, both are still only proposed to Wittmann and Buckeye, respectively. The San Tan Line was originally proposed to terminate in downtown Queen Creek. That remains unchanged.

In the 2010 Study, the Kyrene Line Corridor was proposed to terminate at West Chandler Boulevard just northeast of the I-10/SR 202 interchange. This line is now proposed to terminate near the Wild Horse Pass Hotel and Casino just southwest of the I-10/SR 202 interchange on Gila River Indian Reservation land, an increase of approximately 2 miles.

2.3.4 Arizona Passenger Rail Corridor Study: Tucson-Phoenix

One of the most important changes that have occurred in the MAG region since the 2010 Study has been the ADOT Arizona Passenger Rail Corridor Study: Tucson to Phoenix (APRCS). This is especially important to the San Tan Line (formerly the Southeast) Corridor where commuter and intercity rail operations could both operate within the same corridor.

The FRA was the federal Lead Agency for the Tier 1 Environmental Impact Statement (EIS) for the APRCS conducted by the ADOT under the National Environmental Policy Act (NEPA). FRA and ADOT used a tiered environmental process for the APRCS. Tiering is a phased environmental review process that is commonly used in the development of complex projects. With a tiered approach, the Tier 1 NEPA document evaluates impacts of a broad-scale project.

The Yellow Corridor Alternative (as shown below) mimicks the San Tan Line and was identified as the preferred alternative. FRA considered comments from agencies, tribal governments, and the public received during the scoping process and the public comment period for the Draft Tier 1 EIS. The Record of Decision for the Tier 1 EIS was signed on December 16, 2016.

The APRCS is the first phase in the proposed implementation of the State Rail Plan, linking Arizona's largest metro areas of Tucson and Phoenix. Such a line could connect intermediate locations within the region and be the starting point for later rail connections to other regions of the Southwest and beyond. The concept for rail service within the Yellow Corridor Alternative

assumes train operation at speeds between 80 and 125 mph and a blend of intercity and commuter operations.

As funding becomes available, Tier 2 studies and NEPA documentation would be advanced for logical operable sections of a passenger rail system within the preferred corridor alternative. One or more operable corridor sections that together make up the complete passenger rail system could be developed as individual projects. Any such section would be required to have independent utility with or without construction of other sections. Preliminary design and environmental studies would be conducted in support of a Tier 2 analysis. No individual section of a passenger rail system has been identified for implementation, but the following proposed corridor sections, or any other functional configurations deemed viable, could be evaluated as logical, independent sections subject to available funding and the source of that funding. These corridor sections could also be combined, modified, or revisited in the future based on available funding.

- Amtrak Connection – Potential service can be initiated by Amtrak, using existing freight track.
- Tucson to Marana – Commuter service within the Tucson metro area.
- Queen Creek/San Tan Valley to Phoenix – Commuter service within the Phoenix metro area (making up the San Tan Line Corridor evaluated in this document).
- Coolidge to Phoenix – Regional commuter service between Pinal County and Maricopa County (some of which would be on the San Tan Line Corridor evaluated in this document).
- Coolidge to Tucson – Regional commuter service between Pinal County and Pima County.
- Tucson to Phoenix – Intercity service.

The highest potential level of service in the short term is commuter service from San Tan Valley to the Phoenix hub, connecting the major East Valley communities with the potential to carry major passenger loads along the Union Pacific Railroad freight line in a corridor as yet unserved by passenger rail. This phase could be divided into additional subsections to reduce capital and operating commitments in the short term or to provide additional time to develop solutions to constraints within the corridor. This is the most challenging of the phases from a construction perspective, due to the urban nature of the corridor.

Figure 2-1: Arizona Passenger Rail Corridor Study Preferred Alterative

2.4 Summary of Findings

The purpose of this section is to provide an overall summary of the characteristics of the four potential commuter rail corridors within the MAG region. Findings identified as part of the existing and future conditions evaluation are organized by the individual elements that were examined in order to compare results between corridors.

2.4.1 Demographics

- Significant population and employment growth is expected by 2040 in the outlying areas of the Grand Line, Estrella Line and San Tan Line corridors.
- The Kyrene Line Corridor is projected to experience less significant growth in population and employment than the other corridors located within the System Study, as it is closest to build-out conditions already. The existing and planned population and employment densities throughout the corridors helped the Project Team evaluate and compare the alignments.

2.4.2 Land Use

- The outer limits of the Grand Line, Estrella Line and San Tan Line corridors remain largely undeveloped, and changes in the Regional Transportation Plan suggest that the outer areas will develop at a slower rate than previously expected.
- In the future, the majority of development that is expected to occur along the Grand Line, Estrella Line and San Tan Line Corridors will be residential development.
- The Kyrene Line Corridor is not expected to experience a significant change in land use patterns in the future.

2.4.3 Planning Context

- Many of the transportation and general plans of the communities that the Grand Line, Estrella Line, San Tan Line, and Kyrene Lines Corridors traverse have begun to include discussions of the commuter rail program.

2.4.4 Railroad Characteristics

- Each corridor within the System Study Planning Area has multiple at-grade and grade-separated railroad crossings.
- The Grand Line Corridor is the only corridor in the System Study Planning Area in which the railroad is directly adjacent to a major highway throughout the entire span of the study corridor.
- Each corridor within the System Study Planning Area has multiple freight railroad facilities and customers that could potentially affect future commuter rail service.

2.4.5 Highway Characteristics

- All corridors within the System Study Planning Area are located near travel paths along major highways that provide connections into downtown Phoenix.
- All corridors within the System Study Planning Area will experience significant roadway improvements adding capacity and interchange upgrades and assisting in maintaining traffic flow and travel times into downtown Phoenix.
- Despite planned improvements, travel times and congestion levels in each corridor will generally continue to increase in the future.

2.4.6 Transit Service

- At the time of the 2010 Study, LRT was relatively new to the Phoenix metropolitan area. After the opening of the 20-mile starter line in 2008, two extensions were brought on-line in the spring of 2016, adding six more miles and connecting downtown Mesa to northwest Phoenix. Today the system has 35 stations in Phoenix, Tempe, and Mesa. Seven high-capacity extensions are planned or under construction to create a 66-mile system by 2034.
- Since the 2010 Study, the Regional Connector routes were renamed Rural Routes, and only one (Ajo/Gila Bend to Phoenix) remains. The other regional bus service route, the Wickenburg Connector Route 660, was suspended in October 2011 due to low ridership and an abbreviated schedule. The Route 660 may perhaps be reinstituted to connect the Grand Line Wittmann Station to Wickenburg once commuter rail service is established.
- Portions of the Grand Line, Estrella Line, and San Tan Line Corridor continue to have significant transit service in areas near downtown Phoenix.
- The outlying areas of the Grand Line, Estrella Line, and San Tan Line Corridors have limited existing transit service and fewer routes planned in the future today compared to the 2010 Study, due to slower growth rates in northern and western suburban areas.
- The San Tan Line Corridor has a more robust level of transit service throughout the corridor, particularly within City of Tempe, which has a dedicated transit sales tax.

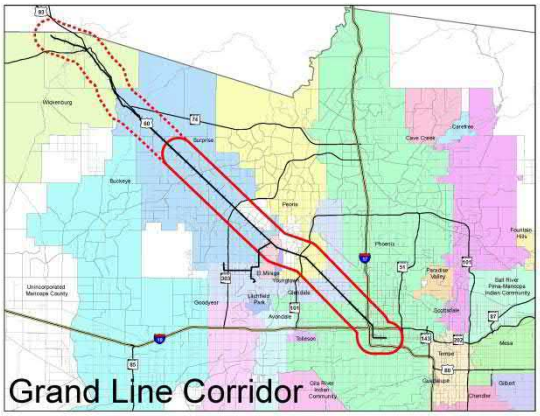
2.4.7 Travel Patterns

- Travel patterns in each of the corridors are expected to remain relatively consistent between 2015 and 2040, even with a significant increase in the number of HBW trips.

2.5 Grand Line Corridor

The 35-mile Grand Line (formerly Grand Avenue Corridor) Corridor has been defined by a two-mile radius surrounding the BNSF line between Union Station in downtown Phoenix and Wittmann in unincorporated Maricopa County. The cities, towns and unincorporated areas that fall within this corridor include:

- City of Phoenix;
- City of Glendale;
- City of Peoria;
- Town of Youngtown;
- City of El Mirage;
- City of Surprise; and
- Portions of unincorporated Maricopa County, including Sun City, Sun City West, and Wittmann.



2.5.1 Demographics

Comprised of a combination of six cities and towns as well as unincorporated land within Maricopa County, this corridor had a 2015 population of approximately 645,000 people, with an expected 46 percent increase to greater than 940,000 people by 2040. Of the municipalities located within the corridor, Surprise is expected to experience the greatest increase in population in the corridor between 2015 and 2040, with an increase of 152 percent. Other municipalities expected to experience significant population growth within the corridor over the same time period are Phoenix, with a 44 percent increase, Youngtown, with a 24 percent increase, and Glendale with a 23 percent increase in population. In addition to the municipalites that are located along the Grand Line, the future near term extension area is also projected to experience an increase in population growth between 2015 and 2040. The area along the corridor between Wittmann and Wickenburg is expected to increase population by over 100 percent in that timeframe.

The Grand Line Corridor is also expected to experience an increase in employment from just over 337,000 jobs in 2015 to nearly 446,000 jobs in 2040, resulting in an increase of 32 percent. Of the municipalities that make up the corridor, Surprise is expected to experience the greatest increase in employment in the corridor between 2015 and 2040, with a 146 percent increase. Other municipalities expected to experience significant employment growth are El Mirage, with a 89 percent increase in jobs in the corridor. In addition to the municipalities that are expected to experience growth in employment, the future near term extension is also expected to grow by 2040. The area along the corridor between Wittmann and Wickenburg is expected to increase employment by almost 50 percent in that timeframe.

Table 2-1 and Table 2-2 identify the existing and forecasted population and employment projections within the Grand Line Corridor.

Table 2-1: Grand Line Corridor Population Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change 2015-2040
City of Phoenix	262,490	377,019	44%
City of Glendale	125,749	154,160	23%
City of Peoria	75,359	87,540	16%
Town of Youngtown	6,467	8,106	25%
City of El Mirage	33,335	38,173	15%
City of Surprise	83,904	211,298	152%
Unincorporated Maricopa County	58,239	65,941	13%
Total	**645,543**	**942,237**	**46%**
Future Extension Area	10,060	20,807	107%

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

Table 2-2: Grand Line Corridor Employment Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change 2015-2040
City of Phoenix	237,394	289,624	22%
City of Glendale	31,967	42,175	32%
City of Peoria	25,831	34,234	33%
Town of Youngtown	1,739	2,264	30%
City of El Mirage	3,801	7,198	89%
City of Surprise	20,861	51,237	146%
Unincorporated Maricopa County	15,599	19,244	23%
Total	**337,192**	**445,976**	**32%**
Future Extension Area	4,175	6,190	48%

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

2.5.2 Land Use

The Grand Line Corridor contains a variety of land uses as shown in Figure 2-2. Table 2-3 summarizes the existing land uses as of the year 2016, as well as future land use within the corridor distinguished by land use category. Existing land use in the corridor is currently 25 percent vacant land, most of which is located northwest of SR 303L. Through build-out, a large percentage of that land is expected to become residential which will make up over 50 percent of the corridor land use.

Table 2-3: Grand Line Corridor Existing and Future Land Use

Land Use Category	Existing Land Use (2016)		Future Land Use (Build-out)	
	Acres	Percent of Total	Acres	Percent of Total
Residential (<1 du/acre)	3,212	3.2%	7,325	7.3%
Residential (1 – 4 du/acre)	3,342	3.3%	9,650	9.6%
Residential (> 4 du/acre)	33,744	33.6%	39,401	39.3%
Commercial	4,593	4.6%	6,213	6.2%
Industrial	5,369	5.4%	6,284	6.3%
Mixed Use	11	0.0%	6,567	6.5%
Office	792	0.8%	879	0.9%
Open Space / Recreation	9,032	9.0%	8,666	8.6%
Public / Private Institutions	8,724	8.7%	9,110	9.1%
Transportation / Parking	6,320	6.3%	6,245	6.2%
Vacant	25,202	25.1%	0	0.0%
Total	**100,340**	**100.0%**	**100,340**	**100.0%**
Extension Land Area	54,309		54,318	

Source: MAG, 2018.

Those locations within the Grand Line Corridor that have the potential to generate ridership based on land use have been identified as activity centers, the majority of which are located near downtown Phoenix. Activity centers throughout the corridor include:

- Downtown Phoenix;
- ASU downtown campus;
- Phoenix Memorial Hospital;
- Grand Canyon University;
- Downtown Glendale; and
- Glendale Community College.

Additional activity centers located throughout this corridor, and the relationship they have with potential station locations have been identified in Appendix C: Grand Avenue Corridor Station Target Area Evaluation of the Grand Avenue Corridor Development Plan.

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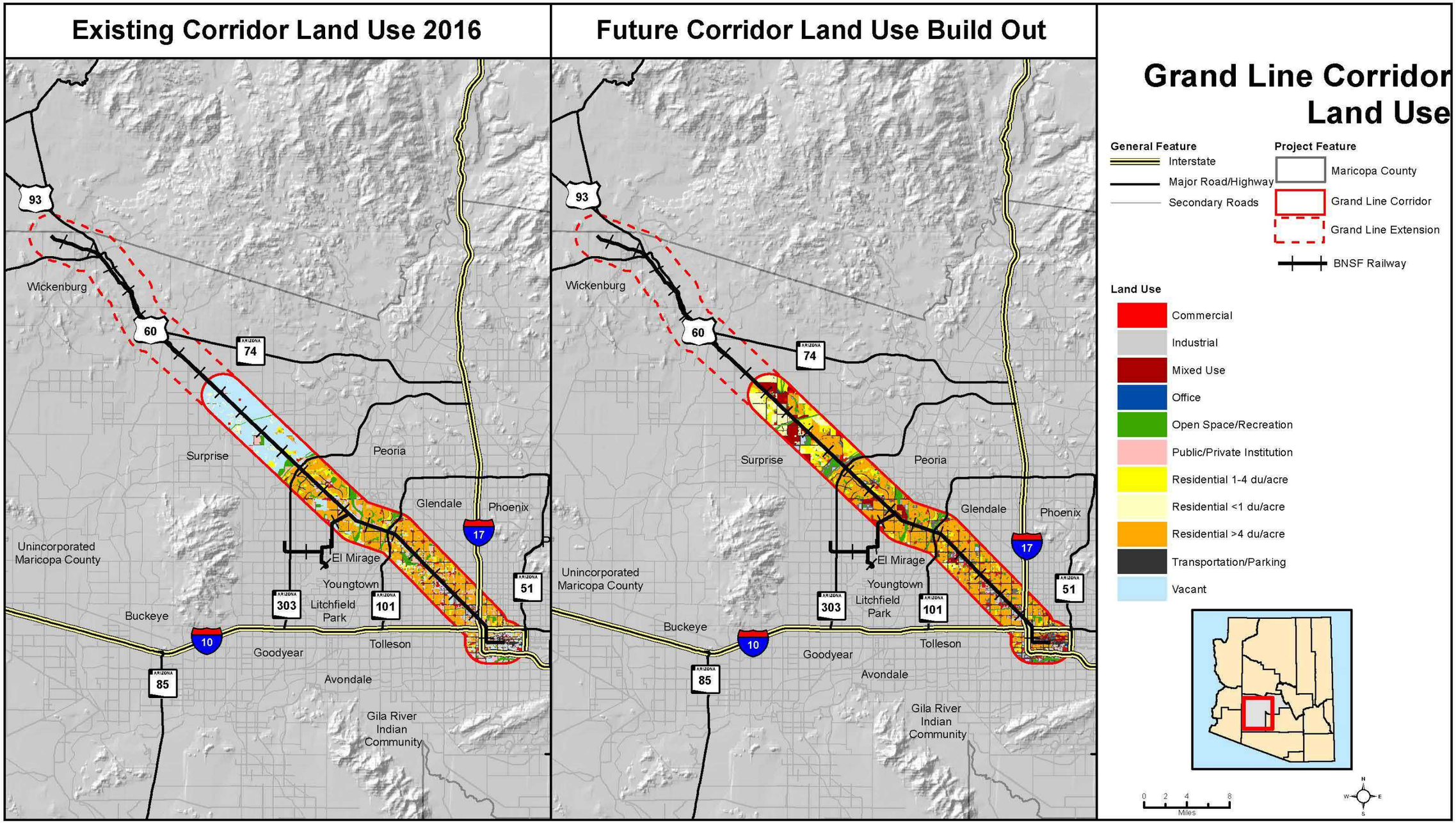
Figure 2-2: Grand Line Corridor – Land Use



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2.5.3 Planning Context

The following general and transportation planning documents are summarized to illustrate the level of planning that has occurred in the communities where commuter rail service would be implemented in the Grand Line Corridor.

General Plans

City of Peoria General Plan (2010)

The City of Peoria is one of the largest cities in the MAG region both in terms of land area and population. The city is largely developed south of SR 303 and under public ownership in areas north of the roadway. The General Plan was completed in 2010 and sets the policies for growth throughout the city. One policy states that the city should encourage site planning and transit-oriented design and land uses around future express route, and commuter rail transit centers to emphasize the ease and safety of pedestrian circulation and orientation of compatible and mutually supportive uses. The general plan notes that the transit and rail plan does not contain LRT or HCT, as current land uses do not support them. Should future land uses change to justify HCT, the transit and rail plan should be amended to reflect the new routes. The Peoria Old Town area that is generally bound by Grand Avenue, SR 101, and Mountain View Road, is a growth area. Additionally, the area just southeast, known as the Grand Avenue Gateway, is also considered a growth area. One of the policies to help rejuvenate the Old Town area is to design a mixed-use transit station to be located north and west of Peoria and 83rd Avenues as part of a Multi-Modal Transportation Plan.

The 2011 City of Peoria Old Town Specific Area Plan went on to add a land use concept to define the vision for future development in the plan area. The concept had 11 land use categories that have been created to describe the desired built environment within the Plan Area. A number of mixed use categories are provided to accommodate developments that integrate multiple land uses such as commercial and residential. These mixed use land use categories will support the development of the dynamic pedestrian and transit oriented environment that is envisioned for the area. The plan also added a circulation concept, which emphasizes the provision of a broad range of interconnected transportation options, with a focus on pedestrians, bicycles, and transit. The plan follows a context sensitive solutions approach to promote roadway designs that support surrounding land uses in terms of mobility, safety, access, and place making. It stated that improving pedestrian and bicycle facilities and creating new transit options will not only increase the ease of traveling to and from and within the Plan Area, it will also contribute an inviting and attractive atmosphere that will make Old Town a destination. While no station planning has occurred on the Grand Line Corridor, the City of Peoria has begun to consider the Old Town area for transit and TOD opportunities.

Youngtown General Plan 2025 (2014)

The Town of Youngtown is located east of El Mirage and west of Sun City where Grand Avenue creates the northern border. The land uses closest to Grand Avenue include commercial; medium, medium to high, and high density residential; and town core with an area of open space along the western edge of the community. Because the Town has no opportunity for a rail station in the community, there is no specific transit-related zoning. However, high density residential, including apartments or condominiums up to 18 dwelling units per acre, may be located adjacent to freeways, arterial or collector roads, or employment and commercial areas. Further, densities exceeding 18 dwellings per acre can be considered in the Town Center Business District or for projects that provide elderly care with assisted living components.

El Mirage General Plan (2010, Land use Map updated 2015)

The City of El Mirage is located along a portion of Grand Avenue (US 60) east of Surprise and west of Youngtown and Sun City. The General Plan was completed in 2009, adopted in 2010, and the land use map was amended in 2015. The area between Greenway Road on the north and Thunderbird Road on the south is zoned for TOD on the north side of Grand Avenue (the site of the existing automotive distribution center) and as a "Mixed Use District" on the south side of Grand Avenue (generally residential with a concentration of commercial uses adjacent to Grand Avenue). Both of these areas make up the "Downtown/Central Business District" (north side) and "Downtown/Arts District" (south side), a region of the city that is seen as a growth area with a great deal of development and redevelopment opportunities. While no station planning has occurred on the Grand Line Corridor, the City of El Mirage has zoned this area for transit and TOD opportunities.

City of Surprise General Plan 2035 (2015)

One of the most important goals of the General Plan is "Multi-Modal Growth", where the policy is to promote physical planning and design techniques that facilitate access to, and use of, transit service and other multi-modal circulation options.

The TOD area land use designation denotes areas where existing or planned transit corridors provide regionally significant connections to and from the City of Surprise. This includes the Grand Line Corridor. The intent of the TOD designation is to recognize the unique connection between the character of the adjoining land uses together with the motorized, non-motorized and potential transit operations of each corridor by developing individual corridor plans. Developments proposed within these corridors will have expanded design and policy guidance on incorporating safe and convenient walking and biking connections to current and future planned transit operations.

The Transportation Chapter of the General Plan notes a lack of public transportation services, including inadequate local transit service within Surprise, as well as regional transit service linking Surprise with other communities in the West Valley and beyond. A primary strategy of the Transit Element is to reduce dependence on the private automobile in order to achieve multiple and interrelated goals including increasing mobility, preserving and enhancing neighborhood character, improving air quality, and fostering compact development and a more walkable city. A greater reliance on public transportation will improve mobility by increasing travel options for residents, and by increasing the people-carrying capacity of the city's transportation system. It will also decrease the environmental degradation caused by the growing use of single-occupant vehicles. The intent is to develop a transit system that supports as well as leads the development of Surprise Land Use Character Areas as set forth by the Surprise General Plan 2035. The plan notes that by 2035 the Grand Line corridor is projected to experience a 41 percent increase in population and a 52 percent increase in employment. As a result of this growth, and even with planned roadway improvements and increased transit service, congestion in the Grand Avenue corridor is expected to worsen. Commuter rail service would provide an opportunity to improve mobility, particularly for peak period trips, by reducing travel time and providing a reliable and consistent alternative to automobile travel in a congested roadway corridor.

The BNSF Phoenix Subdivision rail line currently carries seven to eight trains daily at a maximum speed of 49 miles per hour. Upgrades and changes desired for implementing commuter rail services on the BNSF line may include new signals, a second track, and reduced

main track switching activity. Additional commuter rail implementation requirements include governance and administration, railroad cooperation, and funding.

As described in the plan, in order for transit to be successful, the City of Surprise needs to create a more "transit friendly environment" in which transit has a better opportunity to succeed. One element of this is to provide for denser, mixed use development that will support travel by transit. Another element is to provide the physical facilities that result in a better operating environment for transit, such as bus pullouts, park and ride lots, signal prioritization for transit vehicles, and improved access to transit for pedestrians and bicyclists. Implementation is dependent on the close coordination of land use and transportation planning. The relationship between transit and land use focuses development in concentrated rather than linear patterns adjacent to transit stops and stations. Transit investments are directed to link these transit supportive areas to provide people with an attractive option to the single occupant vehicle. This will allow more people to live and work within walking distance of transit. A new grade separation which opened in 2016 at Bell Road over the BNSF Grand Line was another step in this plan.

Transportation Plans

City of Glendale (2009 Transportation Plan)

The City of Glendale has not updated their Transportation Plan since the 2010 Study.

City of Peoria Multi-Modal Transportation Plan (2011)

The multi-modal plan describes the significant amount of growth in the City of Peoria and proposes that a more balanced transportation system is import for the mobility of its residents. The plan looked at local bus circulators, flex routes, and potential extensions of the Valley Metro routes into Peoria. It was determined that focusing on the grid routes had the most potential for success, as many of Peoria's residents commute out of the city for work trips. A mid-term recommendation proposed the development of a Transit Center/Park-and-Ride lot in the Old Town area on 83rd Avenue. In the long-term, the "Grand Avenue commuter rail line between Wittmann and downtown Phoenix via Peoria" was also included.

2.5.4 Railroad Characteristics

Railroad Infrastructure

The Grand Line Corridor follows the BNSF Phoenix Subdivision line from downtown Phoenix to Wittmann. The corridor is approximately 36 miles long and is located adjacent and parallel to Grand Avenue/US 60. The Grand Line Corridor is primarily an un-signalized single track with sidings located throughout to allow trains to pass as necessary.

BNSF Mobest Yard at Grand Avenue/19th Avenue Phoenix, AZ. Source: MAG.

The diagonal nature of Grand Avenue and the presence of the railroad have created multiple complex six-legged intersections that also include at-grade track crossings. There are also a number of grade-separated crossings throughout the corridor which lessen the impact to traffic on the adjacent highway. In total, there are 51 at-grade track crossings and 19 grade-separated crossings. A new grade separation for Bell Road over Grand Avenue was completed in

November 2016. There is also one active Quiet Zone located at the intersection of 163rd and Grand avenues in the City of Surprise. In addition, there are two pending applications for Quiet Zones located in Sun City at the intersection of Meeker Boulevard and Grand Avenue and at the intersection of RH Johnson Boulevard and Grand Avenue.

Positive Train Control is not yet in effect on this corridor, but is mapped for future installation. The line is governed by Track Warrant Control (TWC) (non-signalized territory) from Wittmann to Peoria with a maximum speed of 49 mph, while the other half of the corridor is limited to Restricted Limits (10-30 mph) from Peoria to Phoenix Union Station.

Providing commuter rail service that does not interfere with the ongoing operations of major BNSF facilities will be key in the implementation of commuter rail in the Grand Line Corridor. Several existing BNSF facilities are located throughout the corridor and are shown in Figure 2-3 they include:

- Phoenix Union Station (BNSF MP 194; Union Pacific Railroad MP 906);
- Phoenix Yard (MP 193.7);
- Mobest Yard – Phoenix (MP 191.6);
- Alhambra Yard (MP 188.3);
- BNSF Intermodal Facility (MP 186.8) (expanded and lengthened in 2016);
- Glendale North/South Yards (MP 183.7);
- BNSF Automobile Distribution Facility (MP 174.1); and
- Ennis Wye (MP 173.6) (new east leg of wye approved for installation by ACC).

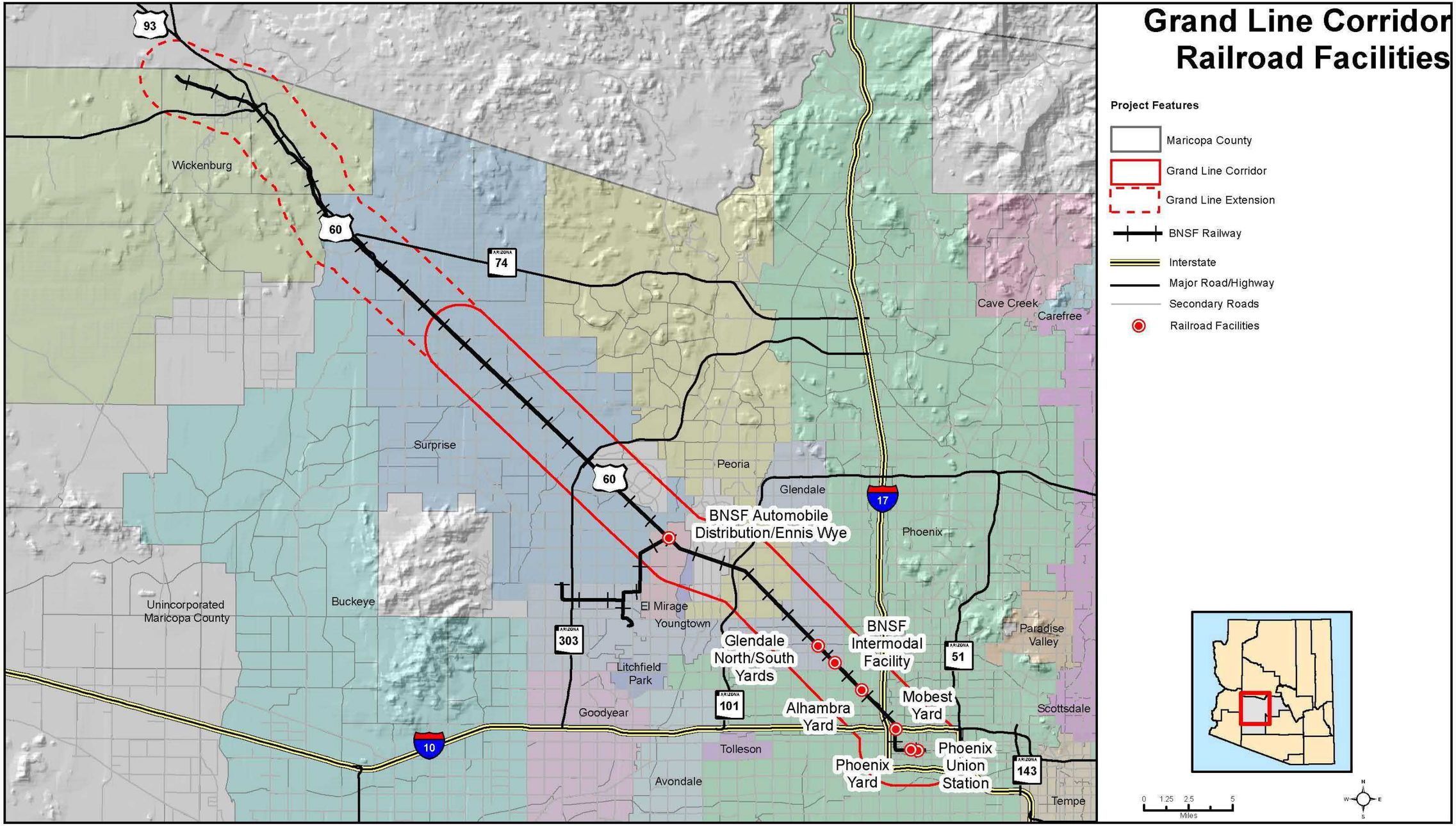
In an effort to expand capacity and reduce the number of trains accessing the downtown area, BNSF had develped and explored options to build additional facilities northwest of the downtown Phoenix area since 2005. Some of the activity currently conducted in the Mobest Yard and BNSF Intermodal Facility could have potentially been relocated near (MP 157.2) (Wittman-Surprise), but zoning for new, nearby homes and neighborhoods appears to have put these plans on hold. BNSF is also looking at the possibility of adding and upgrading existing sidings throughout the corridor which include opportunities in both Peoria and Glendale. These railroad infrastructure improvements would allow for enhanced freight service as well as facilitate needed improvements should potential commuter rail service be implemented. For a more detailed description of Grand Line Corridor railroad conditions and existing and planned facilities, see Appendix E: Systems Study Railroad Conditions and Issues.

Railroad Operations

The following daily railroad operations are typical in a given 24-hour period in the Grand Line Corridor. These numbers represent averages and can change regularly given the nature of the movement of freight.

- Phoenix Union Station (MP 193.7) (Union Pacific Railroad transfer train from Phoenix Junction; Phoenix Yard and Sidewinder Branch) to Mobest Yard (MP 191.6) = 2 round trip trains per day
- Mobest Yard (MP 191.6) to Ennis Branch (El Mirage) (MP 173.6) = 6 trains per day
- Ennis Branch (MP 173.6) to Beardsley (SR 303) (MP 169.2) = 7 trains per day

Figure 2-3: Grand Line Corridor – Railroad Facilities



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2.5.5 Highway Characteristics

The diagonal southeast-northwest orientation of Grand Avenue has created multiple skewed, six-legged intersections that have resulted in excessive delays and safety concerns at north-south and east-west arterial crossings. The presence of the railroad adjacent to the roadway corridor generates additional congestion through delays created by at-grade railroad crossings.

There have been several improvements made to the regional transportation network throughout this corridor. In an effort to reduce delay and improve safety, grade separations have been constructed to eliminate six-legged intersections at select locations between SR 101 and McDowell Road. With the exception of the Indian School Road crossing, which was constructed in the early 1970's, the remaining grade-separated roadways have been completed since 2007. Grade separations have been constructed at the following intersections:

- Grand Avenue over 27th Avenue/Thomas Road;
- Indian School Road over 35th Avenue/Grand Avenue/BNSF Railway;
- Grand Avenue over 43rd Avenue/Camelback Road;
- 51st Avenue over Bethany Home Road/Grand Avenue/BNSF Railway;
- Maryland Avenue over Grand Avenue/BNSF Railway;
- Grand Avenue under 59th Avenue/Glendale Avenue;
- 67th Avenue over Northern Avenue/Grand Avenue/BNSF Railway;
- Olive Avenue over 75th Avenue/Grand Avenue/BNSF Railway; and
- Bell Road over Grand Avenue/BNSF Railway.

Several roadway projects have been completed along the Grand Line Corridor since the 2010 Study, in an effort to remove six-legged intersections and provide additional capacity. A summary of these improvements are shown in Table 2-4.

Table 2-4: Grand Line Corridor Recent and Future Roadway Improvements

Improvement	Extent	Opening Date	Current Status
Widen Grand Avenue to three lanes in each direction	99th to 83rd Avenues	2010	Complete
Widen Grand Avenue to three lanes in each direction	SR 303 to 99th Avenue	2011	Complete
New Interchange	US 60/Grand Avenue at Bell Road	2017	Complete
New Interchange	US 60/Grand Avenue at Thompson Ranch Road/ Thunderbird Road	2017	Construction
Frontage Road Project	US-60/Grand Avenue, Greenway Road to Thompson Ranch Road	2019	Currently Under Construction
Grade Separation Project	US-60/Grand Avenue	2021-2022	Currently in Planning Design

Source: MAG, 2018.

Travel Characteristics: Travel Time, Volume and Congestion

The travel path identified to analyze the Grand Line Corridor follows the Grand Avenue/US 60 alignment between downtown Phoenix and the Town of Wittmann. For the purposes of this analysis the intersection of Washington Street and Central Avenue in Phoenix and the intersection of Center Street and U.S. 60 in Wittmann were used as endpoints to measure travel characteristics. The travel path for the corridor totals 35 miles and was broken down into two segments in order to compare travel characteristics on both ends of the corridor. A third segment was also added to the table, which would extend the line to Wickenburg (as was included in the 2010 Study). Table 2-5 compares the travel characteristics of the these segments for the AM peak period in 2015 and 2040.

Table 2-5: Grand Line AM Peak Period Travel Characteristics (2015 – 2040)

2015 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: U.S. 60/ Center Street to Grand Avenue/Bell Road	14 miles	23 minutes	N/A (no HOV)	15 minutes	2 – 3	2,500-7,200
Segment #2: Grand Avenue/ Bell Road to Downtown Phoenix	21 miles	66 minutes	N/A (no HOV)	29 minutes	2 – 5	1,600-10,500
Total Trip (to Wittmann)	**35 miles**	**89 minutes**	**N/A (no HOV)**	**44 minutes**		**1,600-10,500**
Segment #3: U.S. 60/U.S. 93 to U.S. 60/Center Street	18 miles	20 minutes	N/A (no HOV)	17 minutes	2	1,500-2,400
Total Trip (to Wickenburg)	**53 miles**	**109 minutes**	**N/A (no HOV)**	**62 minutes**		**1,500-10,500**
2040 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: U.S. 60/ Center Street to Grand Avenue/Bell Road	14 miles	48 minutes	N/A (no HOV)	18 minutes	2 – 3	2,100-23,200
Segment #2: Grand Avenue/Bell Road to Downtown Phoenix	21 miles	76 minutes	N/A (no HOV)	29 minutes	2 – 5	1,100-11,400
Total Trip (to Wittmann)	**35 miles**	**124 minutes**	**N/A (no HOV)**	**47 minutes**		**1,100-23,200**
Segment #3: U.S. 60/U.S. 93 to U.S. 60/Center Street	18 miles	33 minutes	N/A (no HOV)	18 minutes	2	4,200-6,800
Total Trip (to Wickenburg)	**53 miles**	**157 minutes**	**N/A (no HOV)**	**65 minutes**		**1,100-23,200**

Source: MAG, 2018.

Between 2015 and 2040, travel characteristics in the AM peak travel period are expected to change significantly throughout the corridor. The segment between the terminus in the 2010 Study at U.S. 60 and U.S. 93 in Wickenburg and the new terminus at U.S. 60 and Center Street in Wittmann would see nearly three times the traffic volumes by 2040 compared to 2015, resulting in an additional 13 minutes of travel time for this segment in the AM peak period. Between the intersection of U.S. 60 and Center Street and the intersection of Grand Avenue

and Bell Road, traffic volume along Grand Avenue is expected to nearly triple and travel time in this segment will double (increasing the segment travel time by 25 minutes in this segment to 48 minutes) in the AM Peak. While the volume is also expected to increase between Bell Road and downtown Phoenix, the total trip time is projected to increase only by 10 minutes. High occupancy vehicle travel times were studied to help determine how effective commuter rail could be in each of the corridors. HOV lanes are not proposed along Grand Avenue, so there is not an HOV travel time associated with the Grand Line Corridor. Off-peak travel times were also studied to illustrate the travel time degredation during peak periods. The table shows that travel times during the AM peak period are generally more than double that of off-peak travel times in 2015, and get even worse by 2040.

Similar to the AM peak period travel characteristics, PM peak period travel time, volume and congestion were analyzed. Table 2-6 shows the comparison between 2015 and 2040 PM peak period travel characteristics in the Grand Line Corridor.

Table 2-6: Grand Line PM Peak Period Travel Characteristics (2015 – 2040)

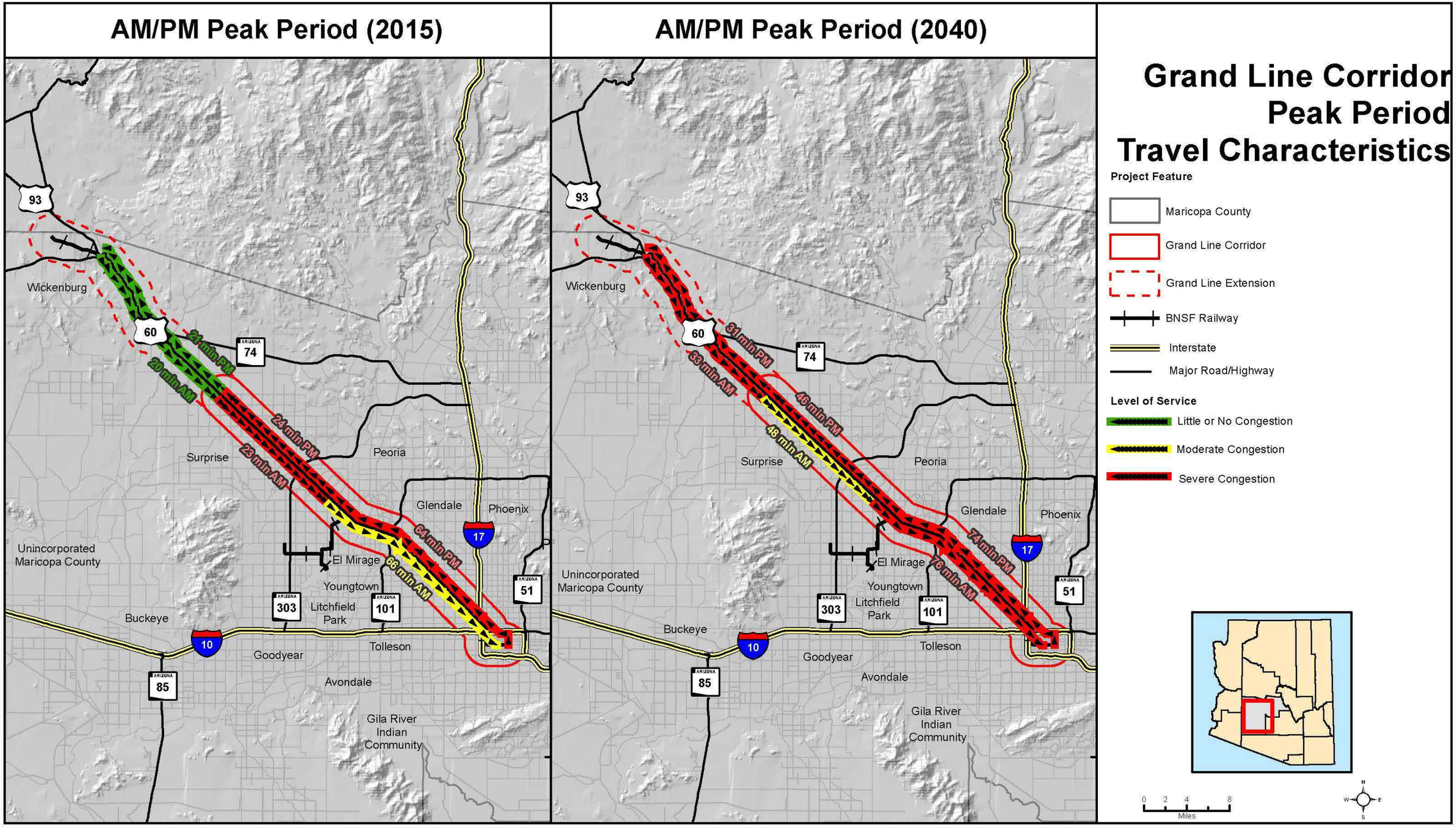
2015 PM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Downtown Phoenix to Grand Avenue/Bell Road	21 miles	64 minutes	N/A (no HOV)	29 minutes	2 – 5	3,800-16,400
Segment #2: Grand Avenue/Bell Road to U.S. 60/Center Street	14 miles	24 minutes	N/A (no HOV)	15 minutes	2 – 3	2,900-12,000
Total Trip (to Wittmann)	**35 miles**	**88 minutes**	**N/A (no HOV)**	**44 minutes**	–	**2,900-16,400**
Segment #3: U.S. 60/ Center to U.S. 60/ U.S. 93 Street	18 miles	21 minutes	N/A (no HOV)	17 minutes	2	2,700-4,100
Total Trip (to Wickenburg)	**53 miles**	**108 minutes**	**N/A (no HOV)**	**62 minutes**	–	**2,700-16,400**
2040 PM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Downtown Phoenix to Grand Avenue/Bell Road	21 miles	74 minutes	N/A (no HOV)	29 minutes	2 – 5	3,100-17,800
Segment #2: Grand Avenue/Bell Road to U.S. 60/Center Street	14 miles	46 minutes	N/A (no HOV)	18 minutes	2 – 3	4,500-33,200
Total Trip (to Wittmann)	**35 miles**	**120 minutes**	**N/A (no HOV)**	**47 minutes**		**3,100-33,200**
Segment #3: U.S. 60/ Center to U.S. 60/ U.S. 93 Street	18 miles	31 minutes	N/A (no HOV)	18 minutes	2	6,300-10,800
Total Trip (to Wickenburg)	**53 miles**	**152 minutes**	**N/A (no HOV)**	**65 minutes**		**3,100-33,200**

Source: MAG, 2018.

In 2015, travel time between downtown Phoenix and Bell Road in the PM peak period was 64 minutes. The travel time is expected to be 74 minutes by 2040, an increase of 10 minutes. Travel between Bell Road and Center Street in Wittmann took 24 minutes in 2015 and is expected to increase to 46 minutes by 2040 in the PM peak period, while the travel time between Center Street and U.S. 93 in Wickenburg is expected to increase from 21 to 31 minutes during this same time period. This anticipated increase in travel times can be attributed to the projected socioeconomic growth and shift in land use to more residential development within the outer segments of the corridor with more than double the traffic in these outer segments. As noted above, HOV lanes are not proposed along Grand Avenue, so there is not an HOV travel time associated with the Grand Line Corridor. Travel times during the PM peak period are also more than double that of off-peak travel times in 2015, and get even worse by 2040.

The level of congestion throughout the corridor is expected to worsen for more segments in the future, especially further out in the corridor around Wittmann. Figure 2-4 shows the travel path for the Grand Line Corridor as well as the level of congestion and travel times in both the AM and PM peak period in 2015 and 2040. Note that levels of congestion within downtown Phoenix are shown, but actual travel times for this area are not shown in this figure.

Figure 2-4: Grand Line Corridor – Peak Period Travel Characteristics



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2.5.6 Transit Service

Transit service in the Grand Line Corridor includes fixed route bus service and numerous transit passenger facilities. It should also be noted that there is the potential for Grand Canyon passenger rail excursion service north of the Grand Line corridor in future years, although no timeframe exists for implementation of this service to date.

Fixed Route Bus Service

Fixed route bus service within the Grand Line Corridor is comprised of local bus, circulators, a regional connector, and express bus service. Figure 2-5 depicts both the existing and funded regional transit network of local bus, circulators, express, and regional connectors that will be in operation by 2040 within the corridor.

Local Bus

Within the Grand Line Corridor, local bus service is provided seven days a week. Sixteen local bus routes currently serve the corridor with the Grand Avenue Limited as the only local bus route that directly serves Grand Avenue. This limited stop route provides only Monday through Friday service, with two inbound (to downtown Phoenix) AM trips and two outbound (from downtown Phoenix) PM trips. This is less service compared to the 2010 Study, which showed four AM and four PM trips between downtown Phoenix.

The 2040 RTP notes that it is anticipated that locally funded routes will incrementally be extended to meet demand within individual jurisdictions consistent with population growth and development patterns.

Circulators

Two circulator routes currently operate in the Grand Line Corridor, both of which are operated by the City of Glendale, and known as the Glendale Urban Shuttle (GUS). This is the same as what was shown in the 2010 Study.

Rural Routes

The rural route that previously operated in the Grand Line Corridor was the Wickenburg Connector or Route 660, as described in the 2010 Study. This route has since been discontinued with no other planned regional service in the corridor.

There is some potential for regional bus service to operate from Wittmann to Wickenburg in future years.

BRT/Express Bus

One express route (Route 571) operates within the Grand Line Corridor; however, there are no stops located along Grand Avenue. The 2010 Study also included Route 572, which has been discontinued.

The RTP identifies two future express bus routes within the corridor. The SR 303 Express, which will operate between Arrowhead Towne Center and the Desert Sky Mall via SR 303 (which was included in the 2010 Study) and the Peoria Express, which will operate between Grand Avenue and I-10 via SR 101. There is no existing or planned arterial BRT service operating within the Grand Line Corridor, however since 2015, Valley Metro has studied ways to improve express and limited stop bus services within the corridor. Figure 2-5 shows both the existing and planned express bus system that will be in operation by 2040.

High Capacity Transit

Currently there are no HCT services in the Grand Line Corridor. However, the RTP identifies a 5-mile HCT extension west along Glendale Avenue to approximately Grand Avenue (now known as West Phoenix/Central Glendale), projected to open in 2026. The Glendale City Council took action in late 2017 to remove the city from participation from this project. The RTP has not yet been updated to reflect this action.

Transit Passenger Facilities

Existing and planned transit facilities located within the Grand Line Corridor are comprised of both transit centers and park-and-rides.

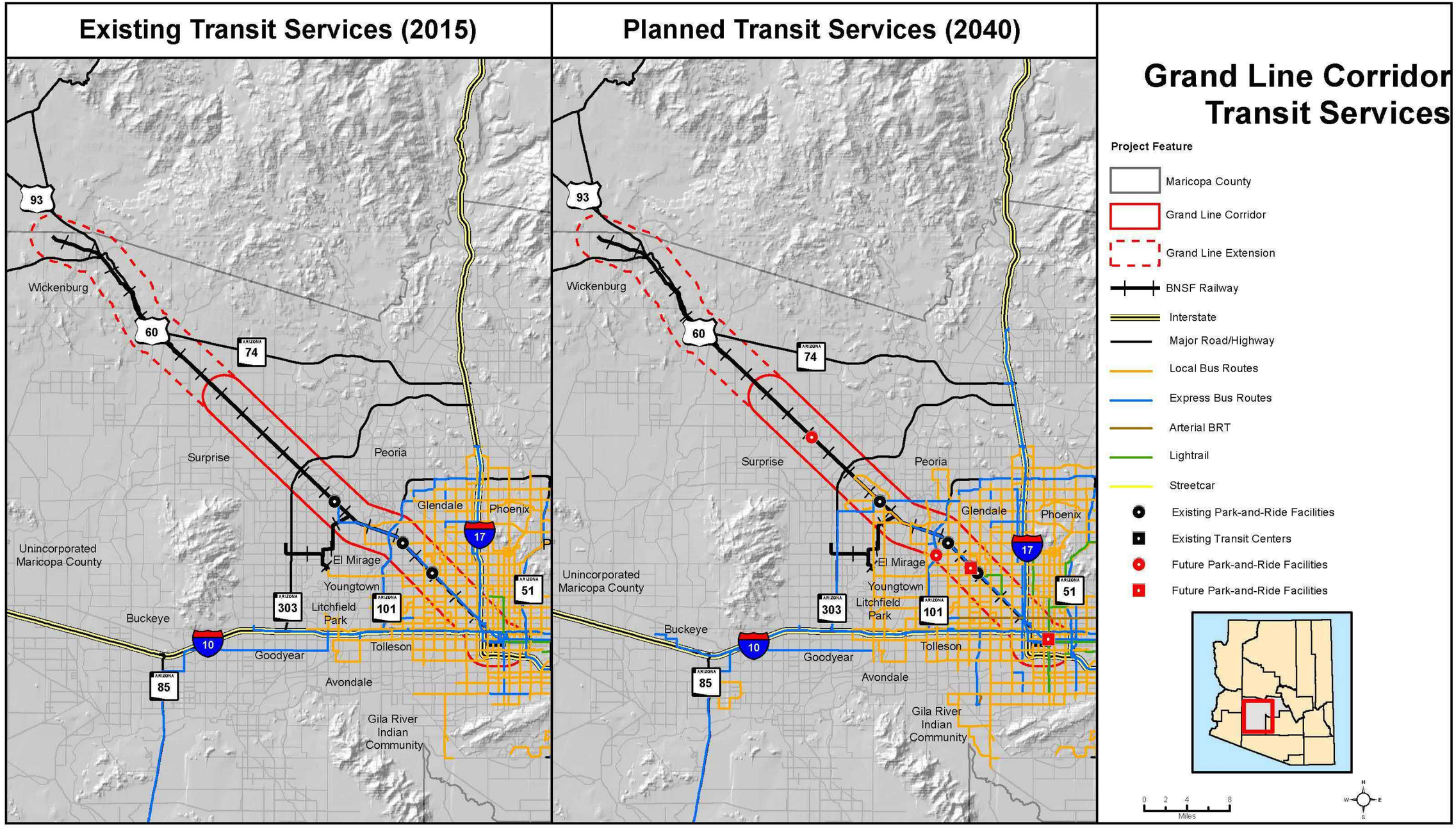
Transit Centers

There are no existing transit centers in the Grand Line Corridor; however, two transit centers are planned in the future. The planned transit centers will serve the City of Glendale and the City of Peoria, respectively, and are shown in Figure 2-5.

Park-and-Ride Facilities

There are a total of three existing park-and-ride facilities in the project corridor that provide transit riders with access to local bus service, circulators, and express bus routes. These include the Glendale City Lot, Peoria park-and-ride, and Surprise park-and-ride. Two additional park-and-ride facilities are planned for the future. Figure 2-5 identifies existing and future facilities.

Figure 2-5: Grand Line Corridor – Transit Services



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2.5.7 Travel Patterns

Home-based work trips originating within the Grand Line Corridor were analyzed for 2015 and 2040. The purpose of this analysis was to understand the destinations of HBW trips that originated within the project corridor. Destinations that were identified as part of this analysis include:

- Within the Grand Line Corridor;
- Within the area of the System Study; and
- Outside the limits of the System Study.

An analysis of HBW trips showed that in 2015, approximately 373,000 trips originated within the Grand Line Corridor, with 45 percent of these trips remaining within the corridor. Of the remaining trips, 15 percent were destined to other locations within the limits of the System Study, while 55 percent were destined to locations outside the limits of the System Study planning area. In 2040, the number of HBW trips originating in the Grand Line Corridor increased by 49 percent to approximately 555,000 trips. A comparison of HBW trips between 2015 and 2040 shows that the percentage of trips traveling to areas other than the Grand Line Corridor stayed relatively the same. The number of trips originating within the Grand Line Corridor for 2015 and 2040 are identified in Table 2-7.

Table 2-7: Home-Based Work Trips Originating within the Grand Line Corridor

Destination Area	2015		2040	
	HBW Trips	Percent	HBW Trips	Percent
Within Grand Line Corridor	166,690	45%	224,497	40%
Within the System Study	56,375	15%	75,667	14%
Outside the System Study	206,188	55%	330,681	60%
Total	**372,878**	**100%**	**555,178**	**100%**

Source: MAG, 2018.

2.5.8 Summary

The Grand Line Corridor is expected to experience significant changes in the demographic makeup of the corridor between 2015 and 2040. During this time the corridor is expected to experience a 46 percent increase in population and a 32 percent increase in employment. The majority of the growth expected to occur will take place within the City of Surprise. Coinciding with this population and employment growth, land use development is expected to be largely residential, increasing from 40 percent in 2015 to 56 percent in the future, with much of this new growth occurring at greater than 4 dwelling unites per acre and through mixed use development. Similar to population and employment, the majority of change in land use is expected to occur within the City of Surprise along the northern end of the corridor.

There are significant railroad facilities along the Grand Line Corridor that will impact future development of commuter rail service. BNSF plans for facilities within the corridor include shifting existing yard activities north to the Ennis Wye.

The BNSF line is located immediately adjacent to Grand Avenue for the vast majority of the corridor. The level of congestion along Grand Avenue northwest of Wittmann is currently low; however that level is expected to increase to a severe level of congestion by 2040. Overall travel time from Wittmann to downtown Phoenix is expected to increase by 32 minutes between 2015 and 2040.

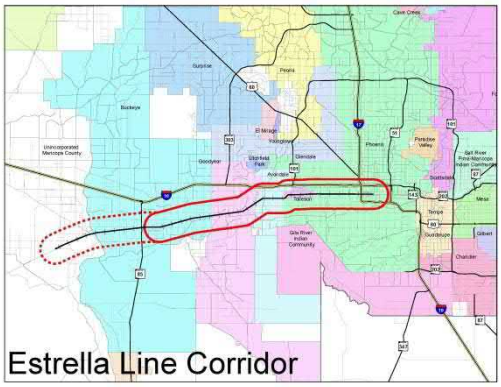
Transit services within the Grand Line Corridor are located primarily south of SR 303 and are limited north of that point. The development of the Glendale Extension of LRT was planned to increase HCT services in the future, however in early 2018, the City of Glendale elected to discontinue participation in the project. The future of LRT as a supporting mode in the Grand Avenue corridor is now unclear.

Travel patterns within the corridor are expected to remain similar between 2015 and 2040, even with a nearly 50 percent increase in HBW trips.

2.6 Estrella Line Corridor

The 30-mile Estrella Line (formerly Yuma West) Corridor has been defined by a two-mile radius surrounding the Union Pacific Railroad between Union Station in downtown Phoenix and downtown Buckeye. The cities, towns and unincorporated areas that fall within this corridor include:

- City of Phoenix;
- City of Tolleson;
- City of Avondale;
- City of Goodyear; and
- City of Buckeye.



2.6.1 Demographics

The Estrella Line Corridor had a 2015 population of approximately 355,000 people. Municipalities will experience a combined average increase in population within the corridor of 63 percent from 2015 to 2040, growing to approximately 580,000 people over that time period. The municipalities expected to experience the most significant population growth within the corridor by 2040 are the City of Buckeye, with a 216 percent increase, the City of Goodyear, with a 137 percent increase, and the City of Tolleson with a 104 percent increase. The area of the corridor that has been identified as a near term extension to Arlington is also expected to exerpience significant population growth, over 700 percent, between 2015 and 2040.

The Estrella Line Corridor is also expected to experience a significant increase in employment between 2015 and 2040. With an expected 43 percent increase in employment to approximately 373,000 jobs, the Estrella Line Corridor will continue to grow through and beyond the year 2040. Of the municipalities that make-up the corridor, the City of Buckeye is expected to experience the greatest employment growth, with a 365 percent increase in jobs in the corridor. Other municipalities expected to experience significant employment growth are the City of Goodyear and the City of Avondale, with a 127 percent increase and 83 percent increase in jobs in the corridor respectively. Employment within the near term extension area of the corridor is also expected to experience growth, nearly 150 percent by 2040.

Table 2-8 and Table 2-9 show both the existing and forecasted population and employment within the Estrella Line Corridor.

Table 2-8: Estrella Line Corridor Population Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change 2015-2040
City of Phoenix	225,772	318,476	41%
City of Tolleson	6,841	13,962	104%
City of Avondale	62,919	85,767	36%
City of Goodyear	33,931	80,468	137%
City of Buckeye	25,732	81,216	216%
Total	**355,195**	**579,889**	**63%**
Extension Area	2,949	24,346	725%

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

Table 2-9: Estrella Line Corridor Employment Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change 2015-2040
City of Phoenix	208,006	260,202	25%
City of Tolleson	14,034	18,446	31%
City of Avondale	14,751	27,060	83%
City of Goodyear	19,175	43,544	127%
City of Buckeye	5,073	23,596	365%
Total	**261,039**	**372,848**	**43%**
Extension Area	3,584	8,892	148%

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

2.6.2 Land Use

The Estrella Line Corridor contains a variety of land uses stretching from downtown Phoenix to the City of Buckeye. Table 2-10 summarizes existing land uses as of the year 2016 as well as future land use at build-out within the Estrella Line Corridor distinguished by land use category. The most prevalent existing land use in the corridor is Open Space/Recreation, which comprises 39 percent of the total corridor. Other significant existing land uses include residential, comprising 21 percent of the total corridor land uses. As shown in Figure 2-6, much of the vacant land and open space within the corridor is projected to be developed by 2040. Residential land uses are projected to increase, with 39 percent of the total corridor comprising residential uses by 2040.

Table 2-10: Estrella Line Corridor Existing and Future Land Use

Land Use Category	Existing Land Use (2016)		Future Land Use (Build-out)*	
	Acres	Percent of Total	Acres	Percent of Total
Residential (<1 du/acre)	2,530	3.0%	3,710	4.4%
Residential (1 – 4 du/acre)	1,552	1.8%	8,702	10.3%
Residential (>4 du/acre)	13,768	16.2%	20,602	24.4%
Commercial	3,332	3.9%	5,432	6.4%
Industrial	10,874	12.8%	14,975	17.8%
Mixed Use	11	0.0%	10,709	12.7%
Office	317	0.4%	797	0.9%
Open Space / Recreation	32,861	38.7%	6,895	8.2%
Public / Private Institutions	5,819	6.8%	6,128	7.3%
Transportation / Parking	6,287	7.4%	6,352	7.5%
Vacant	7,644	9.0%	0	0.0%
Total	**84,995**	**100.0%**	**84,303**	**100.0%**
Extension Land Area	37,549		37,548	

Source: MAG, 2018.
*Future Land Use data includes gaps within Estrella Line Corridor impacting total acreage

Those locations within the Estrella Line Corridor that have the potential to generate ridership based on land use have been identified as activity centers. Activity centers that have been identified throughout the corridor include:

- Downtown Phoenix;
- Downtown Avondale;
- Goodyear Spring Training Complex;
- Phoenix-Goodyear Airport;
- Downtown Buckeye; and
- Palo Verde Nuclear Generating Station (potential future extension).

Additional major activity centers within the corridor, or located outside the two-mile radius, include the Phoenix International Raceway and the State Fair Grounds. Additional activity centers located throughout this corridor, and the relationship they have with potential station locations have been identified in Appendix C: Conceptual Station Planning Technical Memorandum of the Estrella Line Corridor Development Plan.

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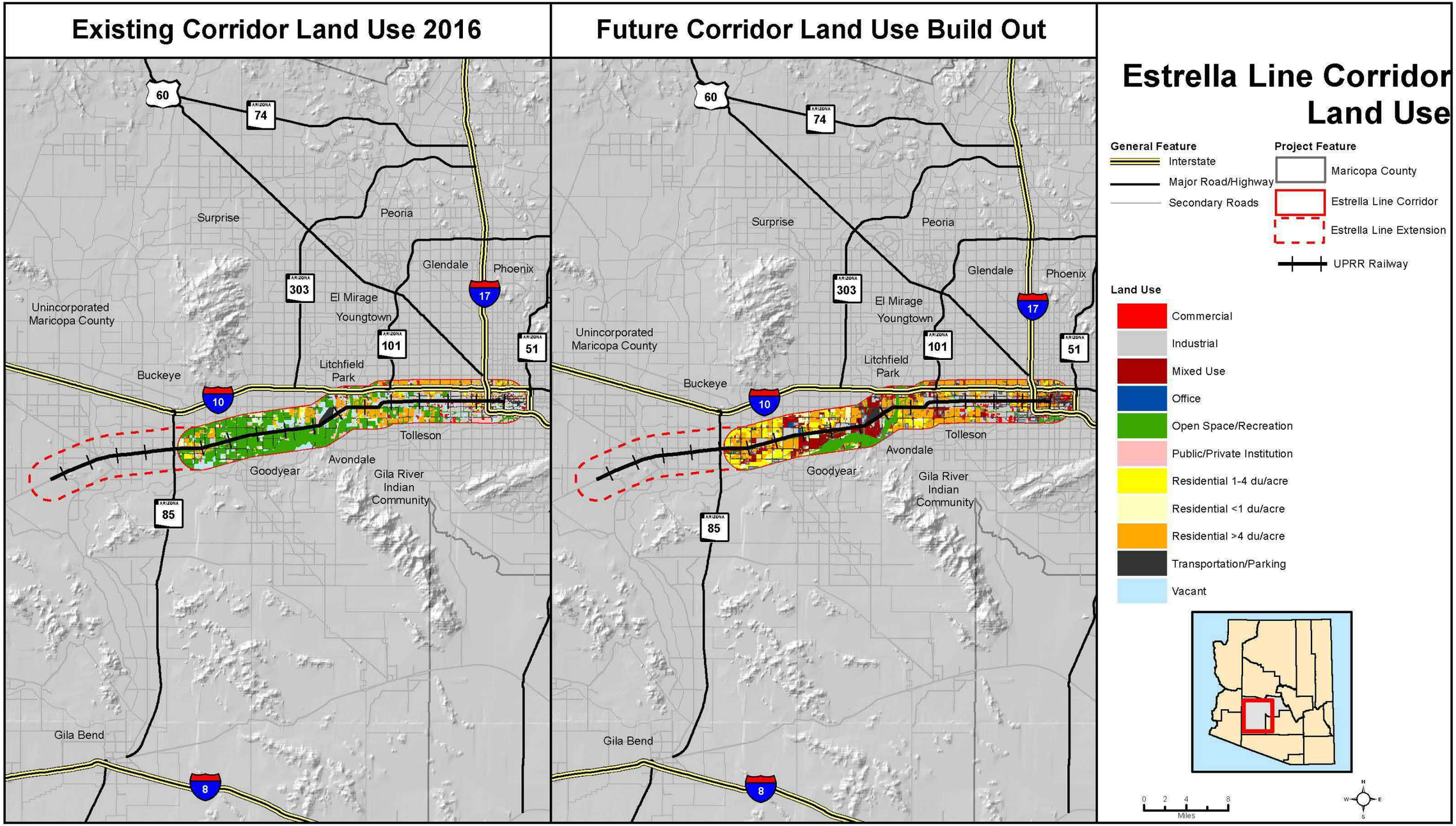
Figure 2-6: Estrella Line Corridor – Land Use



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2.6.3 Planning Context

The following general and transportation planning documents are summarized to illustrate the level of planning that has occurred in the communities where commuter rail service would be implemented in the Estrella Line Corridor.

General Plans

City of Tolleson General Plan 2024 (2014)

The City of Tolleson General Plan was completed in 2014. As described in the plan, over 80 percent of Tolleson residences are located less than ½ mile from Van Buren Street and almost all of the residential development within the City is located within one square mile, generally centered around 91st Avenue and Van Buren Street. Residential land uses comprise approximately 12 percent of the total developed acres within Tolleson. While there is mention of the Union Pacific Railroad on the Estrella Line, most of transit discussion focuses on LRT along I-10. The General Plan states that much of Tolleson does not have convenient access to transit services. With future LRT service planned along I-10 to 79th Avenue, transit access from Tolleson to the LRT service and the nearby Desert Sky Mall Transit Center is desirable. The City clearly sees LRT along I-10 as the corridor that will be implemented first and has described connections to this as being an important aspect of the community.

City of Avondale General Plan 2030 (2012)

The City of Avondale General Plan was completed in 2012. The land use element of the plan is intended to guide the City in making land use changes to achieve a balanced community. The plan notes that land use patterns are critical to the health and well-being of Avondale residents. Healthy land use patterns can be achieved by encouraging infill; focusing development in mixed-use districts and around major transit centers and corridors; constructing a diverse mix of uses throughout the City; and encouraging land use patterns that promote walking, bicycling, and transit use. Together with a range of land uses that foster variety and choice, the city plans to accommodate a range of lifestyles, living, and working conditions to foster a solid community foundation for Avondale to grow.

The circulation element of the plan has a goal of promoting and supporting an integrated transportation system that mitigates congestion, fosters a sense of community, and preserves the environment. Policies to meet this goal include the encouragement of the sustainability and enhancement of transit service within the City by implementing a long range transit plan and through seeking funding opportunities for future BRT and other modes of transit infrastructure, including the development of the Avondale City Center Transit Center.

The TOD element notes that Avondale continues to be vocal as the City pursues future transit opportunities and discussions. The City was an active participant in the MAG Sustainable Transportation and Land Use Integration Study. The Study looked at land use and what cities can do to make themselves more attractive to transit in the long term.

City of Goodyear 2025 General Plan (2014)

The City of Goodyear 2025 General Plan was approved in 2014. One of the goals is to create an efficient multimodal transit system and options for alternative modes of travel. An objective that feeds this goal is to allow and encourage taller buildings to support higher densities and employment uses in appropriate existing locations; provide places to park near transit stations; and, include a mix of uses such as commercial, residential, recreation, and arts. A transit

objective is to establish a transit system that meets the needs of the residents, workforce, and visitors, with policies that include establishing a local circulator bus system in conformance with the Transportation Master Plan, Southwest Valley Transit System Study, and the needs of the community as well as to work with MAG and other regional partners to explore the development of a commuter rail.

The land use and transportation plan has a TOD Overlay which adds standards that include: Development in the TOD Overlay should be pedestrian oriented and walkable/bikeable; mixed use developments may be considered anywhere within in the TOD Overlay and are highly encouraged; higher density and intensity uses are encouraged in the TOD Overlay; and automobile-oriented uses that inhibit walkability are discouraged.

Transportation Plans

MAG Southwest Valley Local Transit System Study: Local Transit System Plan (2013)

The Local Transit System Plan looked at demographics, commute patterns, and existing and planned transit improvements in the Southwest Valley. It provided short term recommendations that included increased bus route frequencies and new circulator routes; mid-term recommendations that included extensions of the arterial grid fixed routes, expanded circulator routes, and new flex service routes; and long-term recommendations that included further extensions of the arterial grid fixed routes, improved service of the arterial grid fixed routes, and additional flex service routes.

City of Avondale Transportation Plan Update (2012)

The Transportation Plan Update noted that many of the recommendations from the previous plan had been implemented by 2012. However, due to regional funding shortfalls, some local bus service had been eliminated, and future bus expansion would be difficult given the funding trends. The study recommended that the City participate in the Southwest Valley Local Transit System Study administered by the MAG. Finally, the Avondale City Center Transit Center, located just off of I-10, on Avondale Boulevard and Roosevelt Street, opened in 2014. The Avondale ZOOM Circulator route began operation in July 2011 after the 2010 Feasibility Study was completed.

Town of Goodyear Transportation Master Plan (2014)

The Goodyear Transportation Plan was developed with five goals, one of which relate to transit. Goal B calls for a community that is linked internally and externally with adequate transit service to meet the needs of its residents, workers, and visitors. Major destinations in Goodyear include the Phoenix-Goodyear Airport, Goodyear Ballpark, Goodyear City Center, and the Estrella Falls Regional Mall.

Existing transit service in Goodyear includes fixed-route bus service (local, express, and rural routes), circulator service, and paratransit service. Goodyear's current transit service is limited and is primarily focused east of Litchfield Road in the McDowell Road, Van Buren Street, and I-10 corridors. The Goodyear Park-and-Ride is located at the northwestern corner of Dysart Road and I-10 and serves Routes 562 (Goodyear Express) and 563 (Buckeye Express). The Goodyear Park-and-Ride includes approximately 400 covered parking spaces.

The plan codifies transit service needs including high-capacity transit in the Estrella Line Corridor, which is shown as a long-term improvement. The plan states that this service will likely

depend on the development of other commuter rail service in the region (most notably the San Tan Line Corridor) and the outcome of the ADOT Passenger Rail Study.

2.6.4 Railroad Characteristics

Railroad Infrastructure

For the purposes of this study, the Estrella Line Corridor refers to the segment of the Union Pacific Railroad Phoenix Subdivision that extends from Union Station in downtown Phoenix to Arlington, a distance of approximately 45 miles. The Phoenix Subdivision formerly hosted Amtrak's *Sunset Limited*, but since June 1996, the train uses the Gila Line, or Sunset main line, through Maricopa south of Phoenix.

Conceptual Buckeye station site located near downtown Buckeye, AZ. Source: MAG.

When the Estrella Line Corridor was used by Amtrak until June 1996, the line was controlled by Direct Traffic Control (DTC) and Automatic Block Signals (ABS). The maximum operating speed was 60 mph for passenger trains. The line is single track with a few sidings and frequent industrial leads and spur tracks. There are no existing Quiet Zones located in the Estrella Line Corridor. PTC is not in-effect on this corridor at present time.

In total, there are 34 public and private at-grade track crossings and 4 grade-separated crossings between Union Station and the proposed end-of-line in the City of Buckeye.

The portion of the Phoenix Subdivision within the corridor currently averages a total of approximately three-four local/switching trains a day. Union Pacific Railroad has made many improvements throughout the corridor including the completed the construction of Campo Yard in the late 2000s, added three additional tracks and a trans-load track to the Phoenix Yard, and made improvements to the Phoenix Automobile Facility at Harrison Street Yard in downtown.

Additional Union Pacific Railroad facilities located throughout the Estrella Line Corridor are shown in Figure 2-7 and include:

- Phoenix Union Station (Union Pacific Railroad MP 906.0; BNSF MP 194);
- Campo Yard (MP 902.0);
- Downtown Buckeye Yard (MP 875.7);
- Buckeye – Palo Verde Rd Yard (MP 870) (potential future extension); and
- Palo Verde Nuclear Power Plant Spur (MP 859.3) (potential future extension).

Union Pacific Railroad has identified various potential future improvements throughout the Estrella Line Corridor and the Phoenix Subdivision which include expanding its yard in west Buckeye-Palo Verde Rd to serve customers in the West Valley. In addition, according to the ADOT State of Arizona 2015 Railroad Inventory and Assessment Report (2015), a private developer has expressed interest in building a cement manufacturing and distribution plant near

99th Avenue and Buckeye Road in Tolleson. These railroad infrastructure improvements would allow for enhanced freight service as well as facilitate needed improvements should potential commuter rail service be implemented.

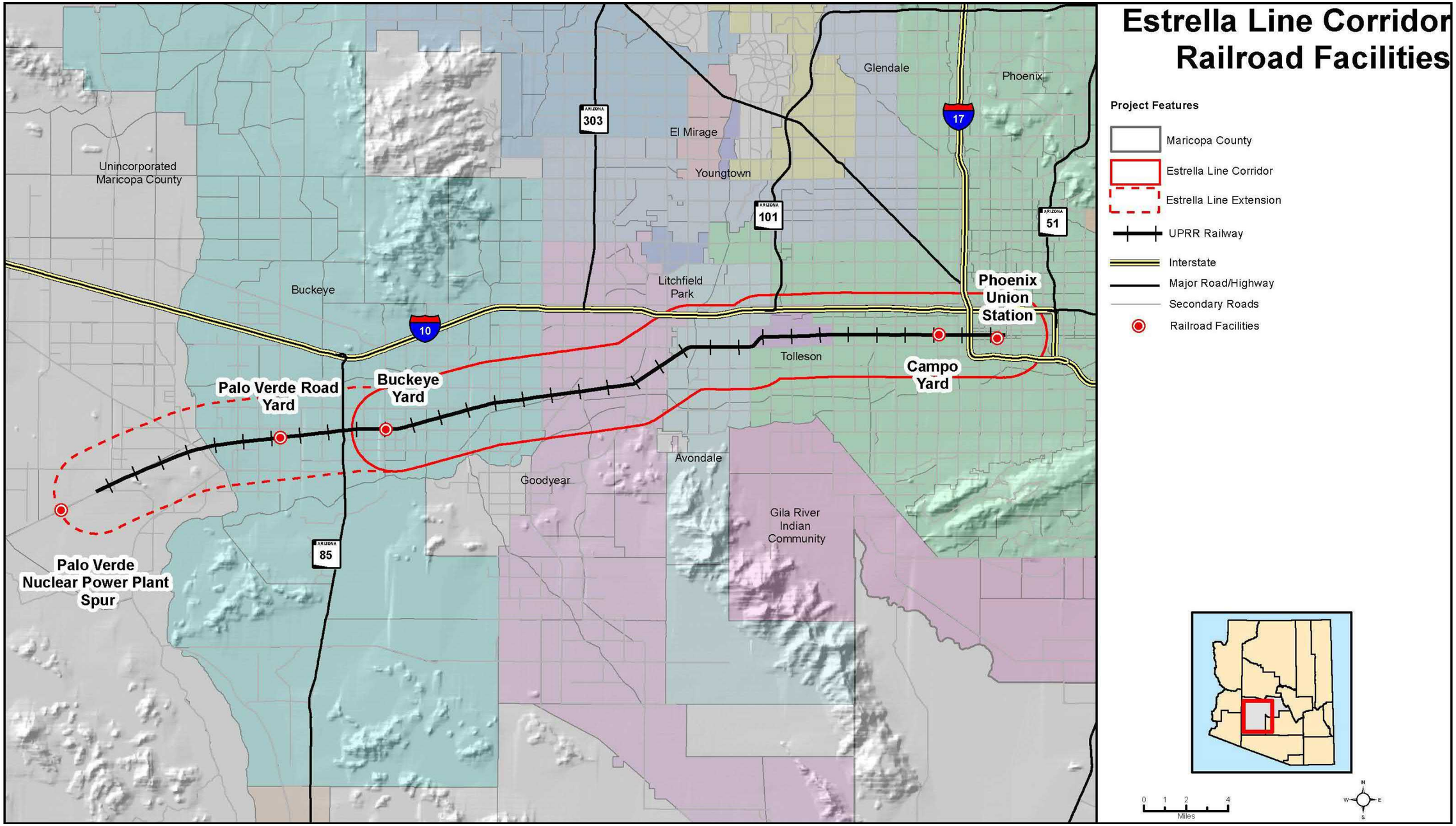
For a more detailed description of Estrella Line Corridor railroad conditions and existing and planned facilities, see Appendix E: Systems Study Railroad Conditions and Issues.

Railroad Operations

The following daily railroad operations are typical in a given 24-hour period in the Estrella Line Corridor. These numbers represent averages and can change regularly given the nature of the movement of freight.

- Phoenix Harrison Street Yard (MP 907) to Buckeye (MP 875.7) = **3-4 trains per day**

Figure 2-7: Estrella Line Corridor – Railroad Facilities



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2.6.5 Highway Characteristics

The primary travel path for those living at the western edge of the Estrella Line Corridor and Maricopa County commuting into downtown Phoenix is the eastbound I-10. In its current state, I-10 ranges from eight to ten general use lanes in addition to a HOV lane extending from approximately SR 303 into downtown Phoenix.

Several roadway projects have been completed or are planned along the Estrella Corridor since the 2010 Study, in an effort provide additional capacity. A summary of these improvements are shown in Table 2-11.

Table 2-11: Estrella Line Corridor Recent and Future Roadway Improvements

Improvement	Extent	Opening Date	Current Status
Phase II SR 303/I-10 Interchange	SR 303/I-10 Interchange	2018	Construction
SR 202 South Mountain Freeway	I-10 (Maricopa Freeway) to I-10 (Papago Freeway)	2019	Design/ Construction
Phase II I-10 Widening	SR 101 to I-17	2023	Planning/Design

Source: MAG, 2018.

Travel Characteristics: Travel Time, Volume and Congestion

The travel path identified to analyze the Estrella Line Corridor follows the I-10 alignment between downtown Phoenix and SR 85 to downtown Buckeye. For the purposes of this analysis, the intersection of Washington Street and Central Avenue in downtown Phoenix and the intersection of Baseline and Miller roads in downtown Buckeye were used as endpoints to measure travel characteristics. The travel path for this corridor totals 35 miles and was broken down into two segments in order to compare travel characteristics on both ends of the corridor. Table 2-12 compares the travel characteristics of the two segments for the AM peak period in 2015 and 2040.

Table 2-12: Estrella Line AM Peak Period Travel Characteristics (2015 – 2040)

2015 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Baseline Road/Miller Road to I-10/SR 303	14 miles	16 minutes	N/A (no HOV)	14 minutes	1 – 3	300 –12,000
Segment #2: I-10/SR 303 to Downtown Phoenix	21 miles	33 minutes	22 minutes	20 minutes	2 – 5	1,600 – 31,000
Total Trip (to Buckeye)	**35 miles**	**49 minutes**	**38 minutes**	**33 minutes**	–	**300 – 31,000**
Segment #3: Narramore Road/355th Avenue to Baseline Road/Miller Road	16 miles	23 minutes	N/A (no HOV)	19 minutes	1	100 – 900
Total Trip (to Arlington)	**51 miles**	**72 minutes**	**61 minutes**	**53 minutes**	–	**100 – 31,000**
2040 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Baseline Road/Miller Road to I-10/SR 303	14 miles	25 minutes	N/A (no HOV)	14 minutes	1 – 3	500 – 21,000
Segment #2: I-10/SR 303 to Downtown Phoenix	21 miles	49 minutes	30 minutes	20 minutes	2 – 5	2,000 – 37,900
Total Trip (to Buckeye)	**35 miles**	**74 minutes**	**54 minutes**	**33 minutes**	–	**500 – 37,900**
Segment #3: Narramore Road/355th Avenue to Baseline Road/Miller Road	16 miles	25 minutes	N/A (no HOV)	19 minutes	1 – 2	100 – 2,500
Total Trip (to Arlington)	**51 miles**	**99 minutes**	**79 minutes**	**53 minutes**	–	**100 – 37,900**

Source: MAG, 2018.

Between 2015 and 2040, travel characteristics in the AM peak travel period are expected to slightly change. Between the intersection of Narramore Road and 355th Avenue in Arlington and the intersection of Baseline Road and Miller Road in Buckeye, traffic volumes are not expected to change significantly, causing a two-minute travel time difference. From the Baseline and Miller roads intersection to the intersection of I-10 and SR 303, traffic volume is expected to nearly double and travel time in this segment is projected to increase by nine minutes. Traffic volume is also expected to increase between SR 303 and downtown Phoenix along I-10, with the travel time along this segment of the corridor is projected to increase by 16 minutes (from 33 minutes in 2015 to 49 minutes in 2040). The anticipated increase in traffic volume and overall trip time can be related to the socioeconomic and land use expectations surrounding the municipalities along this corridor. High occupancy vehicle travel times were studied to help determine how effective commuter rail could be in each of the corridors. There are HOV lanes on I-10 to SR 303, and the HOV travel time is 10 minutes faster for this segment in the AM peak period compared to that of the general purpose lanes. Off-peak travel times were also studied to

illustrate the travel time degredation during peak periods. The table shows that travel times in the AM peak period are generally more than double that of off-peak travel times in 2015, and get even worse by 2040.

Similar to the AM peak period travel characteristics, PM peak period travel time, volume and congestion were analyzed. Table 2-13 shows the comparison between 2015 and 2040 PM peak period travel characteristics in the Estrella Line Corridor.

Table 2-13: Estrella Line PM Peak Period Travel Characteristics (2015 – 2040)

2015 PM Peak Period Travel Characteristics						
Segment	**Distance**	**Peak Travel Time**		**Off-Peak Travel Time**	**Lanes**	**Traffic Volume (vehicles)**
		SOV	**HOV**			
Segment #1: Downtown Phoenix to I-10/SR 303	21 miles	32 minutes	23 minutes	20 minutes	2 – 5	3,800 – 38,800
Segment #2: I-10/ SR 303 to Baseline Road/Miller Road	14 miles	16 minutes	N/A (no HOV)	14 minutes	1 – 3	500 – 17,000
Total Trip (to Buckeye)	**35 miles**	**48 minutes**	**40 minutes**	**33 minutes**	–	**500 – 38,8000**
Segment #3: Baseline Road/Miller Road to Narramore Road/355th Avenue	16 miles	23 minutes	N/A (no HOV)	19 minutes	1	100 – 1,500
Total Trip (to Arlington)	**51 miles**	**71 minutes**	**63 minutes**	**53 minutes**	–	**100 – 38,800**
2040 PM Peak Period Travel Characteristics						
Segment	**Distance**	**Peak Travel Time**		**Off-Peak Travel Time**	**Lanes**	**Traffic Volume (vehicles)**
		SOV	**HOV**			
Segment #1: Downtown Phoenix to I-10/SR 303	21 miles	47 minutes	31 minutes	20 minutes	2 – 5	5,000 – 44,500
Segment #2: I-10/ SR 303 to Baseline Road/Miller Road	14 miles	24 minutes	N/A (no HOV)	14 minutes	1 – 3	800 – 28,600
Total Trip (to Buckeye)	**35 miles**	**71 minutes**	**55 minutes**	**33 minutes**	–	**800 – 44,500**
Segment #3: Baseline Road/Miller Road to Narramore Road/355th Avenue	16 miles	25 minutes	N/A (no HOV)	19 minutes	1 – 2	100 – 4,100
Total Trip (to Arlington)	**51 miles**	**96 minutes**	**80 minutes**	**53 minutes**	–	**100 – 44,500**

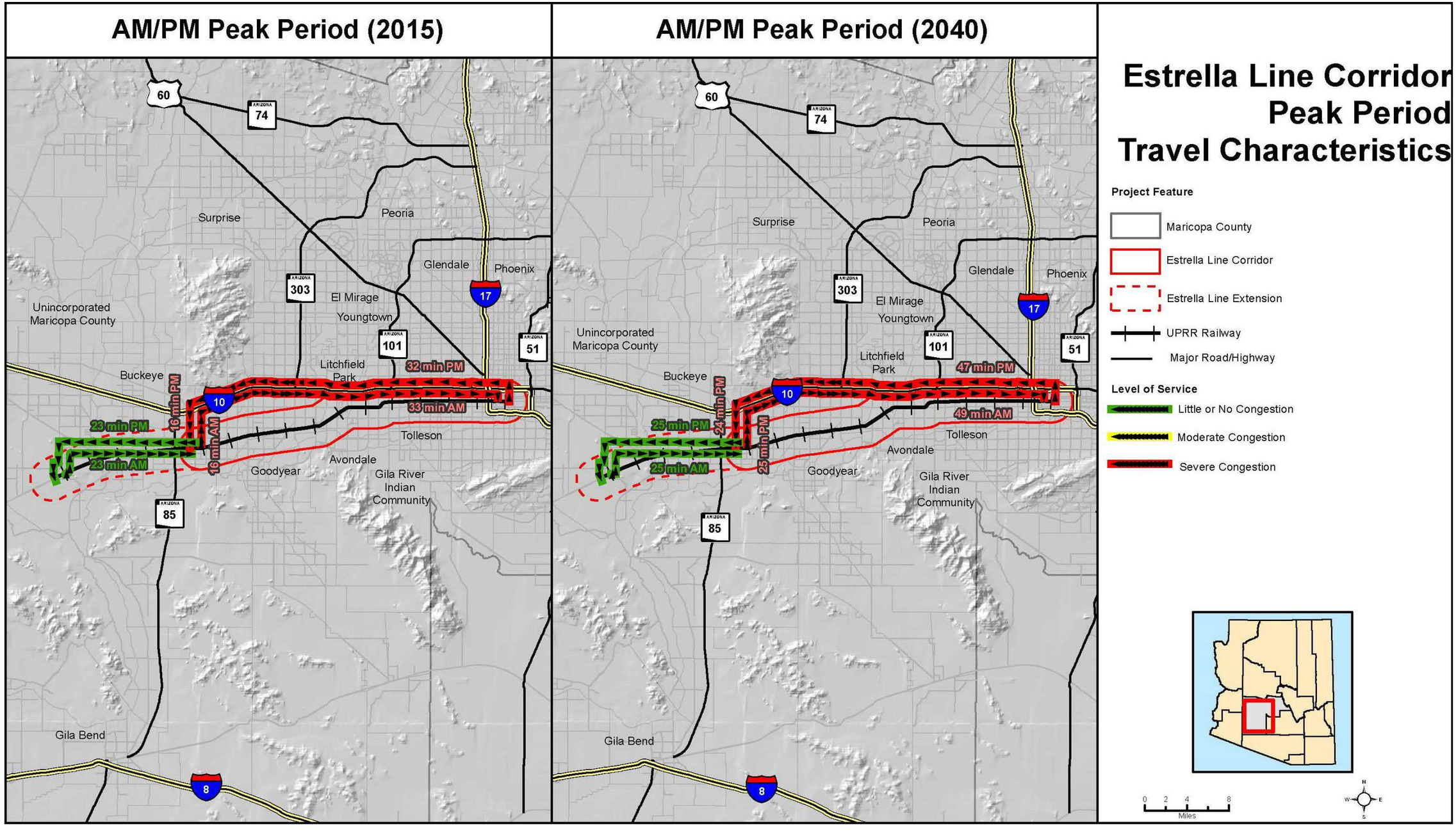
Source: MAG, 2018.

In 2015, travel time between downtown Phoenix and SR 303 in the PM peak period was 32 minutes. The travel time is still expected to worsen by 2040 with an increase of 15 minutes. Similarly, travel time between SR 303 and the Baseline and Miller roads intersection in Buckeye took 16 minutes in 2015 and is expected to increase to 24 minutes by 2040 in the PM Peak. Finally, the segment between the Baseline and Miller roads intersection and the previous end-of-line in Arlington was projected to take 23 minutes. In 2040, this segment is expected to take 25 minutes. This anticipated increase in travel time can be attributed to the projected socioeconomic growth and shift in land use to more residential development within the central

portion of the corridor. The HOV travel time is 8 minutes faster for this segment in the PM peak period in 2015 and is projected to be 16 minutes faster in 2040 compared to that of the general purpose lanes. Off-peak travel times were also studied to illustrate the travel time degredation during peak periods. The table shows that travel times are one and a half times as long in 2015, and double in 2040, compared to the off-peak travel times.

The level of congestion throughout the corridor is expected to deteriorate in the future. In 2015, the segment of the corridor between Buckeye and SR 303 is already experiencing severe congestion during both the AM and PM peak periods. Figure 2-8 shows the travel path for the Estrella Line Corridor as well as the level of congestion and travel times in both the AM and PM peak period in 2015 and 2040. Note that levels of congestion within downtown Phoenix are shown, but actual travel times for this area are not shown in this figure.

Figure 2-8: Estrella Line Corridor – Peak Period Travel Characteristics



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2.6.6 Transit Service

Transit services that are currently provided or are planned for future implementation in the Estrella Line Corridor include fixed route bus service, HCT and transit passenger facilities. Figure 2-9 depicts both the existing and planned regional transit network within the Estrella Line Corridor.

Fixed Route Bus Service

Fixed route bus service within the Estrella Line Corridor is comprised of local bus, circulators, regional connectors, and express bus service.

Local Bus

Within the Estrella Line Corridor, local bus service is provided seven days a week and operates between 5:00 AM and 11:00 PM on the weekdays and between 6:00 AM and 9:30 PM on the weekends. In all, 22 local bus routes currently serve the corridor with nearly two-thirds of the routes operating a weekday peak frequency of 30 minutes or better.

Circulators

The 2010 Study described two circulator routes that operate in the eastern portion of the Estrella Line Corridor, both of which operated by the City of Phoenix. The Downtown Area Shuttle (DASH) provides service along two separate fixed routes identified as either a downtown or government route. In addition to the DASH service, the City of Phoenix operates the Maryvale Area Ride for You (MARY) which provides service to the village of Maryvale within the City of Phoenix.

Due to the lack of transit services in the cities of Goodyear and Avondale, these municipalities conducted separate feasibility studies to determine whether implementing circulator service would benefit the local communities. Avondale implemented its ZOOM circulator in 2011 and it provides 30-minute frequencies from 5:30 AM to 8:00 PM.

Rural Routes

The only rural route that operates within the Estrella Line Corridor is the Ajo/Gila Bend to Phoenix, known as Route 685. This route provides the western most transit service within the corridor and operates Monday through Saturday between the community of Ajo and Desert Sky Mall Transit Center in Phoenix.

BRT/Express Bus

The 2010 Study described three express routes. Today two express routes serve the corridor (562 – Goodyear Express and 563 – Avondale/Buckeye Express). These routes utilize I-10 as the primary connection to downtown Phoenix and the Goodyear and Avondale/Buckeye communities, respectively. Both routes provide four round trips focusing on peak period commute trips to downtown Phoenix.

There is no existing or planned arterial BRT service operating within the Estrella Line Corridor.

High Capacity Transit

Valley Metro LRT serves the Estrella Line Corridor only in portions of downtown Phoenix. However, the RTP identifies an 11-mile HCT extension from the Valley Metro LRT Line west

along I-10 to approximately the 79th Avenue Park-and-Ride. This extension is programmed to open in 2030.

Transit Passenger Facilities

Transit facilities located within the Estrella Line Corridor include transit center and park-and-ride facilities.

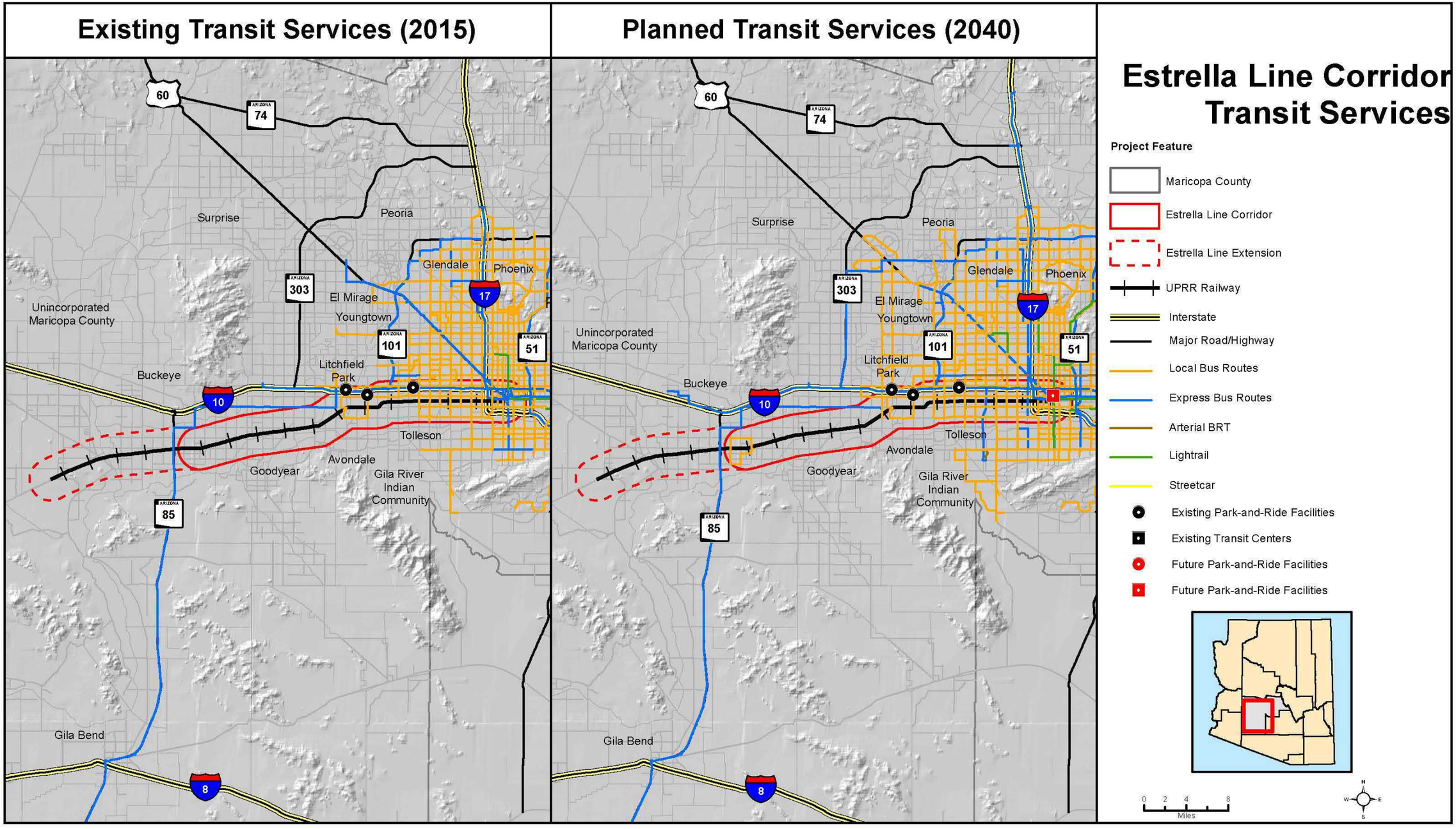
Transit Centers

The Desert Sky Transit Center is located on Thomas Road at the Desert Sky Mall. The transit center is served by Rural Route 685 and several local routes.

Park-and-Ride Facilities

The 2010 Study had two existing park-and-ride facilities located within the Estrella Line Corridor. The 79th Avenue Park-and-Ride and the Goodyear Park-and-Ride, both located off I-10, provide connections with transit service in the West Valley. Two additional park-and-ride facilities have been implemented since, including the Buckeye Park-and-Ride and the Avondale Park-and-Ride. Figure 2-9 identifies the existing facilities.

Figure 2-9: Estrella Line Corridor – Transit Services



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2.6.7 Travel Patterns

Home-based work trips originating within the Estrella Line Corridor were analyzed for 2015 and 2040. The purpose of this analysis was to understand the destinations of those HBW trips that originated within the corridor. Destinations that were identified as part of this analysis include trips:

- Within the Estrella Line Corridor;
- Within the area of the System Study; and
- Outside the limits of the System Study.

An analysis of HBW trips showed that in 2015, just over 205,000 trips originated within the Estrella Line Corridor, with 51 percent of these trips remaining within the corridor. Of the remaining trips, 23 percent were destined to other locations within the limits of the System Study, and 26 percent were destined to locations outside the limits of the System Study planning area. In 2040, the number of HBW trips originating in the Estrella Line Corridor increased by nearly 80 percent to about 370,000 total trips. A comparison of HBW trips between 2015 and 2040 shows that the percentage of HBW trips traveling to locations outside the System Study planning area increased by six percent, while trips within the limits of the System Study decreased by four percent. The number of total HBW trips originating within the Estrella Line Corridor for 2015 and 2040 are identified in Table 2-14.

Table 2-14: Home-Based Work Trips Originating within the Estrella Line Corridor

Destination Area	2015		2040	
	HBW Trips	Percent	HBW Trips	Percent
Within Estrella Line Corridor	104,452	51%	178,828	49%
Within the System Study	48,376	23%	71,004	19%
Outside the System Study	55,557	26%	118,701	32%
Total	**206,385**	**100%**	**368,533**	**100%**

Source: MAG, 2018.

2.6.8 Summary

The Estrella Line Corridor is expected to experience significant changes in the demographic makeup of the corridor between 2015 and 2040. During this time the corridor is expected to experience a 63 percent increase in population and a 43 percent increase in employment. The majority of the change expected to occur will take place west of SR 101. Similar to the Grand Line Corridor, the change in future land use in the Estrella Line Corridor is anticipated to largely be an increase in residential development, with much of this new growth occurring at greater than 4 dwelling unites per acre and through mixed use development. Similar to population and employment growth projections, the majority of change in land use is expected to occur west of SR 101.

Railroad facilities within the corridor include significant yards and junctions used during railroad operations, but are otherwise limited. There are several potential future railroad improvements identified within the corridor, including new yards and manufacturing plants which have been initiated by both the Union Pacific Railroad and private developers.

The primary travel path identified for this analysis from the City of Buckeye into downtown Phoenix is I-10. Despite the expansion that has occurred and is planned, congestion along I-10

is expected to increase. As a result future travel times between downtown Phoenix and the City of Buckeye are expected to increase as well.

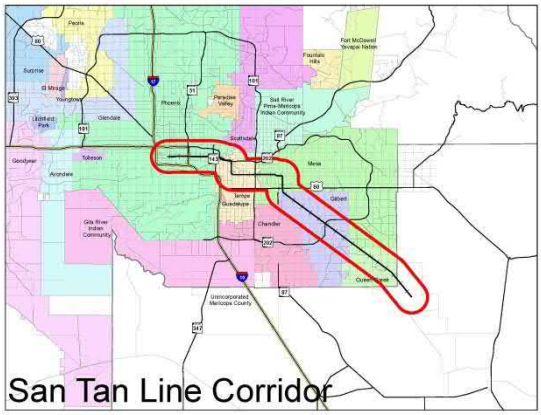
Transit services within the Estrella Line Corridor are located primarily east of SR 303 and are limited west of that point. The development of the I-10 West Extension of LRT will increase transit services in the future. Limited transit services west of SR 303 are expected remain through 2040.

Travel patterns within the corridor are largely expected to remain similar between 2015 and 2040.

2.7 San Tan Line Corridor

The 41-mile San Tan Line (formerly Southeast) Corridor has been defined by a two-mile radius surrounding the Union Pacific Railroad line between Union Station in San Tan Valley. The cities, towns, and Indian Communities that fall within the San Tan Line Corridor include:

- City of Phoenix;
- City of Scottsdale;
- City of Tempe;
- City of Mesa;
- City of Chandler;
- Town of Gilbert;
- Town of Queen Creek; and
- Salt River Pima-Maricopa Indian Community.



2.7.1 Demographics

The San Tan Line Corridor had a total population of just under 686,000 people in 2015 and will experience a 47 percent increase in population to approximately 1,000,000 people by 2040. The most significant growth is expected to occur in Queen Creek, with a 101 percent increase in population, while the City of Tempe is expected to grow by 67 percent.

The San Tan Line Corridor is also expected to experience an increase in employment growth during the same period of time. The San Tan Line Corridor had a total of approximately 536,000 jobs in 2015 and will experience a 34 percent increase in employment to over 700,000 jobs by 2040. Similar to the results seen in population growth, Queen Creek is expected to experience the most significant employment growth, with an 122 percent increase. The Salt River Pima-Maricopa Indian Community is expected to rapidly increase employment by 1,233 percent from 104 to 1,386 jobs. Other municipalities expected to experience considerable employment growth are the City of Scottsdale, with a 66 percent increase, Town of Gilbert with a 49 percent increase and the City of Mesa, with a 47 percent increase in employment by 2040.

Table 2-15 and Table 2-16 show the existing and forecasted population and employment growth for all municipal planning areas located within the San Tan Line Corridor.

Table 2-15: San Tan Line Corridor Population Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change 2015-2040
City of Phoenix	139,732	228,013	60%
City of Scottsdale	10,875	17,430	60%
City of Tempe	116,319	193,890	67%
City of Mesa	175,515	245,289	40%
City of Chandler	19,427	31,223	61%
Town of Gilbert	188,785	228,862	21%
Town of Queen Creek	33,965	68,374	101%
Salt River Pima-Maricopa Indian Community	928	928	0%
Total	**685,546**	**1,009,009**	**47%**

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

Table 2-16: San Tan Line Corridor Employment Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change 2015-2040
City of Phoenix	226,763	275,051	21%
City of Scottsdale	6,203	10,321	66%
City of Tempe	125,796	164,472	31%
City of Mesa	82,359	121,385	47%
City of Chandler	10,966	14,372	31%
Town of Gilbert	76,040	113,622	49%
Town of Queen Creek	7,808	17,305	122%
Salt River Pima-Maricopa Indian Community	104	1,386	1,233%
Total	**536,039**	**717,914**	**34%**

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

2.7.2 Land Use

The San Tan Line Corridor includes a variety of land uses as it stretches between downtown Phoenix and downtown Queen Creek as shown in Figure 2-10. Table 2-17 summarizes existing land uses as of the year 2016 as well as future land use at build-out within the San Tan Line Corridor distinguished by land use category. The most prevalent existing land use in the corridor is residential, which comprises 36 percent of the total corridor. Other significant existing land uses are Open Space/Recreation and Transportation/Parking with 14 and 11 percent respectively. At build-out, the land use mix is expected to be similar to existing uses, with residential uses comprising 39 percent of the total corridor.

Table 2-17: San Tan Line Corridor Existing and Future Land Use

Land Use Category	Existing Land Use (2016)		Future Land Use (Build-out)	
	Acres	Percent of Total	Acres	Percent of Total
Residential (<1 du/acre)	3,065	2.9%	3,492	3.3%
Residential (1 – 4 du/acre)	6,861	6.4%	8,883	8.3%
Residential (>4 du/acre)	28,462	26.6%	29,713	27.8%
Commercial	5,474	5.1%	6,232	5.8%
Industrial	7,387	6.9%	8,640	8.1%
Mixed Use	99	0.1%	6,572	6.1%
Office	1,982	1.9%	1,947	1.8%
Open Space / Recreation	14,562	13.6%	7,228	6.8%
Public / Private Institutions	10,016	9.4%	10,020	9.4%
Transportation / Parking	11,449	10.7%	11,413	10.7%
Vacant	4,783	4.5%	0	0.0%
Outside Maricopa County	12,757	11.9%	12,757	11.9%
Total	**106,897**	**100.0%**	**106,897**	**100.0%**

Source: MAG, 2018.

Those locations within the San Tan Line Corridor that have the potential to generate ridership based on land use have been identified as activity centers. Activity centers in the San Tan Line Corridor include:

- Downtown Phoenix;
- Phoenix Sky Harbor International Airport;
- Arizona State University (ASU);
- Downtown Tempe;
- East Valley Institute of Technology;
- Downtown Mesa;
- Downtown Gilbert;
- San Tan Regional Mall;
- Arizona State University Polytechnic Campus;
- Phoenix-Mesa Gateway Airport; and
- Downtown Queen Creek.

Additional activity centers specific to the San Tan Line Corridor that relate to potential station locations have been identified in Appendix C: System Study Station Target Area Evaluation.

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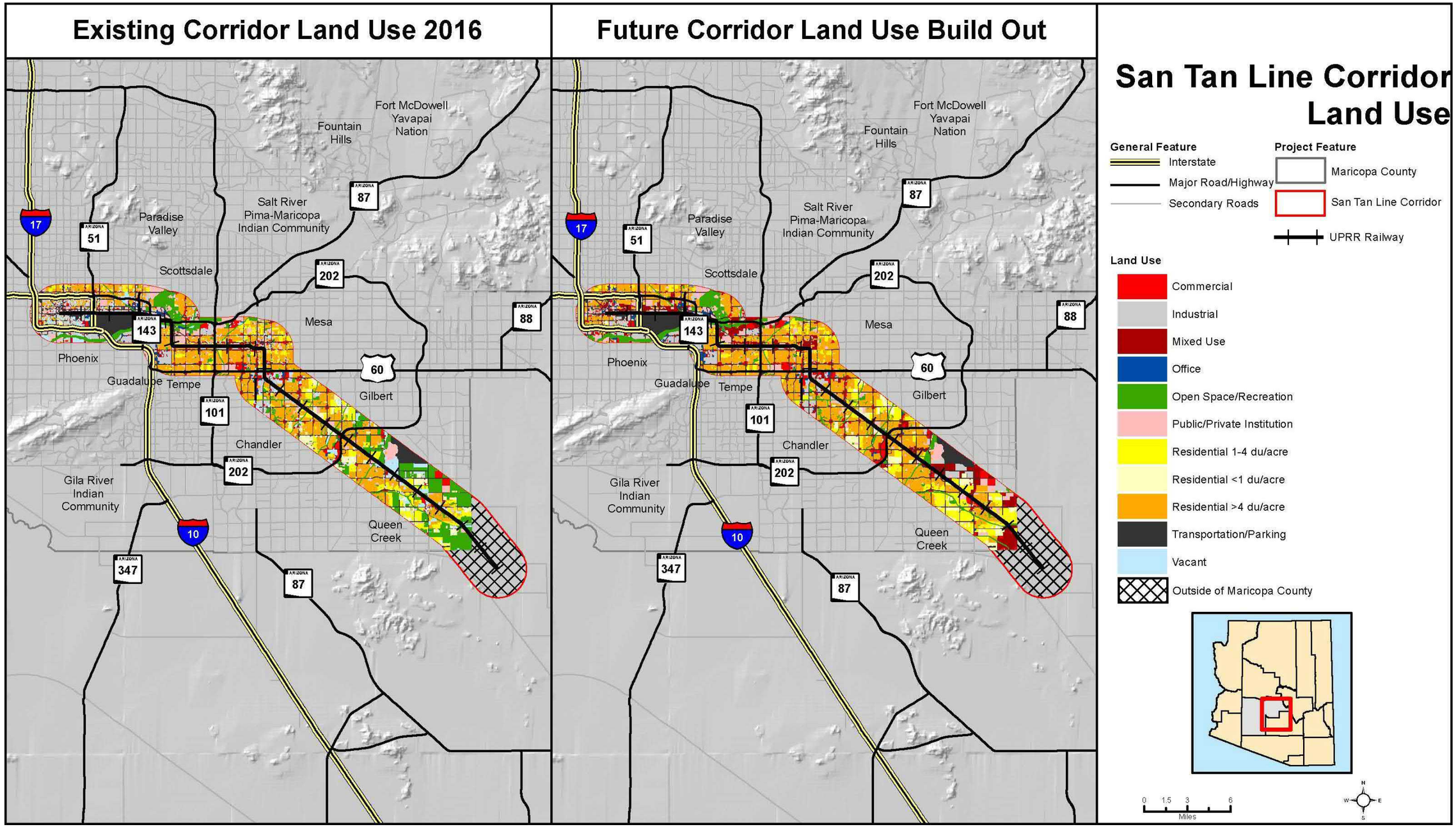
Figure 2-10: San Tan Line Corridor – Land Use



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2.7.3 Planning Context

The following general and transportation planning documents are summarized to illustrate the level of planning that has occurred in the communities where commuter rail service would be implemented in the San Tan Line Corridor.

General Plans

City of Tempe General Plan 2040 (2013)

Major themes from the General Plan include developing as a leader in "urban living" (through building upon Tempe amenities essential to quality of life such as public art and art centers, museums, library, LRT, bus transit, walking and biking network, walkable authentic downtown, multi-generational centers, parks and recreational facilities, and ensure these remain available as the community grows); expanding pockets of urban activity centers or "hubs", enhancing connections for pedestrian, bike, and transit to produce a "20-minute city" (through the creation of safe and comfortable pedestrian and bike connections to schools, parks and multi-generational centers, within a 20-minute walk, bike ride, or local-serving transit. As described, in part, in the circulation chapter, the focus is to expand LRT, streetcar and future transportation options to support TOD as one of the backbones of interhub connectivity and attain more options for HCT to connect to and within the region by bus rapid transit or inter-city/commuter rail.

Further, the sustained guiding principle states that Tempe should continue to be a leader in multi-modal transportation. No single mode of transportation will be sufficient to meet the mobility needs of Tempe. Emphasize movement of people and goods instead of movement of cars, to encourage reduction of single occupancy vehicle trips. Ensure accessibility to transportation modes for persons of all abilities. Investments in rail and bus transit, improved bike and pedestrian connections, technology innovations, along with asset management will all be necessary to meet the mobility needs of the community.

The circulation chapter notes that Tempe is the regional leader in providing public transit. The City has a well-defined transit system that provides a variety of services. The City bus routes provide service along the arterial and some collector streets. The neighborhood circulators, Orbit and FLASH, serve shorter trips with higher frequencies in high demand areas. Tempe's involvement in development of the MAG RTP identified areas where HCT investments will be constructed within Tempe. Rural/Scottsdale Road is an identified corridor for BRT that will connect from San Tan (SR 202) to Scottsdale/Shea Boulevard. The transit section offers two goals: (1) increase transit modes and services that support ridership increases and (2) expand transit mode share to facilitate connections among transportation modes. Each of these goals is supported by a variety of strategies that suggest that the City of Tempe will remain at the forefront of planning for transit options throughout the city.

Arizona State University Campus Master Plan (2011)

The ASU Tempe campus is served by two LRT stations. The campus master plan notes that university sites within a five-minute walk from the existing LRT stations on Veterans Way and Terrace Road at Rural Road should be developed to encourage ridership. Higher density mixed use development that includes academic, research, office, and/or residential uses should also include retail and commercial uses on the primary pedestrian routes to and from the stations. The downtown Phoenix campus is also served by two stations. The campus master plan states that the new Valley Metro LRT connects East Valley to West Valley, and has two stops that directly feed the campus. The stops are located at the Central Station Transit Center south of

Civic Space Park, which also has stops for the intercampus shuttle service. This transit rich environment makes the downtown Phoenix campus highly accessible.

City of Mesa 2040 General Plan (2014)

The City of Mesa 2040 General Plan covers a variety of areas. Under the neighborhoods section, there is a discussion about transit districts. It states that transit districts character type includes the LRT corridor, bus rapid transit corridors, and areas designated for a consistent high level of transit options. The focus in this character type is to develop a mixed-use, pedestrian oriented, urban environment, particularly within walking distance of transit stops. This character type overlays the other character types and is used to transition the area into a more transit- and pedestrian-oriented development form. Sub areas include station areas and corridors, each with a set of form and guidelines, zoning districts, and typical uses that describe the desired attributes.

The general plan describes how transit is not only included in the City's Transportation Plan, but also has its own plan. There is one transit goal in the general plan, to develop an activity center-based transit system that is based on transit priority corridors in the City. This goal is supported by several policies that focus on connecting activity centers, developing priority corridors, focusing on frequency over coverage, compatibility with regional services, and sustainability. The City of Mesa continues to plan for a robust transit network citywide.

City of Chandler General Plan 2016 A Vision Refined

The general plan notes that 85% of Chandler's land is developed; only 15% of land within the city remains undeveloped and there are no annexation opportunities beyond the city's municipal planning area. As part of their development guidance, TOD is included which states that the City of Chandler has identified high-capacity transportation corridors that connect the city to regional destinations and move large numbers of travelers. These corridors are intended to develop over time as mixed-use corridors of higher-intensity development in close proximity to transit. Chandler has identified three high-capacity corridors where TOD could be developed. These corridors include Arizona Avenue, Chandler Boulevard, and Rural Road. TOD may also be considered along fixed-route bus corridors where densities greater than 18 dwelling units per acre are permitted. High-capacity transit corridors are appropriate locations for the development of high-intensity, mixed-land uses. Such developments would create opportunities for living within walking distance of schools, stores, and restaurants.

The Arizona State Rail Plan, prepared by ADOT in 2011, identifies the need for passenger rail in Arizona. To support statewide economic growth, attract sustainable industries, and compete globally, the study determined that an efficient multimodal transportation system is needed to support cost-effective service to shippers and provide reliable passenger rail between cities. As a result, passenger rail with express service between Tucson and Phoenix and local service with stops at several communities has been studied by ADOT. The Passenger Rail Corridor Study Draft Tier 1 EIS September 2015 identified a final route from seven alternatives. The selected route, identified as the yellow alternative in the EIS, passes east of Chandler through the Town of Gilbert, and follows the Union Pacific Railroad right-of-way. Passenger rail with a nearby train station will provide Chandler residents and employees a transportation alternative, increase access to employment centers, attract employers, and decrease road congestion.

Town of Gilbert General Plan (2012)

The vision of the circulation chapter of the general plan states that Gilbert will provide a safe, efficient, and aesthetically pleasing circulation network that considers all modes of vehicular and non-vehicular movements and does so in a manner that is sensitive to the environment.

One goal for circulation is to continue to provide regional public transportation service to Gilbert residents and employers. Several policies were developed to meet this goal including the consideration of the needs of the general public and the special needs of the elderly and individuals with impaired mobility in the planning and operation of transit services; the provision of park-and-ride facilities in several locations for carpooling and commuter bus service; the provision of shaded, safe, well-lit and aesthetically pleasing bus stops for regional and local bus users; continuing to plan for future linkages to regional commuter rail and/or LRT; and the preservation of transit corridors for high speed transit (BRT and commuter rail). The 2012 alternative transportation map shows commuter rail on the San Tan line.

Transportation Plans

MAG Southeast Valley Transit System Study (2015)

The Southeast Valley Transit System Study analyzed transit services and ridership demand in transit-established and transit-aspiring communities within the southeast subarea of the MAG region. The study addressed local bus transit, and rail HCT was not included in the analysis. The study had three planning timeframes including short-term (or optimization of existing services), mid-term, and long-term.

The “Optimization of Existing Services” planning timeframe included concepts to enhance transit services that are currently in operation within the Southeast Valley. Key elements included the consolidation of resources invested in the Arizona Avenue and Main Street corridors to provide a robust, high frequency service; explore alternative service types to more efficiently serve some deviations or lower productivity route segments; obtain a minimum of 30-minute frequency service on all routes; and improve frequencies on high ridership routes. The mid-term planning timeframe included further enhancements to bus route frequencies, new circulator services, expanded transit center and park-and-ride facilities, and adding new commuter services. The long-term planning timeframe included extensions to bus routes and improved bus route frequencies; new local, express, and rural bus routes; and expanded transit center and park-and-ride facilities.

City of Tempe Transportation Master Plan (2015)

The goal of the City of Tempe Transportation Master Plan is to provide a multi-modal transportation guide for the city that includes short term (2020) and long term (2040) recommendations and supports the General Plan 2040. Existing transit service in Tempe includes LRT service, local and express bus service, neighborhood circulators, and paratransit. Transit service in Tempe has changed dramatically with the implementation of LRT in 2008.

The recommended transit improvements for the short term (2020) transportation scenario include premium bus service on Rural Road and Southern Avenue, the Tempe Streetcar starter line, an Orbit Saturn circulator in South Tempe, and other local bus improvements. The recommended transit improvements for the long term (2040) transportation scenario include HCT on Rural Road between the Scottsdale border and Baseline Road, the Tempe Streetcar system, a second Orbit circulator in South Tempe. The plan focuses on citywide transportation improvements and does not specifically discuss commuter rail as part of this project.

City of Mesa 2040 Transit Plan (2013)

The City of Mesa 2040 Transit Plan was developed in an effort to connect activity centers, create transit priority corridors, provide local and regional transit circulation, and to respond to changes in travel patterns. Valley Metro LRT began operation in December 2008. There are five LRT stations in Mesa, located at Sycamore and Main Street, Alma School Road and Main Street, Country Club Drive and Main Street, Center Street and Main Street, and Mesa Drive and Main Street. LRT service in Mesa is supplemented by Express, local, and circulator bus routes as well as paratransit service. The city identifies transit character areas as well as transit priority intersections and nodes to support the development of an activity center based transit plan. The plan concludes with future transit scenarios with two options for the San Tan Line Corridor, either using the Ellsworth Road/US 60 (Orange Alternative in the Passenger Rail Corridor Study, Tucson to Phoenix) corridor or the Phoenix Subdivision (now known as the San Tan Line) (defined as the recommended Yellow Alternative in ADOT's Passenger Rail Corridor Study, Tucson to Phoenix).

City of Chandler Transportation Plan (2011)

The vision statement for the Chandler Transportation Plan is to "Develop an environmentally-friendly, multimodal transportation system that provides choices to make Chandler known as the "Most Connected City." The Transit section details existing transit conditions and presents recommendations for the near-term (2010-2014), mid-term (2015-2019) and long-term (2020-2030). These recommendations include the creation of a circulator system, a continued commitment to BRT and Express Bus services, long-term commitments to LRT service, as well as enhancements to local bus service and ADA and non-ADA Paratransit.

While the San Tan Line would not directly serve the City of Chandler, it would likely attract Chandler residents living on the eastern side of the community (closer to stations that would be constructed in Mesa or Gilbert, although station locations have yet to be determined). The city will continue to work with the region to help bring commuter rail service to the community. The Kyrene Line would also directly serve Chandler on the western edge of the city (see Section 2.6).

Queen Creek Transit Study (2014)

The Queen Creek Transit Study is intended to identify opportunities, challenges, and overall demand for providing transit services and multimodal transportation investments in the Town of Queen Creek. Located in the Southeast Valley, the Town of Queen Creek has experienced enormous growth over the last decade. Along with the Town's growth, the Southeast Valley region has also experienced a significant volume of population and employment growth, resulting in an increased number of daily trips through the town destined for locations across the Valley. Despite the town's substantial growth, transportation options in Queen Creek remain limited.

A range of transit options were developed for consideration including express bus service to several destinations, the extension of existing local bus routes into Queen Creek, community connector service, pre-scheduled on-demand shuttle service, and expansion of Valley Metro's vanpool and carpool programs. One idea was to use available Arizona Lottery Fund dollars to help subsidize a vanpool program, which could help attract additional vanpoolers and help identify key destinations and understanding of the Town's still-evolving transportation patterns. This could act as an important intermediate step towards the implementation of more advanced transit services in the future. A second idea was to develop an express bus service operating from the Queen Creek Town Hall (or other location) to the Superstition Springs Transit Center in

Mesa, which would connect Queen Creek residents with transit service valley-wide. The third idea was to implement “Community Connector” routes. While these types of services are typically defined within the Valley Metro Circulator service type, a starter service in Queen Creek may be better suited under the Rural Connector service designation.

Important to the San Tan Line as part of this project, the Queen Creek Transit Study concluded with a discussion of actions the Town should take to prepare for commuter rail service. The transit study also discussed future transit opportunities to connect other areas of the Town via public transportation.

2.7.4 Railroad Characteristics

Railroad Infrastructure

The San Tan Line Corridor stretches approximately 36 miles from Phoenix Union Station to downtown Queen Creek, and is considered part of the Union Pacific Railroad Phoenix Subdivision Line used by all Union Pacific Railroad trains operating to or from the Phoenix area. The San Tan Line Corridor proposed end-of-line is located at the intersection of Rittenhouse Road and Ellsworth Road in Queen Creek (milepost 941.6), with an illustrative exension five miles southeast into the San Tan Valley, located in Pinal County. From January 2009 to spring 2010, Union Pacific Railroad installed new railroad ties and continuous welded rail (CWR) between downtown Phoenix and Queen Creek. Welded rail was also installed on 1912-era Southern Pacific Salt River-Tempe Town Lake Bridge.

Conceptual station near Rittenhouse Road in downtown Queen Creek, AZ. Source: MAG.

The San Tan Line Corridor section of the Union Pacific Railroad Mainline is single track, with four sidings located throughout the corridor. The San Tan Line Corridor was also used by Amtrak until June 1996, is controlled by DTC and ABS and had a maximum operating speed of 60 mph for passenger trains and 40 mph for freight trains. It features a maximum speed of 60mph for freight trains. The railroad right-of-way is generally 100 feet in width, but varies throughout the corridor. The right of way width is approximately 200 feet in Gilbert, Queen Creek and Pinal County and larger where sidings are located. Positive Train Control is not in-effect on this corridor at present time.

In total, there are 61 public and private at-grade track crossings and 19 grade-separated crossings between Union Station and the proposed end-of-line in Queen Creek/San Tan Valley. There are two existing Quiet Zones located in the San Tan Line Corridor. The downtown Phoenix Quiet Zone (3rd Avenue to 4th Street) was activated in fall 2009. A Quiet Zone was also activated entirely through Tempe from 1st Avenue to Rural Road in the 2012.

Several major railroad facilities located throughout the San Tan Line Corridor are shown in Figure 2-11 and include:

- Phoenix Union Station (Union Pacific Railroad MP 906.0; BNSF MP 194);
- Harrison Street Yard (MP 907.0);

- Kendall Yard (MP 911.1);
- Tempe Depot (MP 914.3);
- Tempe Junction (MP 915.3);
- Mesa Yard (MP 921.8);
- McQueen Junction (MP 921.8); and
- Germann Siding (MP 936.2).

Union Pacific Railroad is continuing to make improvements throughout the corridor and added three additional tracks and a trans-load track to the Harrison Street Yard (MP 907.0) in 2010. They also made improvements to the Phoenix Auto Facility located adjacent to the Harrison Street Yard. These railroad infrastructure improvements would allow for enhanced freight service as well as facilitate needed improvements should potential commuter rail service be implemented.

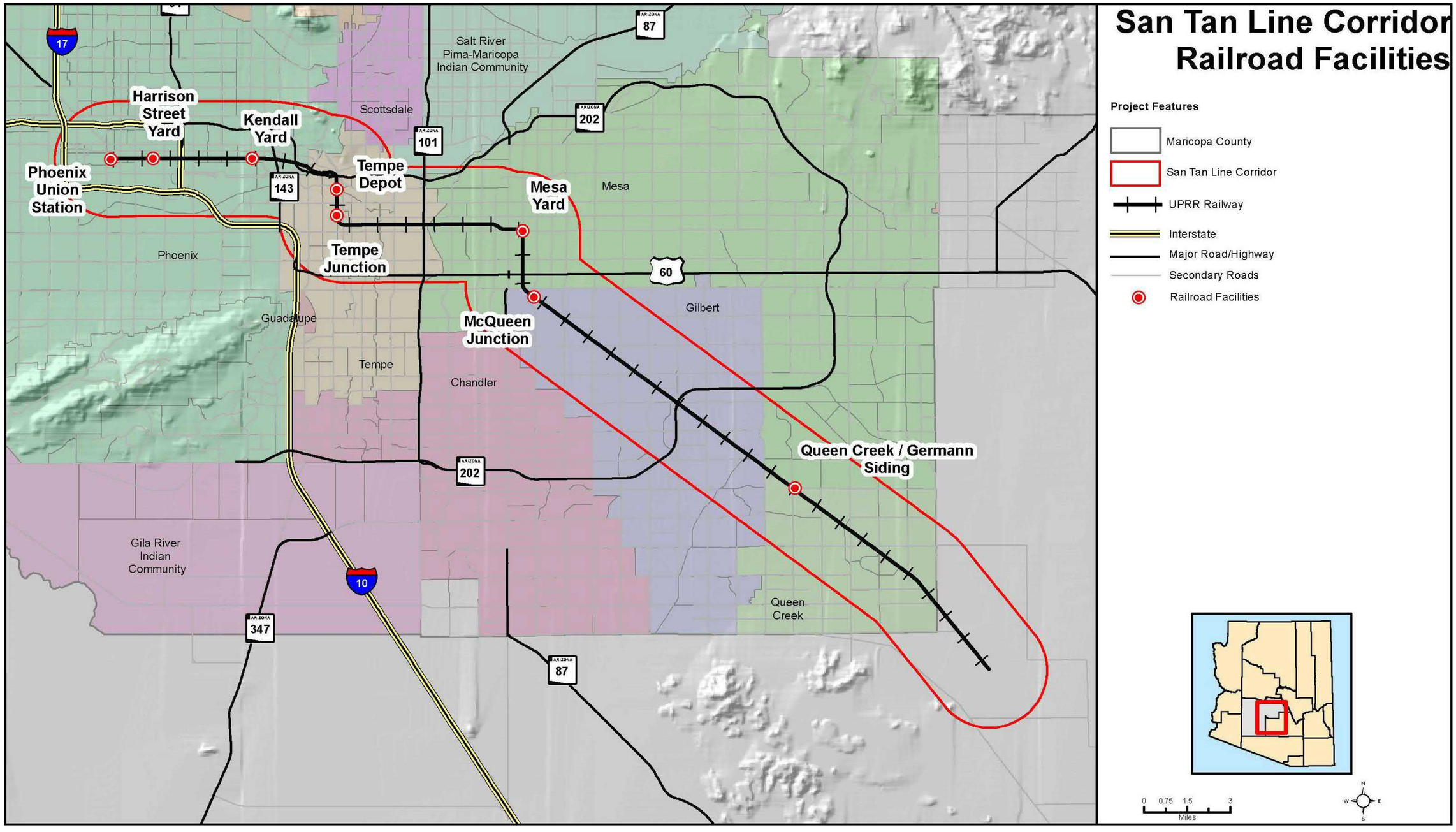
For a more detailed description of San Tan Line Corridor railroad conditions and existing and planned facilities, see Appendix E: Systems Study Railroad Conditions and Issues.

Railroad Operations

The following daily railroad operations are typical in a given 24-hour period in the San Tan Line Corridor. These numbers represent averages and can change regularly given the nature of the movement of freight.

- Phoenix Harrison Street Yard (MP 907) to Tempe Junction (MP 915.3) = **6-7 trains per day.**
- Tempe Junction (MP 915.3) to McQueen Junction (MP 923.6) = **6-7 trains per day.**
- McQueen Junction (MP 923.6) to Magma Jct (San Tan Valley) (MP 948.9) = **4-5 trains per day.**

Figure 2-11: San Tan Line Corridor – Railroad Facilities



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2.7.5 Highway Characteristics

The San Tan Line Corridor offers many travel options connecting into downtown Phoenix. This evaluation identifies the primary travel path for commuters traveling between downtown Queen Creek and downtown Phoenix as following Ellsworth Road north to the northbound SR 202 via Elliot Road, exit SR 202 at U.S. 60 westbound continuing on to I-10 westbound eventually ending in downtown Phoenix via the 7th Street exit from I-17. Currently, the number of lanes for this travel path varies from six to ten general use lanes in addition to HOV lanes located throughout all of U.S. 60 and I-10 through this area, including a direct connect ramp at the U.S. 60/I-10 interchange.

Several roadway projects have been completed or are planned along the San Tan Line Corridor since the 2010 Study, in an effort provide additional capacity. A summary of these improvements are shown in Table 2-18.

Table 2-18: San Tan Line Corridor Recent and Future Roadway Improvements

Improvement	Extent	Opening Date	Current Status
SR 101 Widening	US 60 Superstition Freeway to SR 202 San Tan	2023	Planning
I-10 Widening	SR 143 to U.S. 60/ (Superstition Freeway)	2023	Planning/Design
Reconfigure I-10/US 60 (Superstition Freeway) Interchange	I-10/US 60 Interchange	2023	Planning/Design
SR 202 HOV Lanes (1-lane in each direction)	US 60 (Superstition Freeway) to Gilbert Road	2027-40	Planning

Source: MAG, 2018.

Travel Characteristics: Travel Time, Volume and Congestion

The primary travel path connecting downtown Phoenix to the end of the San Tan Line Corridor in Queen Creek utilizes multiple valley freeways including: SR 202, SR 101, U.S. 60, I-10, and I-17. For the purpose of this analysis, the intersection of Washington Street and Central Avenue in downtown Phoenix and the intersection of Bella Vista Road and Schnepf Road in San Tan Valley were used as end points to measure travel characteristics. This travel path consists of 47 miles broken into three segments in order to compare results on both ends of the corridor. Table 2-19 compares AM peak period travel characteristics for the San Tan Line Corridor in 2015 and 2040.

Table 2-19: San Tan Line Corridor AM Peak Period Travel Characteristics (2015 – 2040)

2015 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Bella Vista Road/Schnepf Road to Ellsworth Road/ Rittenhouse Road	10 miles	26 minutes	N/A (no HOV)	13 minutes	1 – 3	2,200 – 5,500
Segment #2: Ellsworth Road/Rittenhouse Road to SR 101/US60	24 miles	37 minutes	27 minutes	24 minutes	1 – 4	3,500 – 20,400
Total Trip (to Queen Creek)	**34 miles**	**63 minutes**	**53 minutes**	**37 minutes**	–	**3,500 – 20,400**
Segment #3: SR 101/US 60 to Downtown Phoenix	13 miles	22 minutes	16 minutes	13 minutes	1 – 6	300 – 35,800
Total Trip (to San Tan Valley)	**47 miles**	**85 minutes**	**69 minutes**	**49 minutes**	–	**300 – 35,800**
2040 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Bella Vista Road/Schnepf Road to Ellsworth Road/ Rittenhouse Road	10 miles	26 minutes	N/A (no HOV)	13 minutes	2 – 3	4,200 – 5,900
Segment #2: Ellsworth Road/Rittenhouse Road to SR 101/US60	24 miles	36 minutes	28 minutes	24 minutes	1 – 4	3,100 – 23,900
Total Trip (to Queen Creek)	**34 miles**	**62 minutes**	**54 minutes**	**37 minutes**	–	**3,100 – 23,900**
Segment #3: SR 101/US 60 to Downtown Phoenix	13 miles	31 minutes	14 minutes	14 minutes	1 – 6	300 – 31,000
Total Trip (to San Tan Valley)	**47 miles**	**83 minutes**	**68 minutes**	**50 minutes**	–	**300 – 31,000**

Source: MAG, 2018.

Between 2015 and 2040, travel characteristics in the AM peak travel period are not expected to significantly change. From the Bella Vista/Schnepf roads intersection and the Ellsworth /Rittenhouse roads intersection travel times will remain the same. Between the intersection of Ellsworth and Rittenhouse roads and the intersection of SR 101 and U.S. 60, traffic volume is expected to remain the same. While the overall traffic volume is also expected to increase between SR 101 and downtown Phoenix, the total trip time is projected to increase by only nine minutes. The insignificant change in travel time can be attributed to recent and future improvements along sections of I-10 and U.S. 60. High occupancy vehicle travel times were studied to help determine how effective commuter rail could be in each of the corridors. There are HOV lanes on I-10 and SR 60 and the HOV travel time is 16 minutes faster for this segment in the AM peak period compared to that of the general purpose lanes. Off-peak travel times were also studied to illustrate the travel time degredation during peak periods. The table shows that travel times are generally 30 minutes longer for the AM peak period compared to off-peak travel times in 2015, and in 2040.

Similar to the AM peak period travel characteristics, PM peak period travel time, volume, and congestion levels were analyzed. Table 2-20 shows the comparison between 2015 and 2040 PM peak period travel characteristics in the San Tan Line Corridor.

Table 2-20: San Tan Line Corridor PM Peak Period Travel Characteristics (2015 – 2040)

2015 PM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Downtown Phoenix to SR 101/US 60	13 miles	22 minutes	17 minutes	13 minutes	1 – 5	300 – 43,400
Segment #2: R 101/US60 to Ellsworth Road/ Rittenhouse Road	24 miles	36 minutes	29 minutes	24 minutes	1 – 4	4,000 – 30,100
Total Trip (to Queen Creek)	**37 miles**	**58 minutes**	**46 minutes**	**37 minutes**	–	**300 – 30,100**
Segment #3: Ellsworth Road/Rittenhouse Road to Bella Vista Road/ Schnepf Road	10 miles	25 minutes	N/A (no HOV)	13 minutes	1 – 3	3,000 – 7,800
Total Trip (to San Tan Valley)	**47 miles**	**83 minutes**	**71 minutes**	**49 minutes**	–	**3,000 – 7,800**
2040 PM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Downtown Phoenix to SR 101/US 60	13 miles	21 minutes	14 minutes	13 minutes	1 – 6	200 – 43,300
Segment #2: R 101/US60 to Ellsworth Road/ Rittenhouse Road	24 miles	36 minutes	30 minutes	24 minutes	1 – 4	3,800 – 34,000
Total Trip (to Queen Creek)	**37 miles**	**57 minutes**	**44 minutes**	**37 minutes**	–	**200 – 43,300**
Segment #3: Ellsworth Road/Rittenhouse Road to Bella Vista Road/ Schnepf Road	10 miles	25 minutes	N/A (no HOV)	14 minutes	2 – 3	6,600 – 9,600
Total Trip (to San Tan Valley)	**47 miles**	**82 minutes**	**68 minutes**	**50 minutes**	–	**6,600 – 9,600**

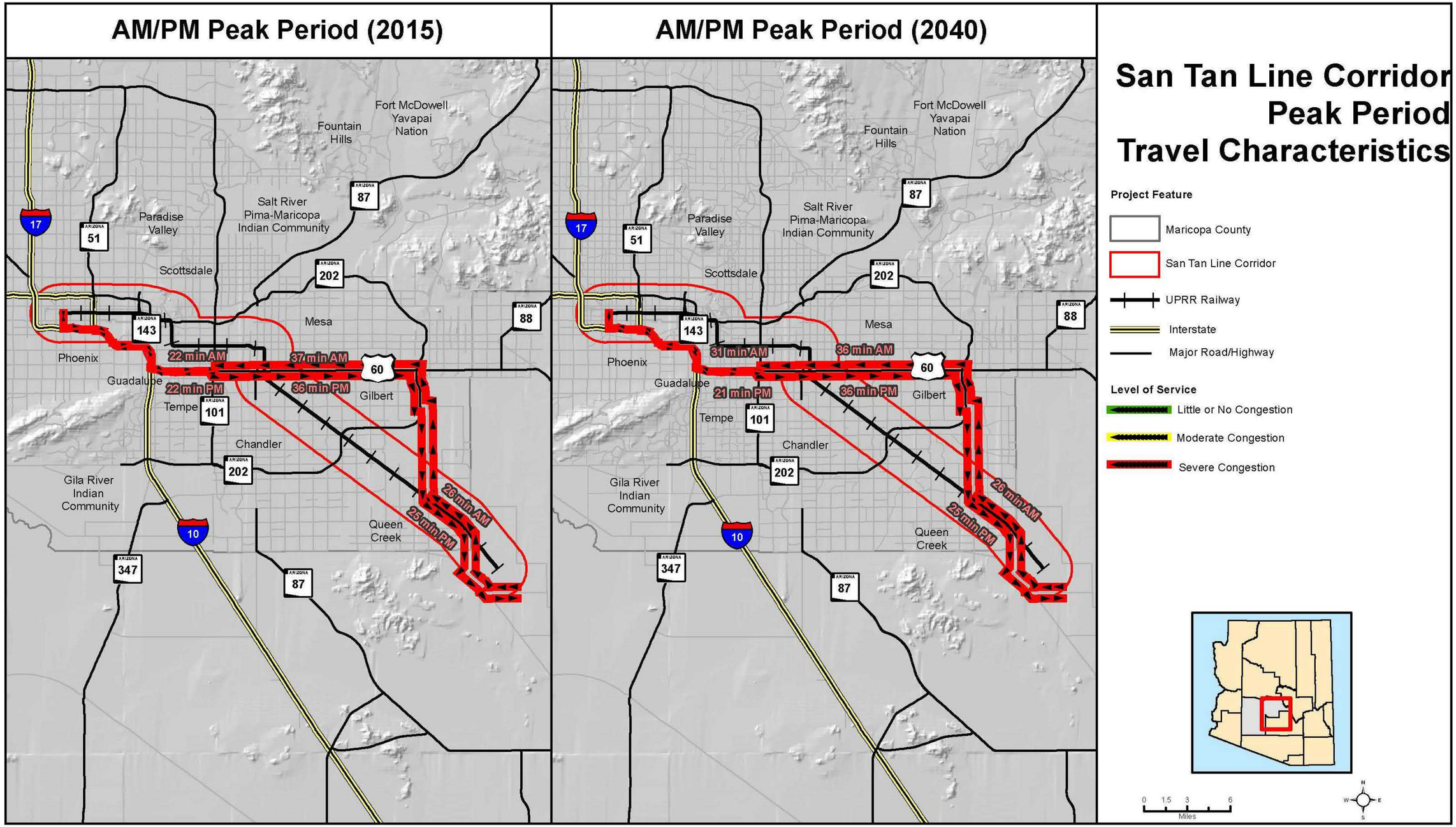
Source: MAG, 2018.

The 2015 travel time between downtown Phoenix and SR 101 in the PM peak period was 22 minutes. Given planned infrastructure improvements throughout this segment of the corridor, the travel time is projected to slightly decrease in the future. Travel between SR 101 and Queen Creek took 36 minutes in 2015 and is expected to remain constant by 2040. The HOV lanes on I-10 and SR 60 provide an HOV travel time that is 12 minutes faster for this segment in the PM peak period compared to that of the general purpose lanes. The table shows that travel times are generally 30 minutes longer for the PM peak period compared to off-peak travel times in 2015, and in 2040.

The level of congestion throughout the San Tan Line Corridor is expected to remain constant between 2015 and 2040. In 2015 and 2040, the segment of the corridor between downtown Phoenix and SR 101 shows severe congestion levels in both the AM and PM peak periods. The

level of congestion in the section of the corridor between Queen Creek and SR 202 is also expected to remain severe until 2040. Figure 2-12 shows the travel path within the Southeast Corridor as well as the level of congestion and travel time in both the AM and PM peak period in 2015 and 2040. Note that levels of congestion within downtown Phoenix are shown, but actual travel times for this area are not shown in this figure.

Figure 2-12: San Tan Line Corridor – Peak Period Travel Characteristics



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2.7.6 Transit Service

Transit services provided or planned for future implementation in the San Tan Line Corridor include fixed route bus service, HCT service, and transit passenger facilities. Figure 2-13 graphically depicts both the existing and planned transit network within the San Tan Line Corridor.

Fixed Route Bus Service

Fixed route bus service within the San Tan Line Corridor is comprised of local bus, circulators, and express bus service.

Local Bus

Within the San Tan Line Corridor, all local routes provide service seven days a week, with the exception of Routes 104, 112, 120, 128 and 136, which provide service Monday through Saturday. Nearly 40 local bus routes serve the San Tan Line Corridor. Typical service operates between 5:00 AM and 11:00 PM on weekdays and between 6:00 AM and 9:30 PM on weekends. Most local routes within this corridor operate at a peak frequency of 30 minutes or better.

Circulators

Currently, eight circulator routes operate with the San Tan Line Corridor serving parts of Mesa, Tempe, and downtown Phoenix. No additional circulators operate within this corridor outside of those that operate within the Chandler Corridor as well. Circulator service operated within portions of this corridor includes DASH in Phoenix; FLASH at ASU; five Orbit routes in Tempe; and the BUZZ in Mesa.

Rural Routes

There are no rural routes currently serving the San Tan Line Corridor.

There is some potential for regional bus service to operate from San Tan Valley to Florence in future years.

BRT/Express Bus

Within the San Tan Line Corridor, express bus service operates five days a week Monday through Friday. Currently, there are eight express routes within the San Tan Line Corridor that connect East Valley cities to either downtown Phoenix or downtown Tempe. Of these routes, the 531, 533, 541, and 542 provide the most similar type of service as would future commuter rail. There is no express service operating south of the San Tan Freeway within the San Tan Line Corridor.

The RTP identifies three new express bus routes within the corridor that will provide service between East Valley cities and downtown Phoenix or downtown Tempe.

There are no arterial BRT routes currently operating within the San Tan Line Corridor. Within the San Tan Line Corridor, one future arterial BRT route is planned in the latest RTP. This route would operate along Chandler Boulevard/Williams Field Road will provide a connection into the Arizona State University Polytechnic campus at the intersection of Power and Williams Field roads in Mesa.

High Capacity Transit

Currently, the only HCT service located in the San Tan Line Corridor is LRT that extends between Mesa Drive in Mesa and downtown Phoenix. However, the RTP identifies an extension of the LRT within this corridor to Gilbert Road (projected to be open by 2019). Tempe Streetcar is under construction and is scheduled to open in 2021. The route will follow Rio Salado Parkway, Ash Avenue, Mill Avenue and Apache Boulevard.

Transit Passenger Facilities

Transit facilities located within the San Tan Line Corridor include both transit centers and park-and-ride facilities.

Transit Centers

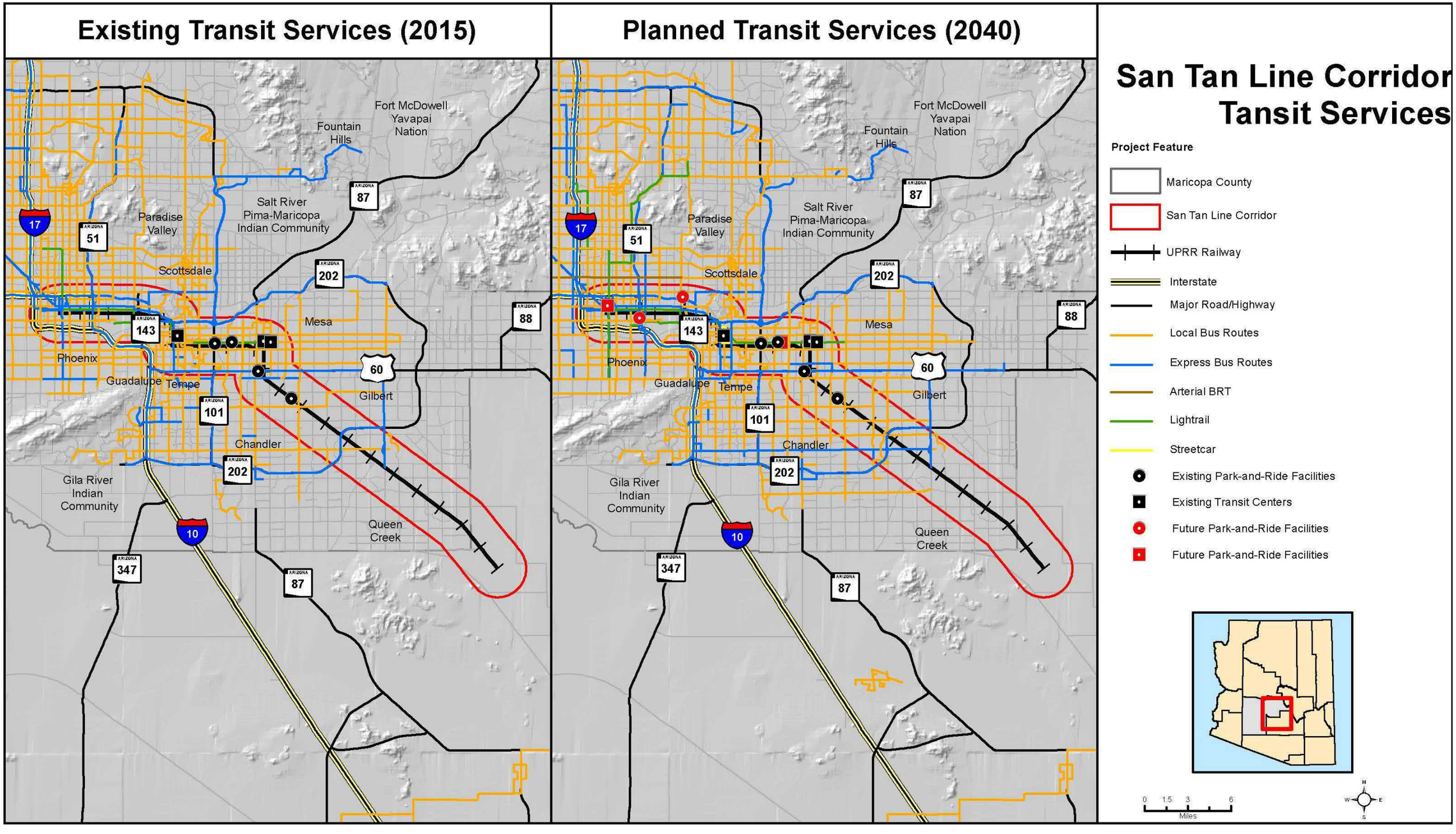
Three existing transit centers are located in the San Tan Line Corridor. These include Central Station located in downtown Phoenix, the Tempe Transit Center located near ASU in downtown Tempe, and the Main Street/Sycamore Street Transit Center located along the LRT in Mesa.

Park-and-Ride Facilities

There are a total of seven existing park-and-ride facilities in the San Tan Line Corridor that provide transit riders with access to local bus service, circulators, or express bus routes.

The RTP notes that additional transit centers and park-and-ride facilities will be needed in the future, but suggests that the locations of new facilities will be determined in other planning processes.

Figure 2-13: San Tan Line Corridor – Transit Services



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2.7.7 Travel Patterns

Home-based work trips originating within the San Tan Line Corridor were analyzed for 2015 and 2040. The purpose of this analysis was to understand the destinations of HBW trips that originated within the corridor. Destinations that were identified as part of this analysis include:

- Within the San Tan Line Corridor;
- Within the area of the System Study; and
- Outside the limits of the System Study.

An analysis of HBW trips showed that in 2015, approximately 455,000 total trips originated within the San Tan Line Corridor, with 55 percent of these trips destined for areas within the limits of the corridor. Of the remaining trips, 11 percent were destined to other locations within the limits of the System Study, and 34 percent were destined to locations outside the planning area of the System Study. In 2040, the number of HBW trips originating in the San Tan Line Corridor increased by 37 percent to nearly 623,000 total trips. A comparison of HBW trips between 2015 and 2040 shows that the percentage of HBW trips traveling to one of the three analyzed areas stayed relatively the same. The total number of trips originating within the San Tan Line Corridor for 2015 and 2040 are identified in Table 2-21.

Table 2-21: Home-Based Work Trips Originating within the San Tan Line Corridor

Destination Area	2015		2040	
	HBW Trips	Percent	HBW Trips	Percent
Within San Tan Line Corridor	249,042	55%	340,284	55%
Within the System Study	51,849	11%	56,388	9%
Outside the System Study	152,928	34%	226,297	36%
Total	**453,819**	**100%**	**622,969**	**100%**

Source: MAG, 2018.

2.7.8 Summary

The San Tan Line Corridor is expected to experience significant changes in its demographic makeup between 2015 and 2040. During this time the corridor is expected to experience a 46 percent increase in population and a 33 percent increase in employment. The majority of the change expected to occur will take place southeast of SR 202. Coinciding with population and employment growth, the change in land use is anticipated to largely be an increase in residential development, the majority of which will be located southeast of SR 202. In addition, there are significant railroad facilities along the San Tan Line Corridor that will impact future development of commuter rail in the corridor, including yards, junctions, and spurs.

The primary travel path from the easternmost portion of the corridor into downtown Phoenix is along U.S. 60 and I-10. Despite recent and future roadway expansions, congestion along this route is severe, but is not expected to increase a great deal as much of the population growth has recently occurred in this area of the region.

Transit services within the corridor are located primarily within the Phoenix, Tempe, and Mesa areas, while the sections of Gilbert have more limited transit services available.

Travel patterns within the corridor are largely expected to remain similar as well. Of those HBW trips originating within the corridor, the same percentage of trips remaining within the limits of the San Tan Line Corridor between 2015 and 2040.

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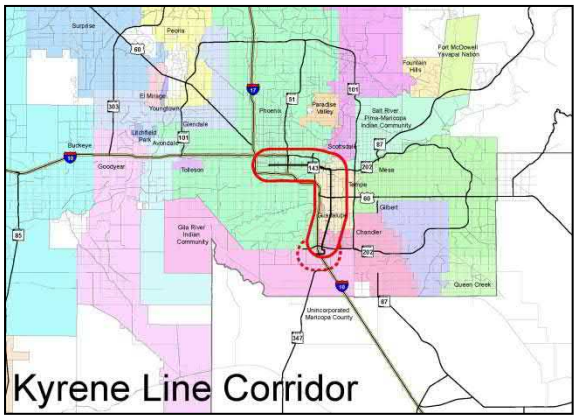
2.8 Kyrene Line Corridor

The approximately 18-mile Kyrene Line (formerly Tempe) Corridor has been defined by a two-mile radius surrounding the Union Pacific Railroad line between Union Station in downtown Phoenix and Wild Horse Pass Boulevard on the Gila River Indian Community, just west of Chandler and south of the Tempe city limits. The cities, towns, and Indian Communities that fall within this area include:



- City of Phoenix;
- City of Scottsdale;
- City of Tempe;
- Town of Guadalupe;
- City of Chandler; and the
- Gila River Indian Community.

2.8.1 Demographics

The Kyrene Line Corridor had a total population of approximately 386,000 in 2015 and will experience a 46 percent increase in population to approximately 563,000 people by 2040. The municipalities expected to experience the most significant population growth within the corridor during this period are the City of Scottsdale, with a 60 percent increase, the City of Tempe, with a 50 percent increase, and the City of Phoenix with a 48 percent increase.

The Kyrene Line Corridor is also expected to experience an increase in employment from approximately 466,000 jobs in 2015 to nearly 577,000 jobs in 2040, resulting in an increase of 24 percent. The City of Scottsdale is expected to experience the greatest employment growth with a 66 percent increase within the corridor. During this same period, the area of the corridor occupied by the Gila River Indian Community is expected to see at 120 percent increase in employment to just fewer than 13,000 jobs.

Table 2-22 and Table 2-23 show the existing and forecasted population and employment within the Kyrene Line Corridor.

Table 2-22: Kyrene Line Corridor Population Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change
City of Phoenix	190,533	278,544	46%
City of Scottsdale	10,875	17,430	60%
City of Tempe	162,504	243,264	50%
Town of Guadalupe	6,135	6,795	11%
City of Chandler	25,516	27,531	8%
Gila River Indian Community	170	174	2%
Total	**395,733**	**573,738**	**45%**

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

Table 2-23: Kyrene Line Corridor Employment Change (2015 – 2040)

Jurisdiction*	2015	2040	Percent Change
City of Phoenix	250,299	301,471	20%
City of Scottsdale	6,203	10,321	66%
City of Tempe	173,575	218,608	26%
Town of Guadalupe	1,193	1,482	24%
City of Chandler	30,275	33,827	12%
Gila River Indian Community	5,842	12,843	120%
Total	**467,387**	**578,552**	**24%**

* Includes portions of Municipal Planning Areas located in the Corridor study area.
Source: MAG, 2018.

2.8.2 Land Use

The Kyrene Line Corridor is comprised of a variety of land uses across multiple jurisdictions as shown in Figure 2-14. Table 2-24 summarizes existing land uses as of the year 2016 as well as future land use at build-out distinguished by land use category within the Kyrene Line Corridor. The most predominant existing land use is residential, accounting for 33.6 percent of the total corridor. Other significant uses include transportation and parking facilities, which comprise 15 percent of the corridor, and Industrial, which comprises 14 percent of the corridor. Overall, the distribution of future land uses within the corridor is expected to remain relatively unchanged. At build-out, residential land uses will continue to be the predominant land use, comprising approximately 34 percent of the total corridor. Industrial uses will make up the next largest land use, with 15 percent of the total corridor.

Table 2-24: Kyrene Line Corridor Existing and Future Land Use

Land Use Category	Existing Land Use (2016)		Future Land Use (Build-out)	
	Acres	Percent of Total	Acres	Percent of Total
Residential (<1 du/acre)	369	0.6%	378	0.6%
Residential (1 – 4 du/acre)	1,795	3.1%	1,724	3.0%
Residential (>4 du/acre)	15,520	26.6%	15,759	27.0%
Commercial	3,330	5.7%	3,443	5.9%
Industrial	7,352	12.6%	8,311	14.3%
Mixed Use	93	0.2%	3,100	5.3%
Office	1,922	3.3%	1,823	3.1%
Open Space / Recreation	8,815	15.1%	9,597	16.5%
Public / Private Institutions	6,594	11.3%	6,342	10.9%
Transportation / Parking	7,829	13.4%	7,801	13.4%
Vacant	4,658	8.0%	0	0.0%
Total	**58,278**	**100.0%**	**58,278**	**100.0%**

Source: MAG, 2018.

Those locations within the Kyrene Line Corridor that have the potential to generate ridership based on land use have been identified as activity centers. Activity centers specific to the Kyrene Line Corridor include:

- Downtown Phoenix;
- Phoenix Sky Harbor International Airport;
- Arizona State University;
- Downtown Tempe;
- Tempe St. Luke's Hospital;
- University of Phoenix;
- Tempe Sports Complex; and
- Wild Horse Pass Hotel and Casino.

Additional activity centers located throughout this corridor and the relationship they have with potential station locations have been identified in Appendix C: System Study Station Target Area Evaluation.

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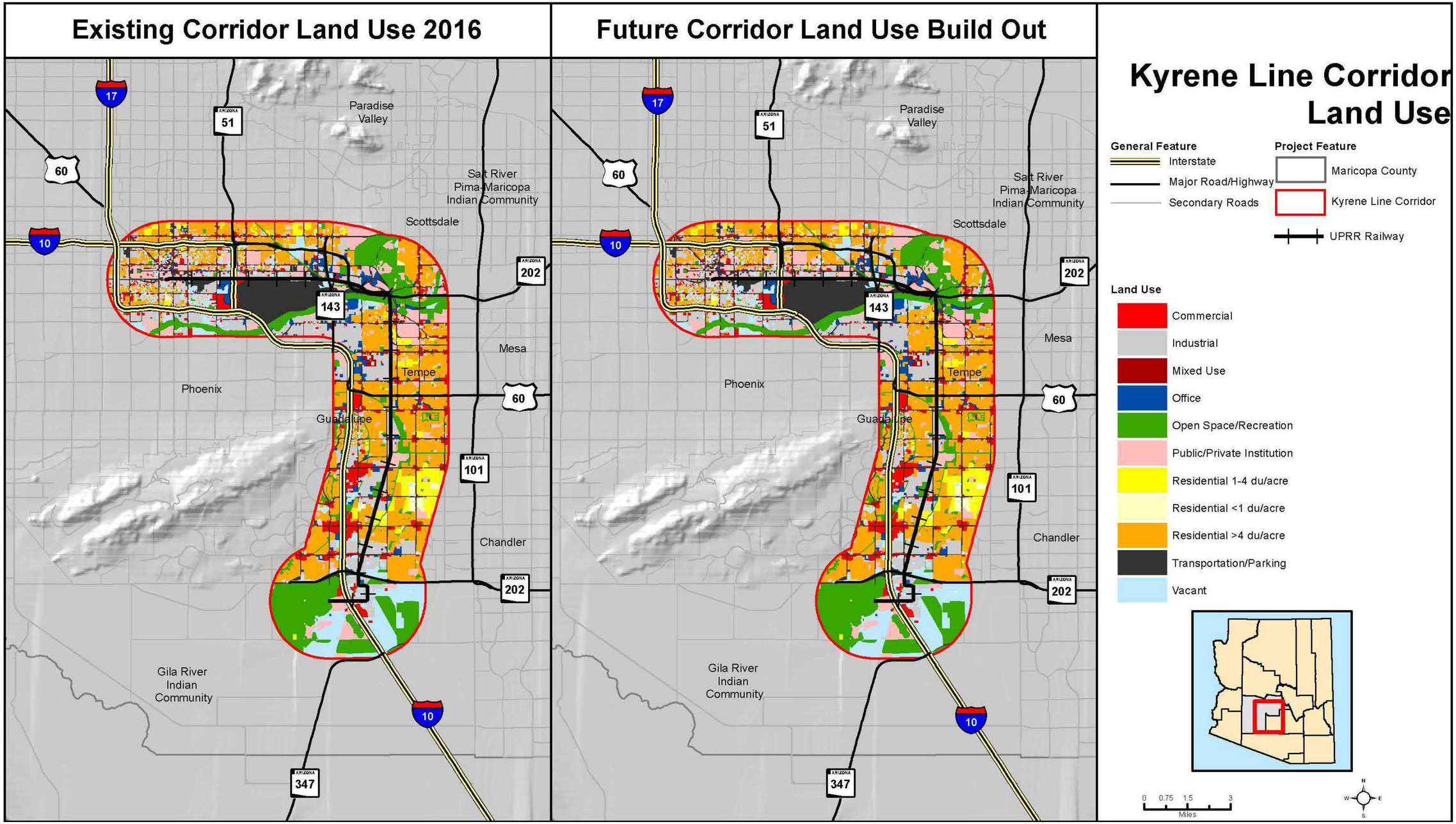
Figure 2-14: Kyrene Line Corridor – Land Use



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2.8.3 Planning Context

The following general and transportation planning documents are summarized to illustrate the level of planning that has occurred in the communities where commuter rail service would be implemented in the Kyrene Line Corridor.

General Plans

City of Tempe General Plan 2040 (2013)

Major themes from the General Plan include developing as a leader in "urban living" (through building upon Tempe amenities essential to quality of life such as public art and art centers, museums, library, LRT, bus transit, walking and biking network, walkable authentic downtown, multi-generational centers, parks and recreational facilities, and ensure these remain available as the community grows); expanding pockets of urban activity centers or "hubs", enhancing connections for pedestrian, bike, and transit to produce a "20-minute city" (through the creation of safe and comfortable pedestrian and bike connections to schools, parks and multi-generational centers, within a 20-minute walk, bike ride, or local-serving transit. As described, in part, in the circulation chapter, the focus is to expand LRT, streetcar and future transportation options to support TOD as one of the backbones of interhub connectivity and attain more options for HCT to connect to and within the region by bus rapid transit or inter-city/commuter rail.

Further, the sustained guiding principle states that Tempe should continue to be a leader in multi-modal transportation. No single mode of transportation will be sufficient to meet the mobility needs of Tempe. Emphasize movement of people and goods instead of movement of cars, to encourage reduction of single occupancy vehicle trips. Ensure accessibility to transportation modes for persons of all abilities. Investments in rail and bus transit, improved bike and pedestrian connections, technology innovations, along with asset management will all be necessary to meet the mobility needs of the community.

The circulation chapter notes that Tempe is the regional leader in providing public transit. The City has a well-defined transit system that provides a variety of services. The City bus routes provide service along the arterial and some collector streets. The neighborhood circulators, Orbit and FLASH, serve shorter trips with higher frequencies in high demand areas. Tempe's involvement in development of the MAG RTP identified areas where HCT investments will be constructed within Tempe. Rural/Scottsdale Road is an identified corridor for BRT that will connect from San Tan (SR 202) to Scottsdale/Shea Boulevard. The transit section offers two goals: (1) increase transit modes and services that support ridership increases and (2) expand transit mode share to facilitate connections among transportation modes. Each of these goals is supported by a variety of strategies that suggest that the City of Tempe will remain at the forefront of planning for transit options throughout the city.

Transportation Plans

MAG Southeast Valley Transit System Study (2015)

The Southeast Valley Transit System Study analyzed transit services and ridership demand in transit-established and transit-aspiring communities within the southeast subarea of the MAG region. The study addressed local bus transit, and rail HCT was not included in the analysis. The study had three planning timeframes including short-term (or optimization of existing services), mid-term, and long-term.

The “Optimization of Existing Services” planning timeframe included concepts to enhance transit services that are currently in operation within the Southeast Valley. Key elements included the consolidation of resources invested in the Arizona Avenue and Main Street corridors to provide a robust, high frequency service; explore alternative service types to more efficiently serve some deviations or lower productivity route segments; obtain a minimum of 30-minute frequency service on all routes; and improve frequencies on high ridership routes. The mid-term planning timeframe included further enhancements to bus route frequencies, new circulator services, expanded transit center and park-and-ride facilities, and adding new commuter services. The long-term planning timeframe included extensions to bus routes and improved bus route frequencies; new local, express, and rural bus routes; and expanded transit center and park-and-ride facilities.

City of Tempe Transportation Master Plan (2015)

The goal of the City of Tempe Transportation Master Plan is to provide a multi-modal transportation guide for the city that includes short term (2020) and long term (2040) recommendations and supports the General Plan 2040. Existing transit service in Tempe includes LRT service, local and express bus service, neighborhood circulators, and paratransit. Transit service in Tempe has changed dramatically with the implementation of LRT in 2008.

The recommended transit improvements for the short term (2020) transportation scenario include premium bus service on Rural Road and Southern Avenue, the Tempe Streetcar starter line, an Orbit Saturn circulator in South Tempe, and other local bus improvements. The recommended transit improvements for the long term (2040) transportation scenario include HCT on Rural Road between the Scottsdale border and Baseline Road, the Tempe Streetcar system, a second Orbit circulator in South Tempe. The plan focuses on citywide transportation improvements and does not specifically discuss commuter rail as part of this project.

2.8.4 Railroad Characteristics

Railroad Infrastructure

Tempe Junction, southward view towards 13th street in Tempe, Arizona. Source: MAG.

The Kyrene Line Corridor stretches approximately 18 miles along the Union Pacific Railroad line from Phoenix Union Station to the Wild Horse Pass Hotel and Casino on Gila River Indian Reservation land. This single-track corridor is divided into two segments consisting of 9.3 miles between Union Station and Tempe Junction; and another 9.2 miles between Tempe Junction extending south to the conceptual end-of-line at the intersection of Interstate 10/Wild Horse Pass Blvd (Gila River Indian Community).The section of the corridor between Tempe Junction and West Chandler/Gila River Indian Community is also referred to as the Tempe Industrial Lead (or Tempe Branch, Kyrene Branch). From January 2009 to spring 2010, Union Pacific Railroad installed new railroad ties and continuous welded rail (CWR) between downtown Phoenix and Tempe Junction. Welded rail was also installed on 1912-era Southern Pacific Salt River-Tempe Town Lake Bridge. In 1999-2000, new railroad ties and CWR were installed between Tempe Junction and the Lone Butte Industrial Park at the Gila River Indian Community.

When the San Tan Line Corridor was used by Amtrak until June 1996, the line was (and still is) controlled by DTC and ABS. The maximum speed for trains between Phoenix Union Station and Tempe Junction is 40 mph. The maximum speed on the Tempe Industrial Lead from Tempe Junction to West Chandler/GRIC is 20 mph under Restricted Limits (RL – Union Pacific Railroad Rule 5.8.2).

In total, there are 21 public and private at-grade track crossings and 11 grade-separated crossings between The section of the corridor between downtown Phoenix and Tempe Junction. The downtown Phoenix Quiet Zone (3rd Avenue to 4th Street) was activated in fall 2009. A Quiet Zone was also activated entirely through Tempe from 1st Avenue to 13th Street (Tempe Junction) in 2012. Positive Train Control (PTC) is not in-effect on this corridor at present time.

Approximately 10 freight customers are located along the Tempe Industrial Lead section of the corridor, particularly within the vicinity of Tempe Junction (between mileposts 916 and 917). In addition, an industrial park extends south beyond the Kyrene Line Corridor end-of-line for another 1.5 to 2.0 miles. In Spring 2010, Union Pacific Railroad removed approximately four miles (20,000 ft) of industrial and warehouse tracks, spurs and sidings within the Tempe Industrial Park, located west of Milepost 1. This industrial park, located between Alameda and Southern, Union Pacific Railroad Tempe Branch and Priest Drive, was built in the late 60s through the late 1980s to serve a variety of light and heavy industrial businesses.

The Tempe Industrial Lead section of the corridor includes one railroad bridge across U.S. 60 and seven culverts. In total, there are 17 public and private at-grade track crossings and 2 grade-separated crossings between Tempe Junction and the Gila River Indian Communtity at SR 202/South 56th Street (Lone Butte Industrial Park).

Most of the at-grade crossings are equipped with active warning devices consisting of bells, flashers, and gates. There is one existing Quiet Zone section located on the Tempe Industrial

Lead - Kyrene Line Corridor: The City of Chandler activated a Quiet Zone from Ray Road to Chandler Boulevard in 2010. There is also an application pending for approval to create a Quiet Zone in Tempe over 12 intersections and pedestrian crossings located throughout the corridor from Broadway Road to Warner Road. The Tempe North-South Rail Spur Multi-Use Path is also planned to be constructed parallel to the Tempe Industrial Lead (within city right of way or railroad easement) from 13th Street to Knox Road.

The eight major railroad facilities that are located along the Kyrene Line Corridor are shown in Figure 2-15 and include:

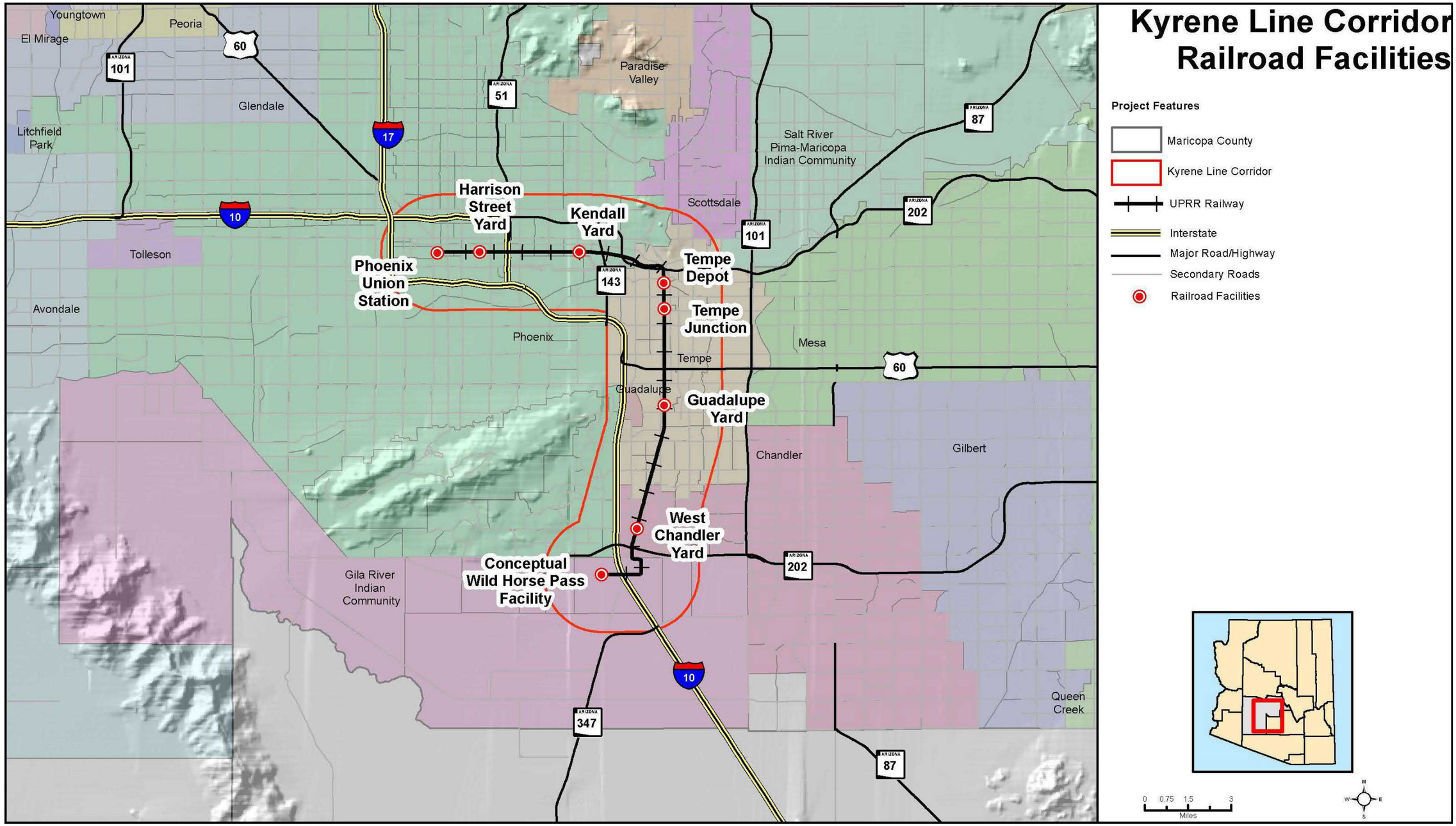
- Phoenix Union Station (Union Pacific Railroad MP 906.0; BNSF MP 194);
- Harrison Street Yard (MP 907.0);
- Kendall Yard (MP 911.1);
- Tempe Depot (MP 914.3);
- Tempe Junction (MP 915.3 / MP 0.0);
- Guadalupe Road Yard (MP 3.5);
- West Chandler Yard (MP 7.7; Lone Butte Inustrial Park industrial trackage extends south to the Gila River Indian Community at MP 9.7 – Rock Solid Way/Germann Rd.); and
- Wild Horse Pass/GRIC at I-10 (MP 9.7X) (Extension requiring 3,000 feet of new track west from 56th Street/Allison Road and new I-10 grade separation to open-area near Wild Horse Pass and Phoenix Premium Outlets).

For a more detailed description of Kyrene Line Corridor railroad conditions and existing and planned facilities, see Appendix E: Systems Study Railroad Conditions and Issues.

Railroad Operations

The following daily railroad operation is typical in a given 24-hour period in the San Tan Line Corridor. This number represent averages and can change regularly given the nature of the movement of freight forTempe Junction (MP 915.3) to West Chandler/GRIC (MP 924) = **1 round trip train per day.**

Figure 2-15: Kyrene Line Corridor – Railroad Facilities



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2.8.5 Highway Characteristics

The location of the Kyrene Line Corridor between downtown Phoenix and the proposed end-of-line in west of Chandler offers one primary travel path along I-10 westbound eventually ending in downtown Phoenix via the 7th Street exit from I-17 for those commuters living at or near the southern edge of Tempe or in West Chandler. Currently, the number of lanes on I-10 between Chandler and downtown Phoenix varies from six to ten general use lanes as well as and HOV lanes in both directions throughout.

Several roadway projects have been completed or are planned along the Kyrene Line Corridor since the 2010 Study, in an effort provide additional capacity. A summary of these improvements are shown in in Table 2-25.

Table 2-25: Kyrene Line Corridor Recent and Future Roadway Improvements

Improvement	Extent	Opening Date	Current Status
SR 202 (South Mountain) New Freeway	I-10 Maricopa to I-10 Papago	2019	Planning/Design
I-10 Widening	SR 143 to U.S. 60/ (Superstition Freeway)	2023	Planning/Design
Reconfigure the I-10/US 60 (Superstition Freeway) Interchange	I-10/US 60 Interchange	2023	Planning/Design
I-10 Widening	US 60/ (Superstition Freeway) to Ray Road	2023	Planning/Design
I-10 Widening	SR-202L to Riggs Road Widening	2026	Planning

Source: MAG, 2018.

Travel Characteristics: Travel Times, Volume and Congestion

The travel path identified to analyze the Kyrene Line Corridor between downtown Phoenix and west of Chandler follows an alignment which combines portions of both I-17 and I-10. For the purposes of this analysis, the intersection of Washington Street and Central Avenue in downtown Phoenix and the intersection of Wild Horse Pass Boulevard and Maricopa Road just south of Chandler on the Gila River Indian Community were used as end points to measure the travel characteristics. The travel path for this corridor totals 17 miles and was broken into two segments in order to compare travel characteristics on both ends of the corridor. Table 2-26 compares travel characteristics for the AM peak period in 2015 and 2040.

Table 2-26: Kyrene Line Corridor AM Peak Period Travel Characteristics (2015 – 2040)

2015 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: I-10/ Sundust Road to I-10/US 60	9 miles	15 minutes	10 minutes	9 minutes	1 – 4	1,400 – 24,600
Segment #2: I-10/US 60 to Downtown Phoenix	9 miles	15 minutes	12 minutes	9 minutes	1 – 6	300 – 35,800
Total Trip	**18 miles**	**30 minutes**	**22 minutes**	**18 minutes**	–	**300 – 35,800**
2040 AM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: I-10/ Sundust Road to I-10/US 60	9 miles	14 minutes	10 minutes	9 minutes	1 – 4	2,100 – 23,800
Segment #2: I-10/US 60 to Downtown Phoenix	9 miles	14 minutes	9 minutes	10 minutes	1 – 6	300 – 31,000
Total Trip	**18 miles**	**28 minutes**	**19 minutes**	**19 minutes**	–	**300 – 31,000**

Source: MAG, 2018.

Between 2015 and 2040, travel characteristics in the AM peak travel period are expected to only slightly change. Between the intersection of Chandler Boulevard and 56th Street and the intersection of I-10 and U.S. 60, traffic volume is expected to see a slight decrease and travel time in this segment will decrease by one minute. The traffic volume is also expected to decrease slightly between U.S. 60 and downtown Phoenix, and the trip time is projected to decrease by one minute in this segment as well. This travel time improvement can be attributed to future improvements along I-10. High occupancy vehicle travel times were studied to help determine how effective commuter rail could be in each of the corridors. There are HOV lanes on I-10 and the HOV travel time is 8 minutes faster for this segment in the AM peak period compared to that of the general purpose lanes. Off-peak travel times were also studied to illustrate the travel time degredation during peak periods. The table shows that travel times are generally 12 minutes longer for the AM peak period compared to off-peak travel times in 2015, and 9 minutes longer in 2040.

Similar to the AM peak period travel characteristics, PM peak period travel time, volume, and congestion levels were analyzed. Table 2-27 shows the comparison between 2015 and 2040 PM peak period travel characteristics in the Kyrene Line Corridor.

Table 2-27: Kyrene Line Corridor PM Peak Period Travel Characteristics (2015 – 2040)

2015 PM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Downtown Phoenix to I-10/US 60	9 miles	16 minutes	13 minutes	9 minutes	1 – 6	300 – 43,400
Segment #2: I-10/US 60 to I-10/ Sundust Road	9 miles	14 minutes	10 minutes	9 minutes	1 – 4	2,300 – 32,800
Total Trip	**18 miles**	**31 minutes**	**24 minutes**	**18 minutes**	–	**300 – 43,400**
2040 PM Peak Period Travel Characteristics						
Segment	Distance	Peak Travel Time		Off-Peak Travel Time	Lanes	Traffic Volume (vehicles)
		SOV	HOV			
Segment #1: Downtown Phoenix to I-10/US 60	9 miles	15 minutes	10 minutes	10 minutes	1 – 6	200 – 43,300
Segment #2: I-10/US 60 to I-10/ Sundust Road	9 miles	14 minutes	11 minutes	9 minutes	1 – 4	4,100 – 33,200
Total Trip	**18 miles**	**28 minutes**	**21 minutes**	**19 minutes**	–	**200 – 43,300**

Source: MAG, 2018.

The 2015 travel time between downtown Phoenix and U.S. 60 in the PM peak period was 16 minutes. Given recent and planned infrastructure improvements throughout this segment of the corridor, the travel time is expected to slightly improve by 2040 with a decrease of 1 minute. Travel between U.S. 60 and west of Chandler took 14 minutes in 2015 and is expected to remain the same by 2040. PM peak travel volumes between downtown Phoenix and U.S. 60 will remain unchanged by 2040. The HOV lanes on I-10 provide an HOV travel time that is 7 minutes faster for this segment in the PM peak period compared to that of the general purpose lanes. The table also shows that travel times are 13 minutes longer for the PM peak period compared to off-peak travel times in 2015, and 9 minutes longer in 2040.

The level of congestion throughout the Kyrene Line Corridor is expected to remain severely congested throughout the corridor in the future. Figure 2-16 shows the travel path within the Kyrene Line Corridor as well as the level of congestion and travel time in both the AM and PM peak period in 2015 and 2040. Note that levels of congestion within downtown Phoenix are shown, but actual travel times for this area are not shown in this figure.

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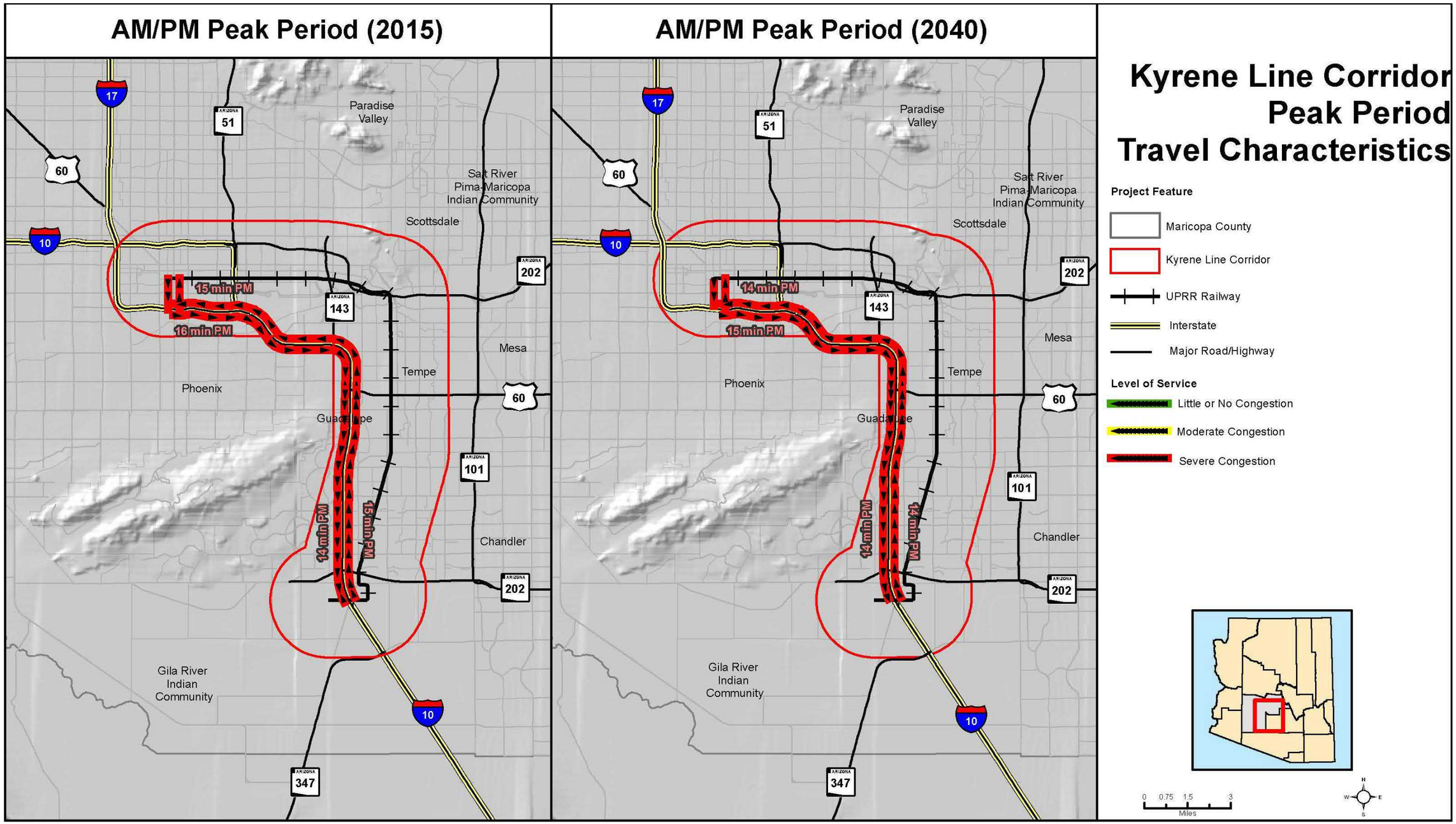
Figure 2-16: Kyrene Line Corridor – Peak Period Travel Characteristics



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2.8.6 Transit Service

Transit services provided or planned for future implementation in the Kyrene Line Corridor include fixed route bus service, HCT and transit passenger facilities. Figure 2-17 graphically represents both the existing and planned regional transit network within the Kyrene Line Corridor.

Fixed Route Bus Service

Currently, fixed route bus service within the Kyrene Line Corridor is comprised of local bus, circulators, regional connectors, and express bus service.

Local Bus

Within the Kyrene Line Corridor, local bus service is provided seven days a week, operating approximately 35 routes that serve the corridor is some capacity. Local routes generally operate on weekdays between 5:00 AM and 11:00 PM and between 6:00 AM and 9:30 PM on the weekends. Most of the local routes operating within the Kyrene Line Corridor operate at a peak frequency of 30 minutes or better.

Circulators

Currently, four circulator systems operate nine routes within the Kyrene Line Corridor, serving portions of the City of Phoenix and the City of Tempe. These systems include the: DASH and ALEX in the City of Phoenix; the BUZZ in the City of Mesa; the FLASH at ASU; and the Orbit (with five routes) in the City of Tempe.

These systems provide circulating transit service and operate seven days a week, with the exception of the DASH in downtown Phoenix and the FLASH at ASU which operates Monday through Friday and the BUZZ in Mesa which operates Monday through Saturday.

Rural Routes

There are no rural routes that serve the Kyrene Line. The Maricopa Xpress (MAX) previously operated in the Kyrene Line by an independent contractor through the City of Maricopa. The MAX service operated two separate routes that connected to both downtown Phoenix and downtown Tempe via I-10 Monday through Friday. The MAX service was suspended in 2010. There is some potential for regional bus service to operate from Wild Horse Pass to the City of Maricopa in future years.

BRT/Express Bus

Within the Kyrene Line Corridor, express bus service operates five days a week Monday through Friday. Currently, there are nine express routes that provide service between east valley cities and downtown Phoenix. Of those routes, the I-10 East RAPID, provide connections between downtown Phoenix and the Kyrene Line Corridor end-of-line in West Chandler. These routes provide similar service to that expected from a commuter rail system in this corridor. Route 540 also provided similar service, but has been eliminated since the 2010 Study.

The RTP identifies four new express bus routes between the East Valley cities and downtown Phoenix. The RTP has identified two arterial BRT routes that will be implemented.

High Capacity Transit

Currently, the only HCT service located in the Kyrene Line Corridor is LRT that extends between Mesa and downtown Phoenix. However, Tempe Streetcar will add a 3.0-mile modern streetcar in 2021.

Transit Passenger Facilities

Transit facilities located within the Kyrene Line Corridor include both transit centers and park-and-ride facilities.

Transit Centers

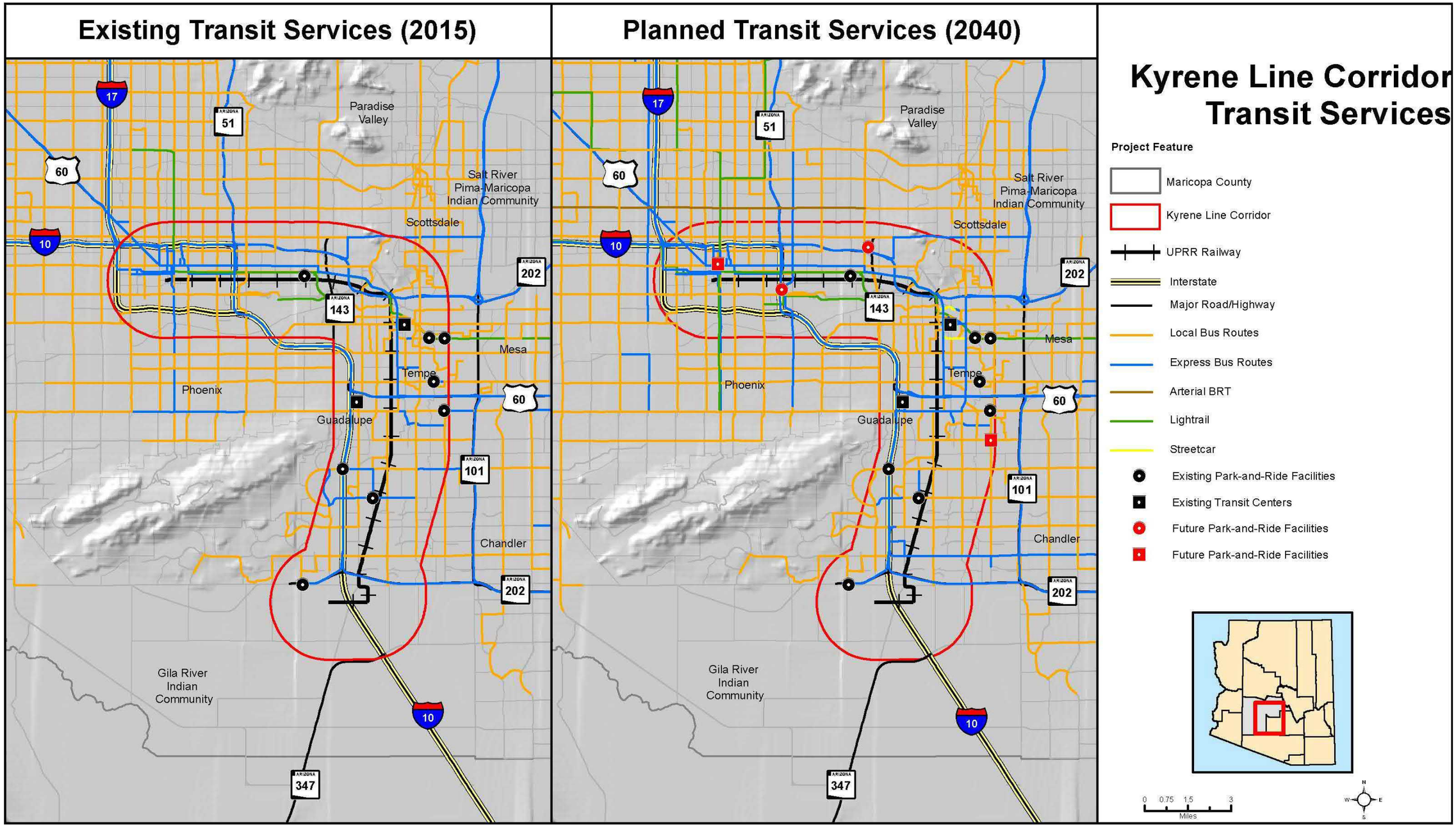
Two existing transit centers are located in the Kyrene Line Corridor. These include Central Station located in downtown Phoenix, the Tempe Transit Center located near ASU in downtown Tempe.

Park-and-Ride Facilities

There are six existing park-and-ride facilities (not including two additional park-and-rides that serve the LRT line) in the Kyrene Line Corridor that provide transit riders with access to local bus service, circulators, or express bus routes.

The RTP notes that additional transit centers and park-and-ride facilities will be needed in the future, but suggests that the locations of new facilities will be determined in other planning processes.

Figure 2-17: Kyrene Line Corridor – Transit Services



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2.8.7 Travel Patterns

Home-based work trips originating within the Kyrene Line Corridor were analyzed for 2015 and 2040. The purpose of this analysis was to understand the destinations of HBW trips that originated within the Kyrene Line Corridor. Destinations that were identified as part of this analysis include trips:

- Within the Kyrene Line Corridor;
- Within the System Study; and
- Outside the limits of the System Study.

An analysis of HBW trips showed that in 2015, nearly 261,000 trips originated within the Kyrene Line Corridor, with 61 percent of these trips remaining within the corridor. Of the remaining originating trips, 11 percent were destined to other locations within the limits of the System Study, and 28 percent went to locations outside the System Study planning area. In 2040, the number of HBW trips originating in the Kyrene Line Corridor increased by 31 percent to nearly 343,000 trips daily. A comparison of HBW trips between 2015 and 2040 shows that the percentage of HBW trips traveling to the three analyzed destination areas remained relatively unchanged. The number of trips originating within the Kyrene Line Corridor for 2015 and 2040 are identified in Table 2-28.

Table 2-28: Home-Based Work Trips Originating within the Kyrene Line Corridor

Destination Area	2015		2040	
	HBW Trips	Percent	HBW Trips	Percent
Within Kyrene Line Corridor	158,692	61%	205,012	60%
Within the System Study	28,937	11%	37,341	11%
Without the System Study	73,329	28%	100,449	29%
Total	**260,985**	**100%**	**342,803**	**100%**

Source: MAG, 2018.

2.8.8 Summary

The Kyrene Line Corridor stretches through largely developed portions of the City of Phoenix, the City of Tempe, and the City of Chandler. This corridor is expected to experience a 46 percent growth in population and 24 percent growth in employment between 2015 and 2040. The Kyrene Line Corridor includes a balanced mix of land uses with residential development making up the largest portion. Land uses are not expected to change significantly in the future and there are very few notable railroad facilities located throughout the Kyrene Line Corridor that will impact future development of commuter rail service.

The primary travel path between downtown Phoenix and the proposed Kyrene Line Corridor end-of-line in west of Chandler is along I-10. Despite expansion planned by 2040, congestion along I-10 will continue to increase.

Transit services are generally spread evenly throughout the corridor and include multiple forms of transit, including high-capacity services. The most concentrated areas of transit services are located in downtown Phoenix and downtown Tempe. Future service will continue this trend as well as provide increased high-capacity transit options.

Travel patterns within the Kyrene Line Corridor are expected to remain similar between 2015 and 2040 although there is an expected increase in overall trips within the limits of the corridor in 2040.

2.9 Future Extensions

2.9.1 Short Term Extensions

Since the 2010 Study, the Grand Line Corridor and the Estrella Line Corridor have been shortened to better match future demographics in the outlying areas of the region. Extensions out to the original termini would likely be completed in the shorter term before new corridors would be planned, but this would be determined in future studies based on future demographic and ridership projections.

2.9.2 Long Term Extensions

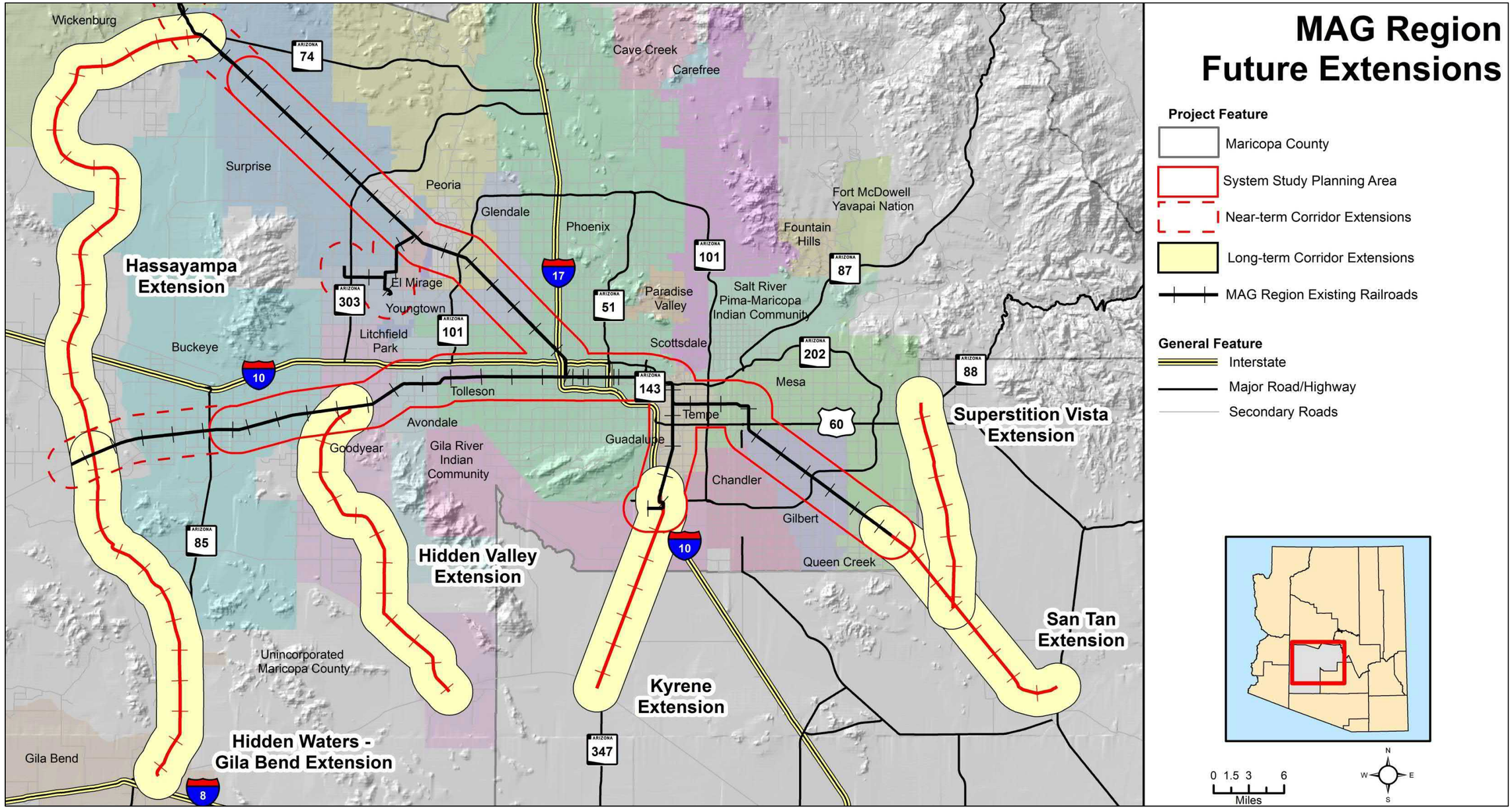
As part of the 2010 MAG Commuter Rail System Study, service areas beyond the current limits of the existing railroad network are also being evaluated. Figure 2-18 illustrates these potential extensions. Potential corridor extensions to the four current commuter rail corridors include the following:

- **Hassayampa Extension**: A conceptual commuter rail service study area between the communities of Morristown, which is located along the Grand Line Corridor, and the end-of-line for the Estrella Line Corridor near Arlington, Arizona.
- **Hidden Valley Extension**: A conceptual commuter rail service study area between the City of Goodyear and Mobile. The extension would run in line with the proposed Hassayampa Freeway, south of the current Estrella Line Corridor, as identified in the MAG Hidden Valley Framework Study. The proposed freeway alignment connects Mobile to the SR 303 Extension and the City of Goodyear along the Estrella Line Corridor.
- **Hidden Waters-Gila Bend Extension**: A conceptual commuter rail service study area between the end-of-line along the Estrella Line Corridor and Gila Bend. The extension would run in line with a proposed major arterial alignment and parallels portions of SR 85 as identified in the MAG Hidden Valley Framework Study.
- **Kyrene Extension**: A conceptual commuter rail service study area between the Wild Horse Pass Hotel and Casino at the proposed Kyrene Line Corridor end-of-line and the City of Maricopa. Between these two points, the extension is located primarily within the Gila River Indian Community along the existing SR 347 alignment.
- **Southeast Extension**: A conceptual commuter rail service study area that extends from the proposed San Tan Line Corridor end-of-line in Queen Creek to Florence. The alignment follows the existing Union Pacific Railroad and Copper Basin Railway alignments that are currently being used in freight rail operations.
- **Superstition Vistas Extension**: A conceptual commuter rail service study area between Magma Junction, northwest of Florence, and Apache Junction. The alignment generally follows the proposed Pinal County North-South Freeway as identified in the Pinal County Comprehensive Plan.

An analysis of these potential extension corridors will focus on high level demographic and land use projections as well as any pertinent information regarding the surrounding transportation infrastructure. For the purpose of this evaluation, all extension corridors should be viewed as generalized corridors, not as specific alignments. Future commuter rail service alignments shall be identified in future planning and design studies.

The complete analysis of these potential corridor extensions is provided in Appendix B: Evaluation of Potential System Study Commuter Rail Corridor Extensions.

Figure 2-18: Future Commuter Rail Extensions and Conceptual Station Area Locations



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3.0 DEVELOPMENT OF THE COMMUTER RAIL PROGRAM

3.1 Introduction

This chapter describes the development and evaluation of the System Study Update alternatives. It is organized as follows:

- Section 3.2 provides an overview of assumptions that went into the development of alternatives. These include updated ridership projections, capital and operating cost estimates, vehicle technology options, corridor extents, station locations, operating characteristics, service levels, and travel times.
- Section 3.3 provides a description of the proposed commuter rail program, including routes, service frequencies, and travel time.
- Section 3.4 presents the commuter rail operations for the proposed commuter rail program.
- Section 3.5 presents a summary of the assumptions used for the proposed commuter rail program.
- Section 3.6 presents the ridership forecasting updates in this System Study Update. The System Study Update only modeled the two cross-region lines that are proposed for the commuter rail program (Grand/Kyrene Line and Estrella/San Tan Line) to update results of the 2010 Study.
- Section 3.7 presents the cost estimates for the proposed commuter rail program. It provides capital cost estimates, which include the cost to obtain right of way, construct the commuter rail tracks and stations, procure vehicles, and make needed infrastructure improvements. This section also presents the operating and maintenance (O&M) costs, which include the annual cost to operate each alternative based on the service plans.

3.2 Development of Commuter Rail Corridors

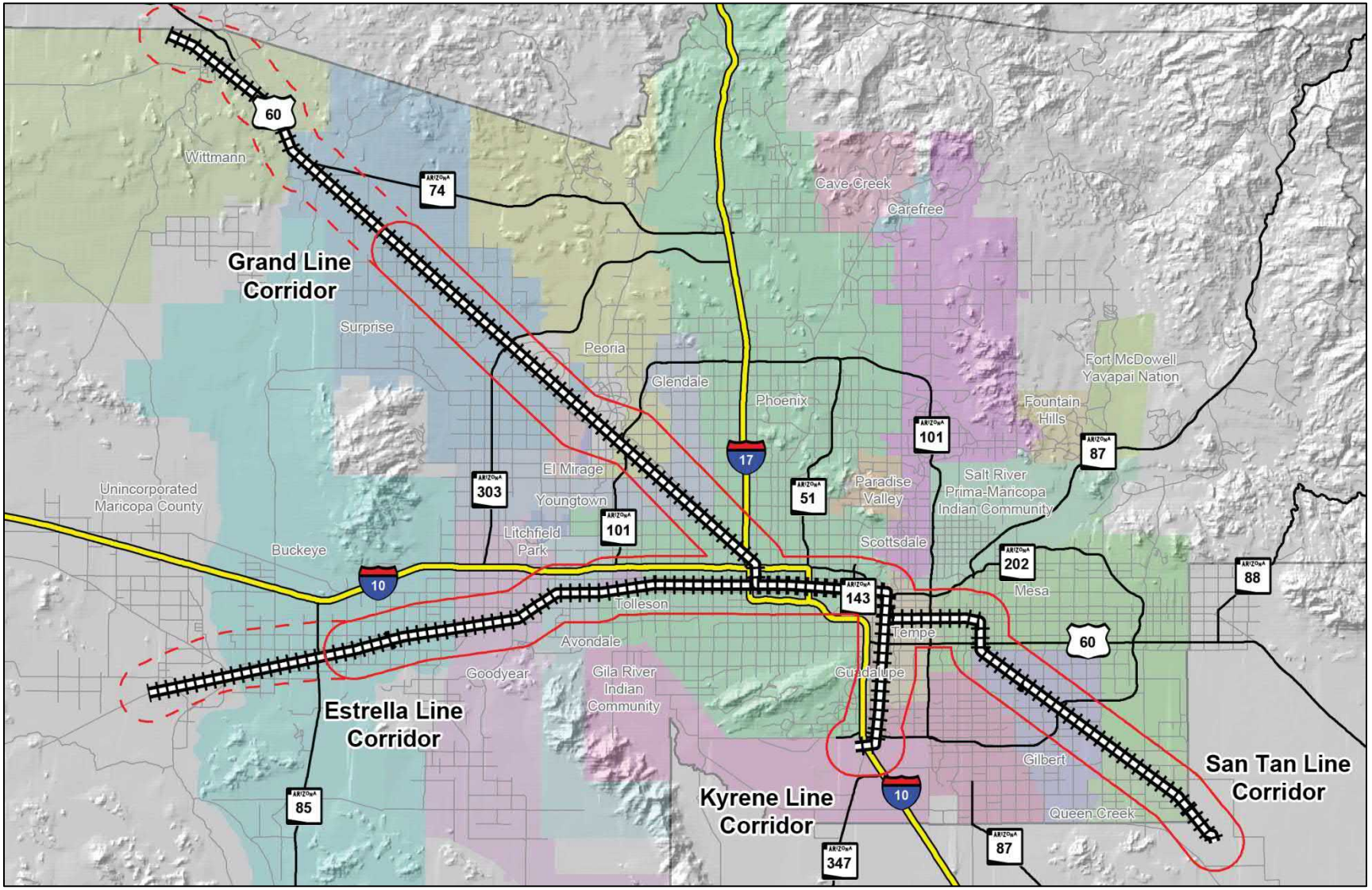
The initial development of alternatives in the 2010 Study built on the recommendations of the MAG Commuter Rail Strategic Plan. The Strategic Plan developed a commuter rail system concept that would radiate from downtown Phoenix to the west, northwest, and south/southeast. This section summarizes the updates to the assumptions that were made to develop the commuter rail program in the original 2010 Study.

As shown in Figure 3-1, each of the four commuter rail corridors under study would be oriented around existing freight rail lines including:

- Grand Line Corridor (BNSF Railway)
- Estrella Line Corridor (Union Pacific Railroad)
- San Tan Line Corridor (Union Pacific Railroad)
- Kyrene Line Corridor (Union Pacific Railroad)

For the development of the commuter rail program, the Project Team updated and evaluated ridership projections, capital and operating cost estimates, vehicle technology options, corridor extents, station locations, operating characteristics, service levels, and travel times as shown in the subsections below.

Figure 3-1: MAG Regional Commuter Rail System Corridors



Source: AECOM, 2018.

3.2.1 Ridership Forecasting

Ridership forecasting was performed using the MAG TransCAD travel demand model. This model was developed with a 2015 base year and a forecast year of 2040. The 2040 model was used for System Study Update ridership forecasting and incorporates improvements specified in the *2040 Regional Transportation Plan* (September 2017), including approximately 66 miles of high capacity transit (light rail and streetcar).

3.2.2 Cost Estimates

Capital costs have also been updated for the entire commuter rail system. Total system costs are inclusive of construction (including trackage, sidings, stations, and maintenance and layover facilities), vehicles, soft costs (including design and environmental review), and project contingencies.

3.2.3 Vehicle Technology

The Project Team evaluated Locomotive Hauled Coaches (LHC) and Diesel Multiple Unit (DMU) technologies to determine which type of commuter rail vehicles would be most appropriate for the MAG commuter rail system. An "off-the-shelf" FRA-compliant DMU was not widely available in 2010. However, U.S. Railcar (formerly Colorado Railcar), Nippon Sharyo, and Stadler Rail Group now manufacture DMUs for the U.S. market. U.S. Railcar supplied vehicles to TriMet for its Westside Express Service (WES) in Portland; Nippon Sharyo supplied vehicles for Sonoma-Marin Area Rail Transit (SMART) commuter rail corridor between the Sonoma County Airport and San Rafael California; and Stadler Rail Group is supplying vehicles to Trinity Metro (Fort Worth) for its TEX Rail corridor between downtown Fort Worth and the Dallas/Fort Worth International Airport. These vehicles now meet structural requirements of the FRA and are able to operate in mixed traffic with freight trains.

LHCs are powered by one diesel-electric locomotive engine and are configured for push-pull operation. In push-pull service, the locomotive pulls the train in one direction and pushes the train in the opposite direction. A cab car with operating controls is put on one end of the train and a locomotive at the other end. Trains of LHCs may range from two-car to 10-car consists depending on ridership needs. LHC commuter rail systems are currently in service in many U.S. cities including Seattle, San Diego, Salt Lake City, Dallas-Fort Worth, and Minneapolis.

The seated capacity of each double-deck passenger car, typically used in LHC commuter rail operations, is approximately 150 passengers; therefore, a three-car train (two coaches and one cab control car) would seat approximately 450 passengers, and the seated capacity of a four-car train (three coaches and one cab control car) is approximately 600 passengers.

The San Diego Coaster (left) LHCs connect downtown San Diego to Oceanside, CA. Seattle's Sounder (right) connects Everett and Lakewood to downtown Seattle. Both lines use a locomotive (left) for power in both directions and a cab control car (right) for operations in the reverse direction. Source: NCTD (left), Sound Transit (right)

DMUs built by Nippon Sharyo that serve the SMART line in the California Bay Area operate in two-car trainsets. Each two-car train can seat 160 passengers. A very similar model of this DMU that operates in Toronto Canada is operated with three cars per trainset. DMUs are similar to light rail in that they usually operate with a maximum of four-car trainsets. The four-car TEX Rail trains built by Stadler can seat up to 440 passengers per train.

The SMART DMUs connecting Santa Rosa and downtown San Rafael, CA (left) operate two-car trainsets, which can be expanded. The TEX Rail DMUs (right) will be operated in four-car consists between downtown Fort Worth and Dallas/Fort Worth International Airport. Source: SMART (left), TEX Rail (right)

Both LHCs and DMUs are being evaluated for commuter rail service in the MAG region. For a complete description of the vehicle technology evaluation, see Appendix F: Commuter Rail Vehicle Technology.

3.2.4 Stations

The Project Team conducted an evaluation of station target areas for each of the commuter rail corridors under consideration in 2010. Potential station target areas were characterized and assessed based on a set of evaluation criteria which included potential station boardings, demographic and employment projections, land use, connectivity with existing and planned transportation systems, and major activity centers. For the purposes of the evaluation, general station target areas were identified by major intersections along each commuter rail corridor. At this level of analysis, specific parcels were not identified.

As part of this System Study Update, MAG conducted interviews with many of the member cities to determine if the station target areas from the 2010 Study should remain in place or be moved to better fit within recent development patterns in the local communities. In most cases, it was determined that the conceptual locations of the stations were still appropriate, given the development that have occurred. One station that could be moved based on recent developments is the station in Avondale. The community suggested that Dysart and MC 85 may be their preferred location for the station rather than at Avondale Boulevard and Buckeye Road.

Table 3-1 contains the station target areas that are considered along each corridor with distances between station locations. Figure 3-2 illustrates the general locations of the stations that are considered.

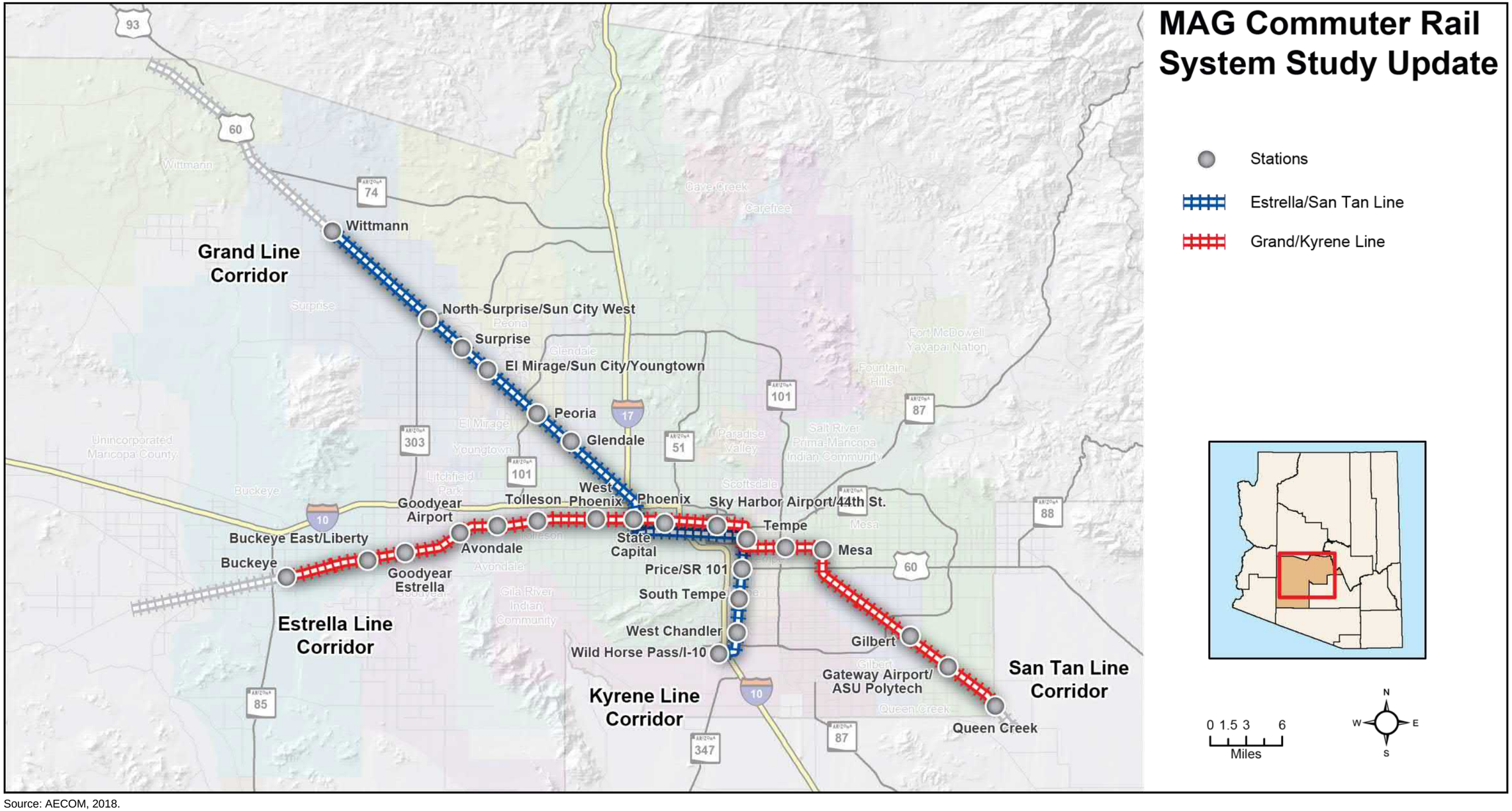
Conceptual illustration of a locomotive (left) and a diesel multiple unit (right) for the proposed MAG commuter rail system. (Note: the vehicle type and vehicle manufacturer have not been selected at this stage in the planning process. These are shown as potential rail vehicles for illustrative purposes only.) Source: MAG (both)

Table 3-1: Distance between Station Target Areas for Each Corridor

From Station Target Area	To Station Target Area	Distance between Station Target Areas
Grand/Kyrene Line Corridor		
Wittmann	North Surprise/Sun City West	9.7
North Surprise/Sun City West	Surprise	4.5
Surprise	El Mirage/Sun City/Youngtown	2.0
El Mirage/Sun City/Youngtown	Peoria	5.8
Peoria	Glendale	4.1
Glendale	State Capitol	8.7
State Capitol	Phoenix	1.0
Phoenix	Sky Harbor Airport /44th Street	5.0
Sky Harbor Airport /44th Street	Tempe	3.3
Tempe	Central Tempe	1.5
Central Tempe	South Tempe	3.9
South Tempe	West Chandler	2.2
West Chandler	Wild Horse Pass/I-10	2.1
Total Distance		**53.8**
Estrella/San Tan Line Corridor		
Buckeye	Buckeye East/Liberty	6.6
Buckeye East/Liberty	Goodyear/Estrella	3.0
Goodyear/Estrella	Goodyear Airport	4.3
Goodyear Airport	Avondale	3.2
Avondale	Tolleson	3.2
Tolleson	West Phoenix	5.0
West Phoenix	State Capitol	4.1
State Capitol	Phoenix	1.0
Phoenix	Sky Harbor Airport/44th Street	5.0
Sky Harbor Airport/44th Street	Tempe	3.3
Tempe	Price SR 101 (Price Freeway)	3.2
Price SR 101 (Price Freeway)	Mesa	3.4
Mesa	Gilbert	5.0
Gilbert	Gateway Airport/ASU Polytech	6.1
Gateway Airport/ASU Polytech	Queen Creek	5.0
Total Distance		**61.4**

Source: AECOM, 2018.

Figure 3-2: MAG Commuter Rail System Study Update Station Areas



Source: AECOM, 2018.

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3.2.5 Operating Characteristics

It is assumed that if the region moves forward with commuter rail service, both the Grand/Kyrene Line and the Estrella/San Tan Line would be constructed, although, they would likely be implemented in phases as funding becomes available.

This Operations Plan shows one service level (ultimate buildout). Initial year service could include peak period only service, and changes in future passenger ridership coupled with less freight activity, could allow for additional passenger trips during the mid-day. These operational options are not described further, as it is the intention to operate some mid-day service during initial year service, and future operational improvements would likely occur after the horizon year of this study. If increases to passenger trains are to occur, additional coordination with the railroads would be required, as there will be operating agreements that stipulate the number of trains that operate daily. There are also options for special event trains, likely to occur on weekends or during evening hours.

3.2.6 Service Level

Commuter rail service would consist of the Grand/Kyrene Line between Wittmann and Wild Horse Pass/I-10 and the Estrella/San Tan Line between Buckeye and Queen Creek both on 30-minute headways during peak periods in both directions and 120-minute headways during off-peak periods. There would be 17 trains in each direction on each of the two cross-region corridors, for a total of 68 daily commuter rail trains.

3.2.7 Coordination with Railroads

While some initial discussions have occurred with the freight railroads during this System Study Update and during the original 2010 Study, it should be noted that there are no operating or other agreements that the freight railroads have signed to allow passenger rail service to operate on the existing freight rail lines at this time.

Additionally, there has been a general understanding about the level of service that is proposed as part of ADOT's Arizona Passenger Rail Corridor Study: Tucson to Phoenix (APRCS). However, there has been no coordination regarding schedules and other operating characteristics of the proposed intercity rail program. It is understood that there is a desire by the MAG region and the state to develop both rail technologies and the project team believes that the commuter rail operational planning has not precluded any future intercity rail to be accommodated if and when it is implemented in the future.

3.2.8 Travel Times

The end-to-end travel times range between 66 minutes (DMU) and 73 minutes (LHC) on the Grand/Kyrene Line including stops at stations between Wittmann and Wild Horse Pass/I-10. On the Estrella/San Tan Line, end-to-end travel times range between 74 minutes (DMU) and 83 minutes (LHC) including stops at stations between Buckeye and Queen Creek.

Single corridor travel times to downtown Phoenix along the Grand Corridor range between 38 minutes (DMU) and 42 minutes (LHC). This compares to peak period auto travel times of 88 minutes today and 124 minutes in 2040 in the inbound direction during the AM peak period.

Travel times in the Kyrene Corridor range between 26 minutes (DMU) and 29 minutes (LHC) to downtown Phoenix. This compares to peak period auto travel times of 30 minutes today and 28 minutes in 2040 in the inbound direction during the AM peak period.

Travel times in the Estrella Corridor to downtown Phoenix range between 34 minutes (DMU) and 39 minutes (LHC). This compares to peak period auto travel times of 49 minutes today and 74 minutes in 2040 in the inbound direction during the AM peak period.

Travel times to downtown Phoenix in the San Tan Corridor range between 37 minutes (DMU) and 41 minutes (LHC). This compares to peak period auto travel times of 63 minutes today and 62 minutes in 2040 in the inbound direction during the AM peak period.

The station to station travel times for both corridors (using both technologies) are shown in Table 3-2 through Table 3-5.

Table 3-2: Estimated Station to Station Travel Times – Grand/Kyrene Corridor (LHC)

From Station	To Station	Distance (miles)	Max Speed (mph)	Run Time (min)	Station Dwell (min)	Total Trip Time (min)	Cumulative Travel Time (min)
Wittmann	North Surprise/Sun City West	9.7	79.0	8.68	0.50	9.18	9.18
North Surprise/Sun City West	Surprise	4.5	79.0	4.73	0.50	5.23	14.42
Surprise	El Mirage/Sun City/Youngtown	2.0	79.0	2.84	0.50	3.34	17.75
El Mirage/Sun City/Youngtown	Peoria	5.8	79.0	5.72	0.50	6.22	23.98
Peoria	Glendale	4.1	79.0	4.43	0.50	4.93	28.91
Glendale	State Capitol	8.7	60.0	9.70	0.50	10.20	39.11
State Capitol	**Phoenix**	1.0	35.0	2.30	0.00	2.30	41.40
Phoenix Dwell					3.00		44.40
Phoenix	Sky Harbor Airport/44th Street	5.0	50.0	6.83	0.50	7.33	51.74
Sky Harbor Airport/44th Street	Tempe	3.3	45.0	5.15	0.50	5.65	57.39
Tempe	Central Tempe	1.5	79.0	2.46	0.50	2.96	60.34
Central Tempe	South Tempe	3.9	79.0	4.28	0.50	4.78	65.12
South Tempe	West Chandler	2.2	79.0	2.99	0.50	3.49	68.61
West Chandler	Wild Horse Pass/I-10	2.1	40.0	3.67	0.50	4.17	72.93

Source: AECOM, 2018.

Table 3-3: Estimated Station to Station Travel Times – Grand/Kyrene Corridor (DMU)

From Station	To Station	Distance (miles)	Max Speed (mph)	Run Time (min)	Station Dwell (min)	Total Trip Time (min)	Cumulative Travel Time (min)
Wittmann	North Surprise/Sun City West	9.7	79.0	8.03	0.50	8.53	8.53
North Surprise/Sun City West	Surprise	4.5	79.0	4.08	0.50	4.58	13.10
Surprise	El Mirage/Sun City/Youngtown	2.0	79.0	2.18	0.50	2.68	15.78
El Mirage/Sun City/Youngtown	Peoria	5.8	79.0	5.06	0.50	5.56	21.34
Peoria	Glendale	4.1	79.0	3.77	0.50	4.27	25.61
Glendale	State Capitol	8.7	60.0	9.20	0.50	9.70	35.31
State Capitol	**Phoenix**	1.0	35.0	2.01	0.00	2.01	37.32
Phoenix Dwell					3.00	3.00	40.32
Phoenix	Sky Harbor Airport/44th Street	5.0	50.0	6.42	0.50	6.92	47.24
Sky Harbor Airport/44th Street	Tempe	3.3	45.0	4.78	0.50	5.28	52.51
Tempe	Central Tempe	1.5	79.0	1.80	0.50	2.30	54.81
Central Tempe	South Tempe	3.9	79.0	3.62	0.50	4.12	58.93
South Tempe	West Chandler	2.2	79.0	2.33	0.50	2.83	61.76
West Chandler	Wild Horse Pass/I-10	2.1	40.0	3.33	0.50	3.83	65.74

Source: AECOM, 2018.

Table 3-4: Estimated Station to Station Travel Times – Estrella/San Tan Corridor (LHC)

From Station	To Station	Distance (miles)	Max Speed (mph)	Run Time (min)	Station Dwell (min)	Total Trip Time (min)	Cumulative Travel Time (min)
Buckeye	Buckeye East/Liberty	6.6	79.0	6.33	0.50	6.83	6.83
Buckeye East/Liberty	Goodeyear/Estrella	3.0	79.0	3.60	0.50	4.10	10.92
Goodeyear/Estrella	Goodyear Airport	4.3	79.0	4.58	0.50	5.08	16.01
Goodyear Airport	Avondale	3.2	79.0	3.75	0.50	4.25	20.25
Avondale	Tolleson	3.2	79.0	3.75	0.50	4.25	24.50
Tolleson	West Phoenix	5.0	79.0	5.11	0.50	5.61	30.12
West Phoenix	State Capitol	4.1	50.0	5.75	0.50	6.25	36.37
State Capitol	**Phoenix**	1.0	35.0	2.30	0.00	2.30	38.67
Phoenix Dwell					3.00	3.00	41.67
Phoenix	Sky Harbor Airport/44th Street	5.0	50.0	6.83	0.50	7.33	49.00
Sky Harbor Airport/44th Street	Tempe	3.3	45.0	5.15	0.50	5.65	54.65
Tempe	Price SR 101 (Price Freeway)	3.2	55.0	4.41	0.50	4.91	59.56
Price SR 101 (Price Freeway)	Mesa	3.4	55.0	4.63	0.50	5.13	64.68
Mesa	Gilbert	5.0	79.0	5.11	0.50	5.61	70.30
Gilbert	Gateway Airport/ASU Polytech	6.1	79.0	5.95	0.50	6.45	76.75
Gateway Airport/ASU Polytech	Queen Creek	5.0	79.0	5.11	0.50	5.61	82.36

Source: AECOM, 2018.

Table 3-5: Estimated Station to Station Travel Times – Estrella/San Tan Corridor (DMU)

From Station	To Station	Distance (miles)	Max Speed (mph)	Run Time (min)	Station Dwell (min)	Total Trip Time (min)	Cumulative Travel Time (min)
Buckeye	Buckeye East/Liberty	6.6	79.0	5.67	0.50	6.17	6.17
Buckeye East/Liberty	Goodeyear/Estrella	3.0	79.0	2.94	0.50	3.44	9.61
Goodeyear/Estrella	Goodyear Airport	4.3	79.0	3.92	0.50	4.42	14.03
Goodyear Airport	Avondale	3.2	79.0	3.09	0.50	3.59	17.62
Avondale	Tolleson	3.2	79.0	3.09	0.50	3.59	21.21
Tolleson	West Phoenix	5.0	79.0	4.46	0.50	4.96	26.17
West Phoenix	State Capitol	4.1	50.0	5.34	0.50	5.84	32.00
State Capitol	**Phoenix**	1.0	35.0	2.01	0.00	2.01	34.01
Phoenix Dwell					3.00	3.00	37.01
Phoenix	Sky Harbor Airport/44th Street	5.0	50.0	6.42	0.50	6.92	43.92
Sky Harbor Airport/44th Street	Tempe	3.3	45.0	4.78	0.50	5.28	49.20
Tempe	Price SR 101 (Price Freeway)	3.2	55.0	3.95	0.50	4.45	53.65
Price SR 101 (Price Freeway)	Mesa	3.4	55.0	4.17	0.50	4.67	58.32
Mesa	Gilbert	5.0	79.0	4.46	0.50	4.96	63.27
Gilbert	Gateway Airport/ASU Polytech	6.1	79.0	5.29	0.50	5.79	69.06
Gateway Airport/ASU Polytech	Queen Creek	5.0	79.0	4.46	0.50	4.96	74.02

Source: AECOM, 2018.

3.3 Description of the Proposed Commuter Rail System

For the System Study Update, the Project Team focused only on interlined alternatives that were first evaluated in the 2010 System Study. It should be noted that in the 2010 Study, the single corridor, stand-alone alternatives were first modeled individually and then combined with a second corridor which included a transfer in Central Phoenix. This provided valuable information about how best to combine the interlined alternatives which now make up the proposed commuter rail program.

Based on the results of the 2010 Study, the Grand Line was interlined with the Kyrene Line and the Estrella Line was interlined with the San Tan Line. These combinations showed very good ridership potential during the 2010 Study. Interlined alternatives would provide a one-seat ride through each entire corridor. Both corridors proposed as part of the commuter rail program were developed with 30-minute peak headways and 120-minute off-peak headways. Table 3-6 shows the characteristics of the proposed commuter rail system.

Table 3-6: Characteristics of Proposed Commuter Rail System

Alternatives	Description	Distance	Peak Service	Off-Peak Service	No. of Stations	Travel Time
Individual Corridors						
Grand Line	Service between Wittmann and downtown Phoenix	35.8 miles	30 min.	120 min.	8	38-42 min.
Kyrene Line	Service between Wild Horse Pass/I-10 and downtown Phoenix	18.0 miles	30 min.	120 min.	7	26-29 min.
Estrella Line	Service between Buckeye and downtown Phoenix	30.4 miles	30 min.	120 min.	9	34-39 min.
San Tan Line	Service between Queen Creek and downtown Phoenix	31.0 miles	30 min.	120 min.	8	37-41 min.
Combined Corridors						
Grand/Kyrene Line	Service between Wittmann and Wild Horse Pass/I-10 with a stop in Phoenix	53.8 miles	30 min.	120 min.	14	66-73 min.
Estrella/San Tan Line	Service between Buckeye and Queen Creek with a stop in Phoenix	61.4 miles	30 min.	120 min.	16	74-82 min.

Source: AECOM, 2018.

3.4 Commuter Rail Operations

Commuter Rail service differs from light rail service, which focuses on shorter corridors and more frequent service throughout the day. Commuter rail corridors are typically longer than light rail lines, which traditionally are fewer than 20 miles in length. In the MAG region, the two cross-region corridors have total distances of 53.7 miles (Grand/Kyrene Line) and 61.4 miles (Estrella/San Tan Line).

Another difference is that commuter rail focuses on peak period service. The commuter rail program proposed for the MAG region would have trains departing every 30-minutes during peak periods (5:00-7:30 AM and 3:30-6:30 PM) with three mid-day trains (at 9:30 AM, 11:30 AM, and 1:30 PM) and one evening train (8:30 PM). It is assumed that trains would leave from both ends of both corridors at each of these times, with the focus of providing service from the

suburban stations to downtown Phoenix during the morning commute and from downtown Phoenix back to the suburbs during the evening commute.

It should be noted that schedules will be refined in future phases of the study, as scheduling at this level of analysis is used to determine the number of trains that are required to operate the service, and to begin to understand how passenger traffic would fit in with freight traffic on the proposed alignments.

3.5 Summary of Commuter Rail System Assumptions

Table 3-7 presents a summary of the major assumptions that have been used to develop the proposed commuter rail system and develop operating plans, operating costs and capital costs.

The table also shows where trains traveling in both directions on the line would meet. Two sets of tracks (in the form of double tracked alignment or passing sidings) are needed at locations where trains are expected to meet. Often times, schedules can be changed slightly to allow these meets to occur at stations where it is more likely to have two sets of tracks and two platforms. When meets do not occur at stations and the alignment is a single track, a passing siding is used for trains to pass. At this conceptual stage, the schedules show trains leaving the origin station at either the top of the hour or at the bottom of the hour. As planning continues, more focus will be placed on where these meets will occur. The project team has accounted for passing sidings in the conceptual cost estimate, but the specific locations are not yet defined.

Table 3-7: Summary of Commuter Rail System Assumptions

Element	Assumption
System Descriptions	
Two cross-region corridors	Grand/Kyrene Line: 53.8 miles (14 Stations) Estrella/San Tan Line: 61.4 miles (16 Stations)
Commuter rail to share existing upgraded freight tracks, and use second track through middle portion of the corridors	Grand Line: 7 daily freight trains Estrella Line: 4-5 daily freight trains San Tan Line: 6-7 daily freight trains Kyrene Line: 1 daily round trip freight train
Schedule	30-minute peak and 120-minute off-peak service (in both directions) AM Peak: 5:00 – 7:30 AM; Mid-day: 9:30 AM, 11:30 AM, and 1:30 PM; PM Peak: 3:30 – 6:30 PM; Evening: 8:30 PM
Vehicle Technology	Evaluating: Locomotive Hauled Coach (LHC) and Diesel Multiple Units (DMU)
Corridor Travel Times to DT Phoenix	Grand Line: 38 min. (DMU), 42 min. (LHC) Kyrene Line: 26 min. (DMU), 29 min. (LHC) Estrella Line: 34 min. (DMU), 39 min. (LHC) San Tan Line: 37 min. (DMU), 41 min. (LHC)
Grand Line Description	
Tracks in Use	Double Track: Union Station to SR 303 (26.4 miles) Single Track: SR 303 to Wittmann (10 miles)
Passing Sidings/Train Meets (3)	Just north of State Capitol Station (both vehicle types); at El Mirage/Sun City/ Youngtown Station (DMU) or west of Peoria Station (LHC); and near Wittmann Station (both vehicle types).
Crossings	43 at-grade crossings
Railroad Communications	Positive Train Control (PTC)/Quiet Zones throughout
Kyrene Line Description	
Tracks in Use	Single Track: 9.5 miles (Tempe Junction to Wild Horse Pass/I-10)
Passing Sidings/Train Meets (2)	At Sky Harbor Airport/44th Street Station, and at West Chandler

Element	Assumption
	Station (both vehicle types).
Crossings	16 at-grade crossings
Railroad Communications	Positive Train Control (PTC)/Quiet Zones throughout
Estrella Line Description	
Tracks in Use	Double Track: Union Station to 59th Avenue (6 miles) Single Track: 59th Avenue to Buckeye (20.5 miles)
Passing Sidings/Train Meets	At Tolleson Station (both vehicle types); at or near Buckeye East/ Liberty Station (DMU) or at Goodyear/Estrella Station (LHC).
Crossings	34 at-grade crossings
Railroad Communications	Positive Train Control (PTC)/Quiet Zones throughout
San Tan Line Description	
Tracks in Use	Double Track: Union Station to 44th Street (5.2 miles), SR 202 to Center Parkway (1.2 miles) Single Track: 44th Street to SR 202 (1.1 miles), Center Parkway to Queen Creek (28.5 miles)
Passing Sidings/Train Meets (2)	At or near the Tempe Station (both vehicle types); north of Gateway Airport/ASU Polytech Station (DMU) or at Gilbert Station (LHC).
Crossings	48 at-grade crossings
Railroad Communications	Positive Train Control (PTC)/Quiet Zones throughout

Source: MAG and AECOM, 2018.

3.6 Ridership Forecasting Results

As noted above, there were numerous modeling runs completed during the 2010 Study which helped the project team understand how best to combine and interline corridors. Those results were used in this System Study Update which allowed the project team to focus on the cross-region corridors that showed the highest ridership potential in the 2010 Study.

Ridership results for the two cross-region lines, forecast approximately 10,830 riders in 2040 for the Grand/Kyrene Line and 10,100 riders in 2040 for the Estrella/San Tan Line. The total system ridership is projected to be nearly 21,000 for the system in 2040. Table 3-8 shows projected boardings by station for both the 2010 Study and this System Study Update. It should be noted that ridership results from the regional travel demand model are calibrated at the corridor level. This means that while the modeling provides good regional and corridor projections, it is far less accurate at predicting the number of boardings each individual station.

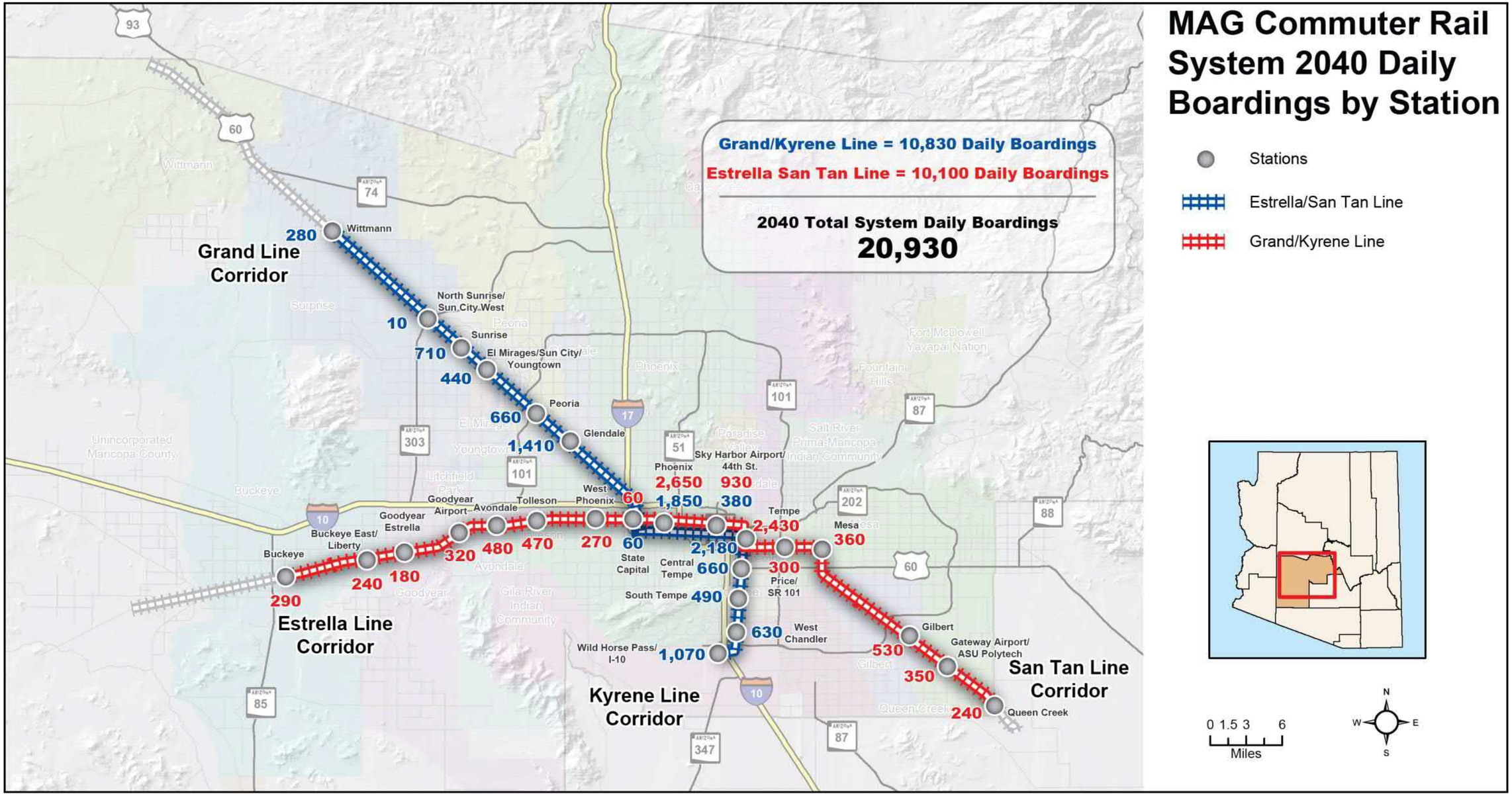
Table 3-8: Comparison of Projected Boardings by Station

Station	2010 Study (2030 Boardings)	System Study Update (2040 Boardings)
Grand/Kyrene Line Corridor		
Wittmann	320	280
North Surprise/Sun City West	210	10
Surprise	760	710
El Mirage/Sun City/Youngtown	470	440
Peoria	860	660
Glendale	870	1,410
State Capitol	255*	60
Phoenix	790*	1,850
Sky Harbor Airport/44th Street	340*	380
Tempe	1,400*	2,180
Central Tempe	170	660
South Tempe	400	490
West Chandler	640	630
Wild Horse Pass/I-10	N/A	1,070
Total Grand/Kyrene Line Boardings	**7,485**	**10,830**
Estrella/San Tan Line Corridor		
Buckeye	250	290
Buckeye East/Liberty	140	240
Goodyear/Estrella	280	180
Goodyear Airport	380	320
Avondale	240	480
Tolleson	260	470
West Phoenix	330	270
State Capitol	255*	60
Phoenix	790*	2,650
Sky Harbor Airport/44th Street	340*	930
Tempe	1,400*	2,430
Price SR 101 (Price Freeway)	400	300
Downtown Mesa	460	360
Mesa/McQueen Junction (removed in System Study Update)	650	N/A
Gilbert	910	530
Gateway Airport/ASU Polytech	2,100	350
Queen Creek	1,190	240
Total Estrella/San Tan Line Boardings	**10,375**	**10,100**
Total System Boardings	**17,860**	**20,930**

Note: Ridership from the 2010 Study for common Stations (noted with an *) are split between the two cross-region alternatives.
Source: AECOM, 2018.

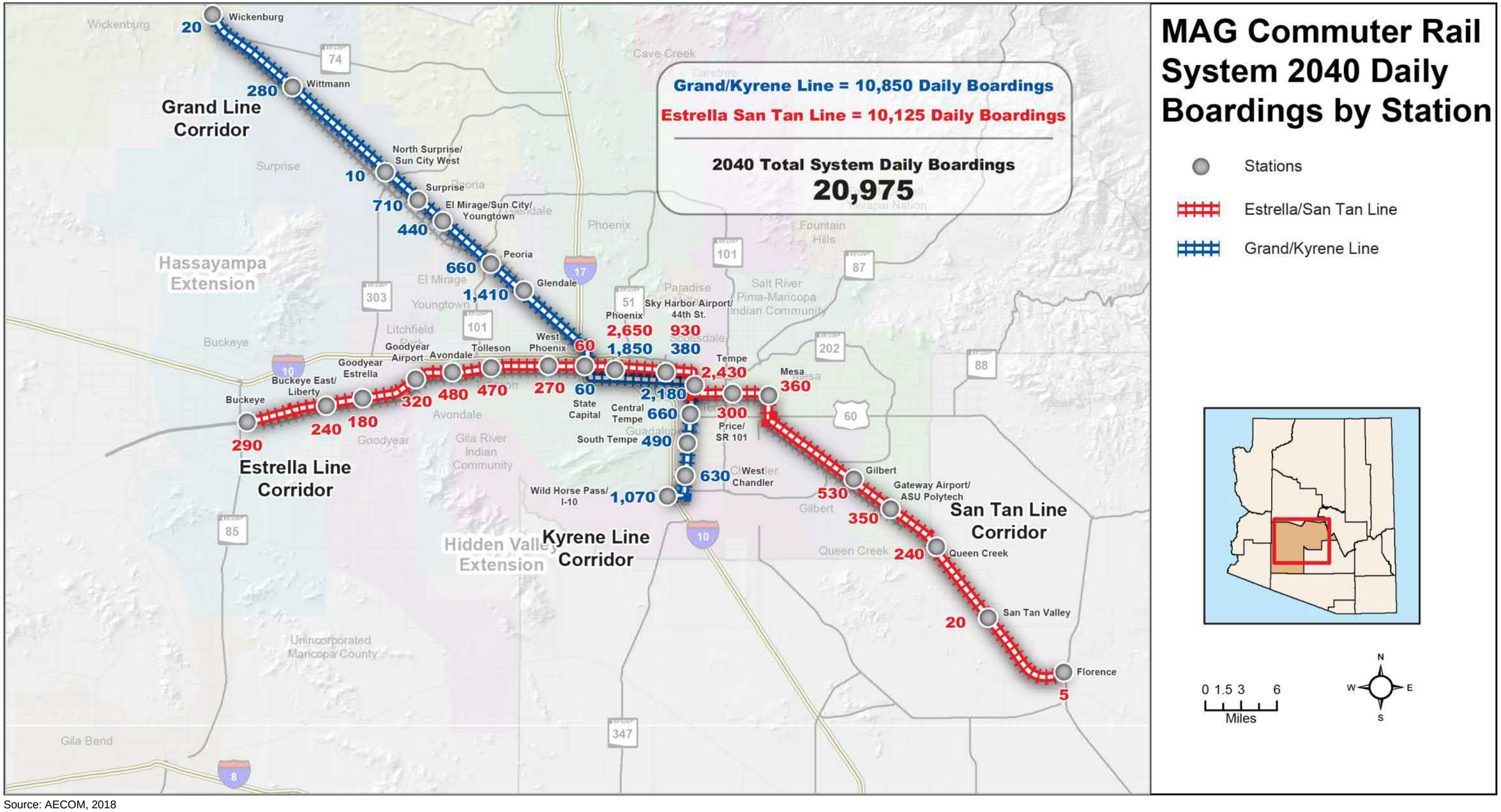
Figure 3-3 graphically illustrates the ridership forecasting results for the Interlined Alternatives. Figure 3-4 shows potential ridership to extension areas of Wickenburg and San Tan Valley.

Figure 3-3: MAG Commuter Rail System 2040 Daily Boardings by Station



Source: AECOM, 2018.

Figure 3-4: MAG Commuter Rail System Potential Ridership to Extension Areas of Wickenburg and San Tan Valley



Source: AECOM, 2018

Special Events Ridership

Special events ridership has proven to be a substantial contributor to light rail ridership in the region, but it is difficult to quantify the impact on commuter rail ridership using available model information. The operations plans summarized in Section 3.4 indicate that special events service would occur in all phases. Several of the special event venues in downtown Phoenix include Talking Stick Resort Arena, Chase Field, Comerica Theater, Phoenix Convention Center, and Symphony Hall. Downtown Tempe is also a center for special events that attract attendees from throughout the region.

To assess the magnitude of the potential impact on ridership, special events were considered through a review of major events and their expected attendance in these two downtown areas. Downtown Phoenix is the home of two major sports teams, the Arizona Diamondbacks and the Phoenix Suns. The Phoenix Convention Center hosts a number of large events throughout the year, such as the International Auto Show. First Fridays Artlink is a monthly event that continues to grow in popularity and attract people downtown. The annual attendance of these events in downtown Phoenix is estimated in Table 3-9.

Downtown Tempe hosts a number of large events that could be served in part by commuter rail. Arizona State University football games as well as the college bowl game draw large numbers of people from the entire region. In addition, Tempe hosts a number of annual events including: the Tempe Festival of the Arts, New Year's Block Party, Tempe 4th of July Celebration, and the Tempe Music Fest. The estimated attendance for these events is shown in Table 3-9.

Table 3-9: Estimated Major Special Events Attendance

Special Event	Typical Annual Attendance
Downtown Phoenix	
Arizona Diamondbacks games	2,100,000
Phoenix Suns games	705,000
Phoenix Convention Center	1,000,000
First Fridays Artlink	300,000
Total for Downtown Phoenix	**4,105,000**
Downtown Tempe	
ASU athletic events	400,000
College Bowl Game	50,000
Tempe Arts Fest	250,000
New Year's Block Party	100,000
Fourth of July	100,000
Tempe Music Fest	25,000
Total for Downtown Tempe	**925,000**

Source: AECOM, 2018.

While downtown Phoenix and Tempe each host the large events as described above, they also host many smaller events, as well. Additionally, ASU has a variety of other sporting events that are well attended including basketball (averaging nearly 10,000 per game in recent years) and baseball/softball. However, the events listed above are some of the largest and are thus most likely to have a threshold of attendees high enough to benefit from and be attracted to commuter rail service.

Annual attendance to large special events in downtown Phoenix and Tempe is estimated at 5,030,000. Studies of other regions have found that transit may capture between 10 and 25 percent of special event trips. A conservative estimate of 10 percent of trips that would use some form of transit would equate to approximately 500,000 trips annually (one-way).

3.7 Cost Estimates

This section presents the cost estimates for both cross-region lines of the proposed commuter rail system. It provides capital cost estimates, which include the cost to construct the commuter rail tracks and stations, procure vehicles, and make needed infrastructure improvements. In general, capital costs assume the sharing of the existing freight rail tracks in each corridor with a second track being constructed within the central portions of the system to accommodate both freight and passenger trains. Stations would be double tracked or constructed to allow for future double tracking, depending on the operational needs. Locations of possible passing sidings are also identified as needed in places along the corridors where there is not a proposed double track and meets do not occur at stations.

Finally, it is assumed that all track would be upgraded to Class 4 track to allow for 80 mph train speeds throughout the system. Trackwork is one of the most expensive components of implementing passenger rail service. There is also a degree of variation when comparing capital costs of other systems, as the existing infrastructure in some cases needs more work than in others. In the MAG region, the freight railroads use these tracks in regular daily service. The cost estimates do not include the purchase of right of way or payments to the freight railroads for operating rights.

3.7.1 Capital Cost Estimates

Design Options

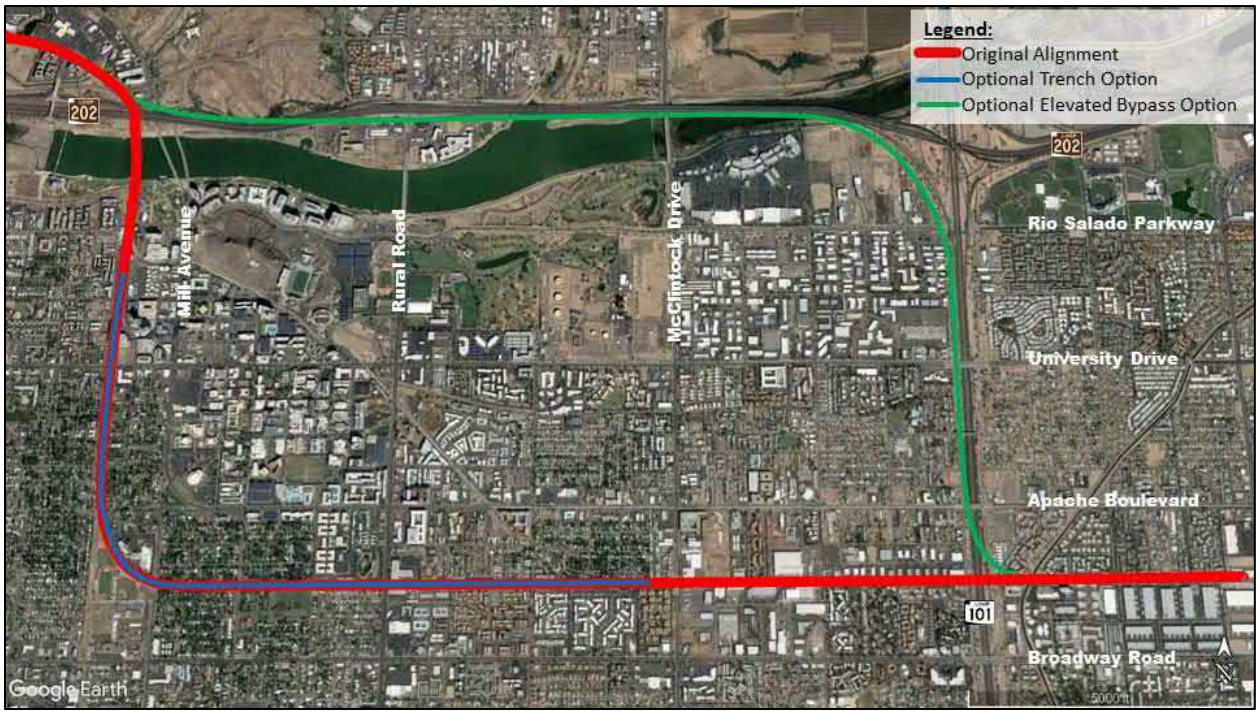
Two design options related to commuter rail service operating through the City of Tempe have developed and an addition option has been identified in the Town of Gilbert. Discussions have centered on an elevated bypass that would follow SR 202 and SR 101 around Tempe to the north or a trench option along the existing alignment on the south side of Tempe, as well as a trench option in Gilbert. These discussions began due to right of way constraints, the reduction of potential environmental impacts, and removing several at-grade crossings. More details about each alternative are presented below.

Tempe Elevated Bypass Option

During the ADOT APRCS, a bypass option emerged in Tempe that would transition the rail line onto an elevated alignment following SR 202 from about Mill Avenue (where the original alignment would turn south over the Salt River) to SR 101, then continuing south on SR 101 where it would reconnect to the original alignment south of Apache Boulevard, as shown in Figure 3-5. This bypass was described as “a routing option that could be used to avoid or minimize the potential use of Section 4(f) resources and/or potential adverse effects to historic properties”. The original alignment uses the Union Pacific Railroad tracks that are located south of the University Park Historic District and north of Daley Park between Mill and McAllister avenues. The elevated bypass would avoid the potential Section 4(f) and historic resources, but it would also introduce a potential visual impact near the freeway segment that it would travel through. The elevated bypass would be approximately 4.5 miles in length. One consideration to note is that the elevated portion would only be used for passenger trains, so there would be no

improvement to the community in terms of noise due to the continued existence of freight trains through this segment.

Figure 3-5: Tempe Elevated Bypass and Trench Options



Source: AECOM, 2018.

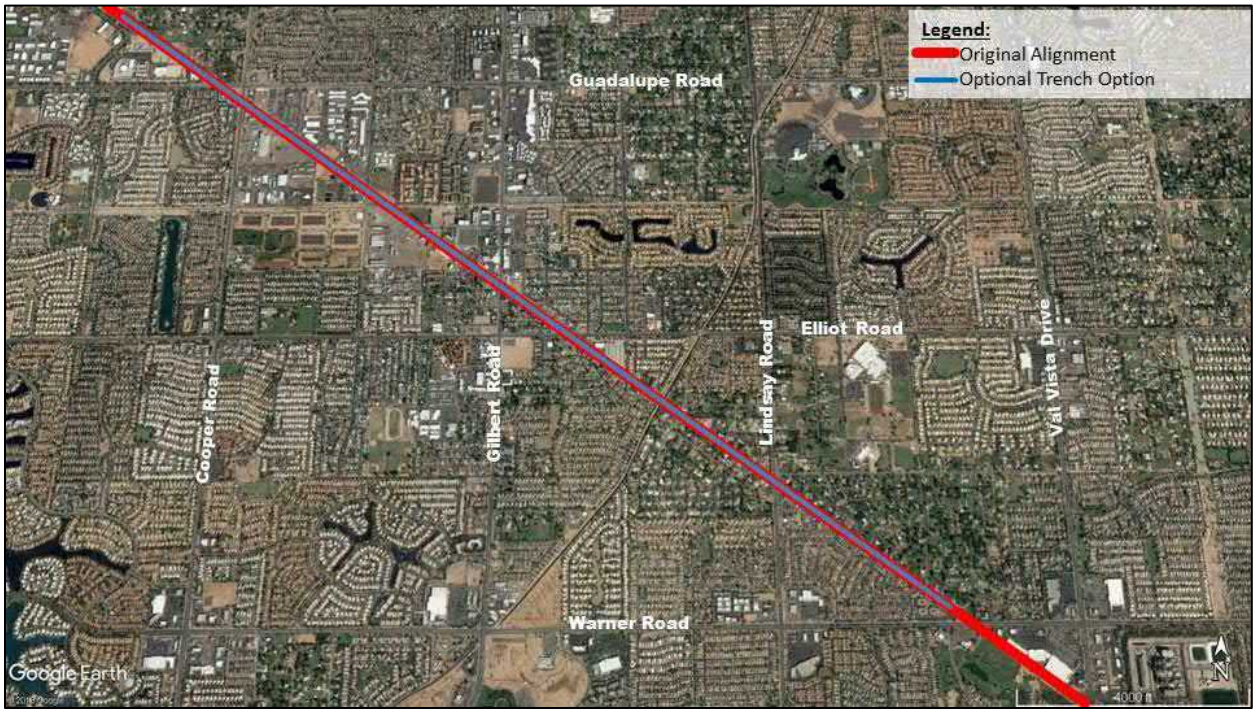
Tempe Trench Option

More recently, there has been discussion surrounding the idea to remaining within the original Union Pacific Railroad alignment but trenching the segment between the Salt River and SR 101. From the west, a trench would likely begin south of University Drive and then come back up to grade level between Rural Road and McClintock Drive on the east, as shown in Figure 3-5. This segment is approximately 2.7 miles in length from incline to incline and could also allow a short segment of the Kyrene Line to be trenched to north of Broadway Road. A trenched alignment would likely require several street closures (in the area of the incline near University Drive) and new bridge crossings over the rail line, which would likely include 13th Street, Mill Avenue, College Avenue, and Rural Road. Mill Avenue is grade-separated with the rail line crossing over this bridge structure. A trench option would provide greater improvements for the community compared to the elevated bypass option, as both freight and passenger trains would use the trench portion of the alignment.

Gilbert Trench Option

A second trench option could also be implemented in Gilbert. This option would trench a 3.5-mile segment (from incline to incline) between north of Guadalupe Road to north of Warner Road, as shown in Figure 3-6. A trench in this segment could likely be done without street closures at the inclines. Additionally, a trenched option in Gilbert would provide for grade separations of Guadalupe, Cooper, Gilbert, Elliot, and Lindsay roads. Neely Street could also connect north and south of the rail line with the implementation of a trench in Gilbert as well.

Figure 3-6: Gilbert Trench Option



Source: AECOM, 2018.

Table 3-10 presents the capital costs for the proposed commuter rail system. The Table also shows additional costs associated with implementing the elevated bypass or either trench option through Tempe and Gilbert.

The elevated bypass or trench options would be added to the total cost of the commuter rail system, and are shown separately. The cost for the elevated bypass is calculated at $100 million per mile. The costs for the trench options are calculated at $120 million per mile based on similar projects completed in downtown Reno, NV ($117 million per mile) and a proposed rail trench in Carlsbad, CA (projected at $134 million per mile).

Changes at Phoenix Union Station

Several changes are proposed at Union Station based on updated discussions with the railroads and other changes to the operating philosophy of the proposed commuter rail system.

At the time of the 2010 System Study the project team was unsure if passenger trains in the region would be able to operate using both the BNSF tracks on the Grand Line and the Union Pacific Railroad tracks on the Estrella, Kyrene, and San Tan lines, or how connections between tracks owned by the two railroads would occur. To ensure that passenger trains using the tracks of both railroads would work, the Grand Line (using the BNSF tracks) was planned to operate using only BNSF tracks to Union Station thus creating a stub-ended station for this line, meaning trains could not pass through the station to serve another corridor, and a transfer would be required at Union Station to the Kyrene Corridor, as shown in Figure 3-7.

It is no longer assumed that the Grand Line would be required to use its own tracks at Union Station. Today, the belief is that trains serving the Grand Line would continue on to serve the Kyrene Line on the Union Pacific Railroad's tracks beyond Union Station. The area that was to

be used for the Grand Line facilities and platform would likely be used as a layover facility where commuter rail trains may be stored or maintained.

Additionally, the original station design showed switches being located in the pavement on 3rd Avenue. While the drawings from the 2010 Study were conceptual, the platforms are proposed to be moved slightly to the west to ensure that only two tracks would cross at 3rd Avenue to make this at-grade crossing safer than what is shown in the original track designs.

Finally, the east house track shown on Figure 3-6 has been removed. It is assumed that this track would not be needed in the future, and there are no plans to add this back into the station plans. Other tracks may be added or removed as necessary as track plans advance at Union Station. These changes are not expected to have an impact on ridership and little to no change in capital costs, but they are expected to create a safer area around the station (with fewer tracks crossing 3rd Avenue), more flexibility for special event service, and the location of a layover facility at Union Station.

Table 3-10: Capital Costs of Proposed Commuter Rail System

Interlined Alternative	Capital Cost	
	DMU	LHC
Grand/Kyrene Line Corridor (same for both vehicle types) (does not include Union Station, Commuter Rail Maintenance Facility, or vehicles)	$1.075 B ($23.4 Million/mile)	$1.075 B ($23.4 Million/mile)
Estrella/San Tan Line Corridor (same for both vehicle types) (does not include Union Station, Commuter Rail Maintenance Facility, or vehicles)	$1.160 B ($16.2 Million/mile)	$1.160 B ($16.2 Million/mile)
System Elements (includes Union Station and Commuter Rail Maintenance Facility)	$152 M	$152 M
Vehicles (15 trainsets)	$180 M	$135 M
System Total	**$2.566 B**	**$2.521 B**
Tempe Elevated Bypass Option (shows additional cost (4.5 miles at $100 million/mile), not vehicle dependent)	$450 Million	
Tempe Trench Option (shows additional cost (2.7 miles at $120 million/mile), not vehicle dependent)	$324 Million	
Gilbert Trench Option (shows additional cost (3.5 miles at $120 million/mile), not vehicle dependent)	$420 Million	

Source: AECOM, 2018.

3.7.2 Operating Cost Estimates

This section also presents the operations and maintenance (O&M) costs, which include the annual cost to operate commuter rail service in each of the two cross-region corridors based on the service plans developed for the project, as presented in Appendix A: Methodology for Cost Estimating. Costs are based on the hours and miles of service developed in the operating plan, and the average costs of similar systems.

For the DMU vehicle technology, these included the:

- A-Train in Denton County, TX;
- MetroRail in Austin, TX,
- Sprinter in San Diego, CA;
- WES in Portland, OR; and
- River Line in Camden, NJ.

For the LHC vehicle technology, these included the:

- Frontrunner in Salt Lake City, UT;
- RailRunner in Albuquerque, NM;
- Sounder in Seattle, WA;
- NorthStar in Minneapolis, MN;
- Tri-Rail in Miami, FL;
- TRE in Dallas/Fort Worth, TX;
- Coaster in San Diego, CA;
- Music City Star in Nashville, TN; and
- ACE in San Jose, CA.

Table 3-11 presents the annual O&M costs for the proposed commuter rail system. It is likely that commuter rail in the MAG region would cost somewhere between the cost per train mile and train hour, as actual costs include a mix of both measures.

Table 3-11: Annual O&M Costs of Proposed Commuter Rail System

Interlined Alternative	DMU		LHC	
	Train Miles	Train Hours	Train Miles	Train Hours
Annual Weekday Train Miles and Hours	465,579	20,910	465,579	20,910
Annual Weekend Train Miles and Hours	35,442	1,210	35,442	1,210
Total Annual Train Miles and Hours	501,021	22,120	501,021	22,120
Average Peer City Cost per Mile and Hour	$38.72	$901.54	$20.93	$683.54
Grand/Kyrene Line Corridor Total Cost	**$19.4 M**	**$19.9 M**	**$10.5 M**	**$15.1 M**
Annual Weekday Train Miles and Hours	532,338	20,910	532,338	20,910
Annual Weekend Train Miles and Hours	40,524	1,210	40,524	1,210
Total Annual Train Miles and Hours	572,862	22,120	572,862	22,120
Average Peer City Cost per Mile and Hour	$38.72	$901.54	$20.93	$683.54
Estrella/San Tan Line Corridor	**$22.2 M**	**$19.9 M**	**$12.0 M**	**$15.1 M**

Source: AECOM, 2018.

3.7.3 Farebox Recovery

Farebox recovery is the percentage of commuter rail O&M costs that are paid for by passenger fares. According to National Transit Database, the national average farebox recovery for commuter rail systems was approximately 52 percent in 2016. This number includes all commuter rail systems throughout the U.S. For reference, Caltrain released its Fare Study in October 2017, and data showed that Caltrain had about a 70 percent farebox recovery rate. Other large systems also see a higher farebox recovery rate, often above 50 percent. Smaller systems typically realize a lower farebox recovery rate. Sounder commuter rail had 30 percent and Coaster had 23 percent, while peer cities for this project (as described in Chapter 4) see between 15 and 30 percent farebox recovery rates.

For the proposed MAG Commuter Rail System, annual O&M costs were projected to be in the range of $19-22 million for each corridor using the DMU technology or between $10-15 million using LHC technology. Annual ridership was calculated by multiplying the 2040 weekday ridership projection by 255 weekdays and then adding 55 Saturdays and Holidays (assuming 10 percent of the 2040 weekday ridership). Total farebox revenue is projected to be $7.9 million for the Grand/Kyrene Line and $8.5 million for the Estrella/San Tan Line, as shown in Table 3-12.

This equates to between a 36 and 40 percent farebox recovery rate, based on a $3.00 fare that was used in the ridership forecasting model. This is slightly below the national average, but as noted above, it is higher than many of the smaller commuter rail systems in the U.S.

It should be noted that opening day operating costs for the proposed MAG commuter rail system may be lower if the system does not operate service on Saturdays or during the mid-day. Similarly, ridership will likely be less on opening day compared to 2040, so farebox revenue would likely be lower as well.

Table 3-12: Annual Farebox Recovery

Farebox Revenue							
Commuter Rail Line	2040 Projected Weekday Ridership	Weekdays/ Year	Annual Weekday Ridership	Saturdays & Holidays/ Year	Annual Weekend/ Holiday Ridership (10% weekday)	Total Annual Ridership	Annual Farebox Revenue ($3.00/trip)
Grand/Kyrene	10,100	255	2,575,500	55	55,550	2,631,050	$7,893,150
Estrella/San Tan	10,830	255	2,761,650	55	59,565	2,821,215	$8,463,645
System	20,930	255	5,337,150	55	115,115	5,452,265	$16,356,795
Farebox Recovery							
Commuter Rail Line	Annual Operating Cost (Train Mile)	Annual Operating Cost (Train Hour)	Average Annual Operating Cost	Annual Fare Box Revenue (90%)	Annual Fare Box Revenue (100%)	Farebox Recovery Rate (90%)	Farebox Recovery Rate (100%)
Grand/Kyrene	$19,399,533	$19,942,065	$19,670,799	$7,103,835	$7,893,150	36.1%	40.1%
Estrella/San Tan	$22,181,217	$19,942,065	$21,061,641	$7,617,281	$8,463,645	36.2%	40.2%
System	$41,580,750	$39,884,130	$40,732,440	$14,721,116	$16,356,795	36.1%	40.2%

Source: AECOM, 2018.

3.8 BNSF Coordination

Subsequent to the completion of the System Study Update, BNSF evaluated the proposed commuter rail operations plan and provided capital requirements for the operation of passenger rail service within the existing BNSF freight railroad right-of-way. The findings are included in Appendix N: BNSF Coordination.

There do not appear to be any fatal flaws in terms of operating passenger rail service within the BNSF freight rail right-of-way at this time. Infrastructure needs, costs, and passenger rail operations (including travel times) will continue to be revisited at each subsequent stage in this planning process. Coordination with BSNF will also in subsequent stage of the planning process.

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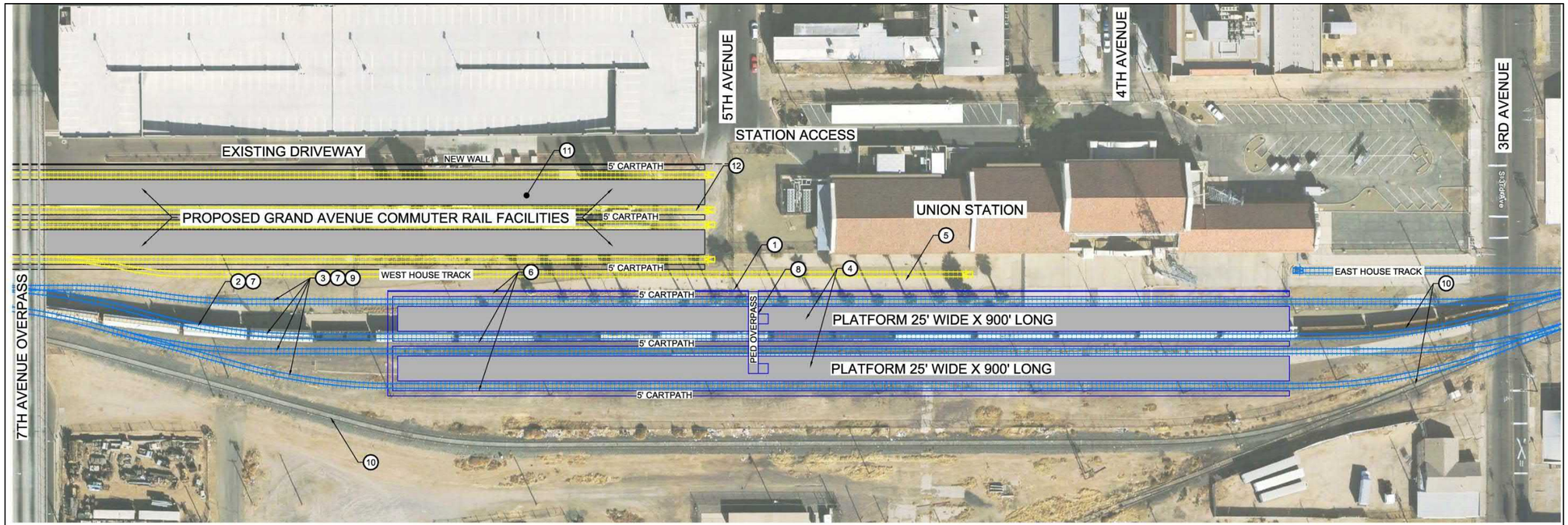
Figure 3-7: Phoenix Union Station Track Layout from 2010 Study



NOTES:

1. LANDSCAPING, FENCE AND AMENITIES ALONG UNION STATION.
2. RELOCATE AND REBUILD EXISTING SIDINGS, #10 TURNOUTS, POWER OPERATED.
3. NEW TRACKS WITH #10 TURNOUT, POWER OPERATED.
4. ISLAND PLATFORM, 25' W x 900' L (LEVEL BOARDING) OPERATIONAL PHASE C.
5. REWORK UNION STATION AREA AS NEEDED TO PROVIDE PASSENGER AREAS AND AMENITIES.
6. MOE CART PATHS TO ACCESS TRACK SWITCHES.
7. REGRADE AS NEEDED FROM 7TH AVENUE OVERPASS TO 3RD AVENUE TO ACCOMODATE TRACKS, PLATFORMS, ETC.
8. POSSIBLE OVERPASS AT 5TH AVENUE OF PASSENGER PLATFORM TO UNION STATION.
9. INSTALL PTC ON ALL NEW TRACK REQUIRED FOR COMMUTER RAIL.
10. REMOVE EXISTING FREIGHT BYPASS TRACK FROM 3RD AVENUE TO 9TH AVENUE AND RECONFIGURE TO PROVIDE A FREIGHT BYPASS USING EXISTING SOUTHERLY TRACK AND MODIFYING THE EXISTING SOUTHERLY TRACK BETWEEN 7TH AVENUE AND 9TH AVENUE/BUCHANAN STREET.
11. REMOVE EXISTING CEMENT PLANT (COORDINATE W/ COMMUTER RAIL).
12. THE PROPOSED GRAND AVENUE COMMUTER RAIL FACILITIES IS BASED ON OPERATIONS PRIOR TO YUMA WEST COMMUTER RAIL. IF GRAND AVENUE COMMUTER RAIL AND YUMA WEST COMMUTER RAIL ARE CONSTRUCTED AT THE SAME TIME, THE BNSF TRACKAGE COULD BE RECONFIGURED TO A LAYUP FACILITY (TO BE CONFIRMED).

LEGEND:

- NEW RAILROAD TRACK
- EXISTING TRACK UPGRADED
- NEW PASSENGER PLATFORM
- NEW MOE CARTPATH, PEDESTRIAN OVERPASS AND SIDEWALK
- OPERATIONAL PHASE A
- OPERATIONAL PHASE B
- OPERATIONAL PHASE C
- GRAND AVE COMMUTER RAIL TRACK AND STATION PLATFORMS - SEE GRAND AVE DRAWINGS

N

GRAPHIC SCALE
50 0 25 50 100
(IN FEET)

THIS DRAWING IS FOR CONCEPTUAL PRESENTATION ONLY AND SHOULD NOT BE USED NOR CONSIDERED AN ENGINEERING PLAN FOR CONSTRUCTION.

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SCALE: AS SHOWN

YUMA WEST COMMUTER RAIL CORRIDOR
DOWNTOWN PHOENIX TO ARLINGTON
YUMA WEST AT UNION STATION
CONCEPTUAL LAYOUT

JOB NO: 048052
DATE: 1-13-10
SHEET: 3B of 23

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4.0 RECOMMENDATIONS AND IMPLEMENTATION STRATEGY

4.1 Introduction

This chapter presents decisions to be made and steps to be taken to further the planning and preparation for implementation of commuter rail in the MAG region. The chapter includes the following sections:

- Section 4.2 provides peer city comparisons related to ridership, capital costs, and operating costs relative to other commuter rail systems currently in operation throughout the western U.S.
- Section 4.3 a discussion of phasing considerations.
- Section 4.4 discusses the opportunities and constraints associated with integrating commuter rail transit with other transit modes throughout the region, particularly at key transit hubs within and outside of downtown Phoenix.
- Section 4.5 provides an overview of commuter rail layover and maintenance facility needs and illustrates potential locations for each type of facility within the proposed commuter rail system.
- Section 4.6 describes several models for operating commuter rail, including Sale or Capacity Rights agreements with the railroads.
- Section 4.7 discusses options for governance and evaluates the suitability of these options for this region.
- Section 4.8 provides options and strategies for funding the proposed commuter rail system.
- Section 4.9 provides near-term and longer-term steps towards implementing the proposed commuter rail system.

4.2 Peer City Comparisons

In order to gauge the relative ridership potential and cost-effectiveness of each the two cross-town corridors, comparisons are made to peer city commuter rail systems currently in operation. Table 4-1 lists a number of commuter rail systems currently in operation and characteristics such as length and ridership. Not all peer systems are used for each of the comparisons in the following subsections.

Table 4-1: Peer City Commuter Rail Systems

Commuter Rail System	Opening Year	Route Length (in miles)	Trains Per Day (Weekday)	Avg. Daily Ridership (Weekday)
Systems Using Locomotive Hauled Coach Vehicles				
Coaster (San Diego-Oceanside, CA)	1995	41	22	4,600
Trinity Railway Express (TRE) (Dallas-Ft. Worth, TX)	1996	34	72	7,700
Altamont Commuter Express (ACE) (San Jose-Stockton, CA)	1998	86	8	5,200
Sounder, South Line (Seattle-Tacoma, WA)	2000	47	26	15,800
Sounder, North Line (Seattle-Everett, WA)	2003	35	8	
Music City Star (Nashville-Lebanon, TN)	2006	32	12	1,200
New Mexico Rail Runner Express (Santa Fe-Albuquerque-Belen, NM)	2006	93	30	2,700
Front Runner (Salt Lake City-Ogden, UT)	2008	44	63	17,200
Systems Using Diesel Multiple Unit Vehicles				
Northstar (Minneapolis, MN)	2009	40	12	2,400
Sprinter (San Diego, CA)	2008	22	19	8,800
River Line (Camden, NJ)	2004	34	86	9,000
Westside Express (Portland, OR)	2009	15	32	1,700
MetroRail (Austin, TX)	2010	32	36	2,700
A-Train (Denton County, TX)	2011	21	58	2,000

Source: AECOM, 2018; National Transit Database, 2016.

Throughout the 2010 System Study and this update, peer city commuter rail systems have been used to compare boardings per revenue mile, capital cost per mile, and annual operations and maintenance (O&M) cost per passenger trip to the Study corridors.

The peer city commuter rail systems selected to compare daily boardings per revenue mile and annual O&M cost per passenger trip include the Sounder in Seattle, WA, the Coaster in San Diego, CA, and the Altamont Commuter Express (ACE) between Stockton and San Jose, CA. These peer city systems were selected because they represent (1) commuter rail systems in the western United States and (2) their daily boardings per revenue mile and annual O&M cost per passenger trip have been recorded in the Federal Transit Administration's (FTA) National Transit Database (NTD). The NTD is the national database of statistics for the transit industry.

The peer city commuter rail systems selected to compare capital cost per mile include the Sounder in Seattle, WA, Front Runner in Salt Lake City, Utah, Northstar in Minneapolis, MN and the Westside Express in Portland, OR. These four systems were selected because they represent a handful of commuter rail systems that have been recently implemented and therefore provide the closest approximation to what it would cost to build a new commuter rail system in the MAG region.

4.2.1 Peer City Comparison: Capital Costs

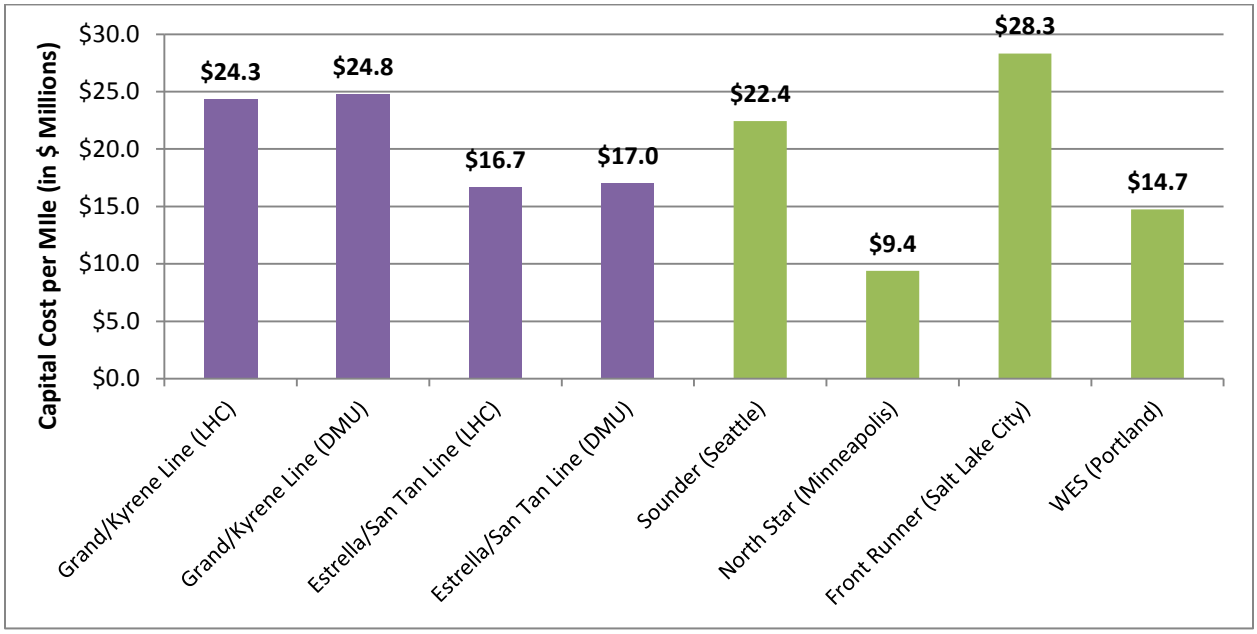
As described in Chapter 3, the capital cost per mile for the proposed MAG commuter rail system is projected to be $24.8 million per mile using DMU vehicles or $24.3 million per mile using LHC vehicles for the Grand/Kyrene Line. The Estrella/San Tan Line is projected to cost $17.0 million per mile using DMU vehicles or $16.7 million per mile using LHC vehicles,

As shown in Figure 4-1, total capital cost per mile for the proposed MAG commuter rail system ranges from approximately $22.8 million per mile for the Grand/Kyrene Line to $15.9 million per

mile for the Estrella/San Tan Line. The cost to build either line would be comparable to other systems and within the range of what most industry experts would consider reasonable.

As described in Chapter 3, the primary variable on per-mile capital costs for commuter rail systems is the quality of existing track and infrastructure and improvements needed to accommodate both commuter rail and freight rail traffic. For example, the North Star Commuter Rail system in Minneapolis is the least expensive of the peer city systems because that system is using an existing high-quality double-track alignment. The FrontRunner system in Utah has a relatively high cost per mile because it was required to install a significant amount of new track.

Figure 4-1: Capital Cost per Mile (in 2017 Dollars)

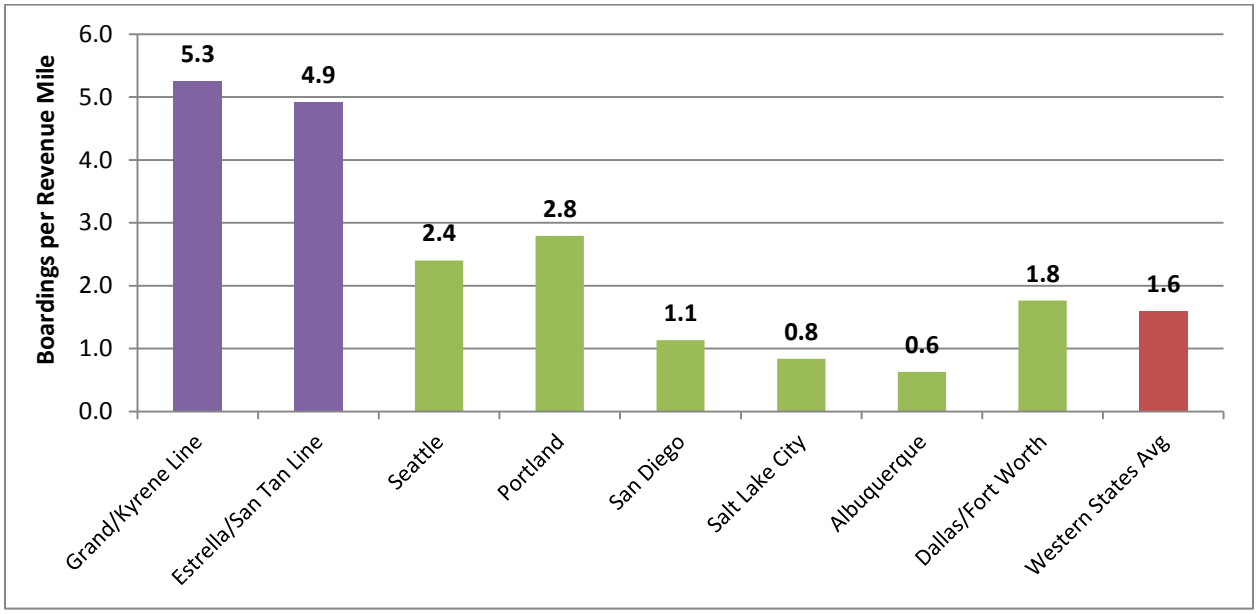


Source: AECOM, 2018.

4.2.2 Peer City Comparison: Boardings per Revenue Mile

With approximately 10,100 daily riders forecast for 2040, the Grand/Kyrene Line would have approximately 5.3 weekday boardings per revenue mile; while the Estrella/San Tan Line is expected see approximately 10,830 riders per day or approximately 4.9 weekday boardings per revenue mile. As shown in Figure 4-2, these figures are higher than other western cities based on statistics from 2016. However, it should be noted that these represent 2040 ridership projections. These numbers would likely be more similar to the other systems for the first few years of service. Additionally, as the other systems continue to grow, their numbers would likely increase as well.

Figure 4-2: Boardings per Revenue Mile Comparison

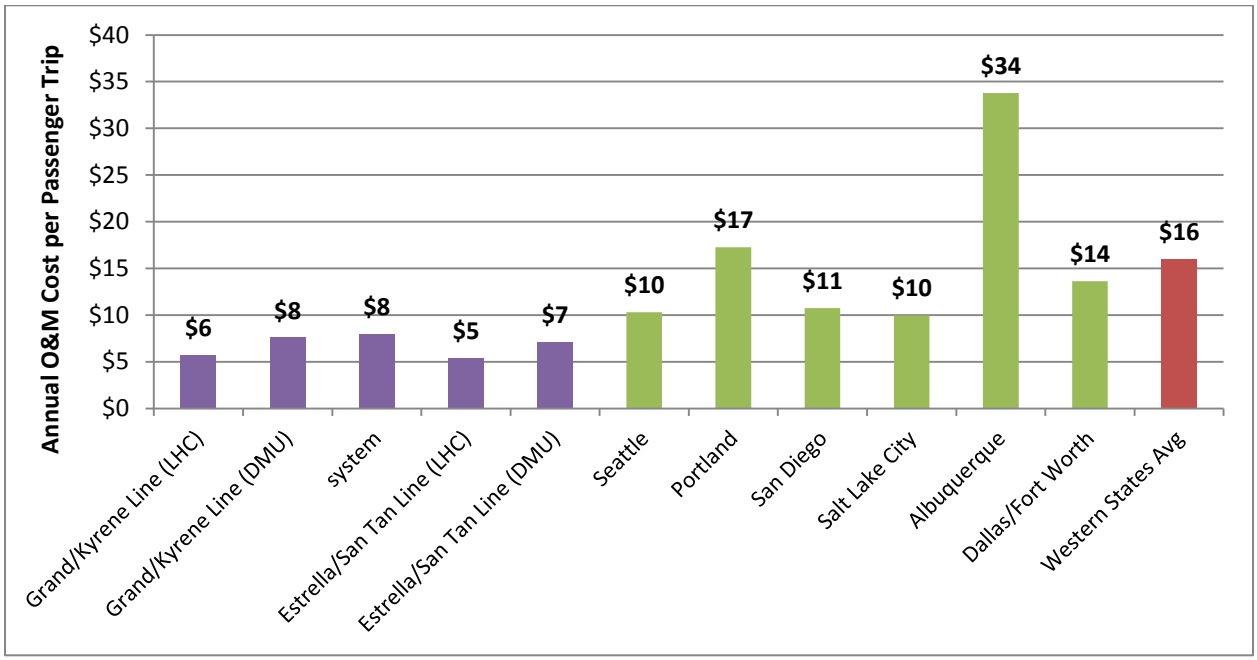


Source: AECOM, 2018; National Transit Database, Transit Profiles 2016.

4.2.3 Peer City Comparison: O&M Costs per Passenger Trip

According the National Transit Database, Transit Profiles 2016, the average annual O&M cost per passenger trip for commuter rail systems in the western states is approximately $16 per passenger trip. Strong ridership forecasted for the MAG commuter rail system would result in lower O&M cost per passenger trip for both technologies under consideration (Locomotive Hauled Coach [LHC] and Diesel Multiple Unit [DMU]) among its peer cities, as shown in Figure 4-3.

Figure 4-3: Annual O&M Cost per Passenger Trip



Source: AECOM, 2018; National Transit Database, Transit Profiles 2016.

4.2.4 Findings

The ridership estimates and costs associated with the two proposed cross-town commuter rail corridors in the MAG region are comparable to other systems and within the range of what most industry experts would consider reasonable. The operating costs are higher when using DMU vehicles compared to more traditional LHC vehicles. However, the DMU vehicles provide better acceleration and deceleration performance, and as more systems use this technology, prices are likely to become more comparable to the LHC vehicles. In 2010, there were no good DMU options for the MAG region to consider, but that has changed in recent years. As design of the MAG region commuter rail corridors progress, ridership forecasts and cost estimates will continue to be refined and updated.

Based on these findings, the Project Team recommends that MAG and their partnering agencies continue to advance the design of the System Study Update corridors.

4.3 Phasing Recommendations

Both Grand/Kyrene and Estrella/San Tan lines have exhibited strong ridership potential. Based on these results, both lines are proposed to operate as a full system. As part of the 2010 study, it was recommended that the system be implemented in phases as funding became available. However, as part of this update it is assumed that if the MAG region moves forward with any commuter rail program, the full system would be funded and implemented at the same time. This strategy does not take construction into consideration, as one line may be completed before the other, and the system could come on-line in stages.

4.4 Integration with other Transit Modes

The analysis of ridership forecasting affirmed that the commuter rail system would be more productive when connections with other transit modes are maximized. The strongest station areas typically are characterized by high levels of connectivity with bus and light rail systems as well as activity/employment centers. The approach to station planning in this study was generalized, in that large areas were identified as targets to site a commuter rail station. Further study will be required to plan for the functionality of these areas as regional transit centers that would serve key destinations and maximize intermodal connections that strengthen the overall productivity of the transit system.

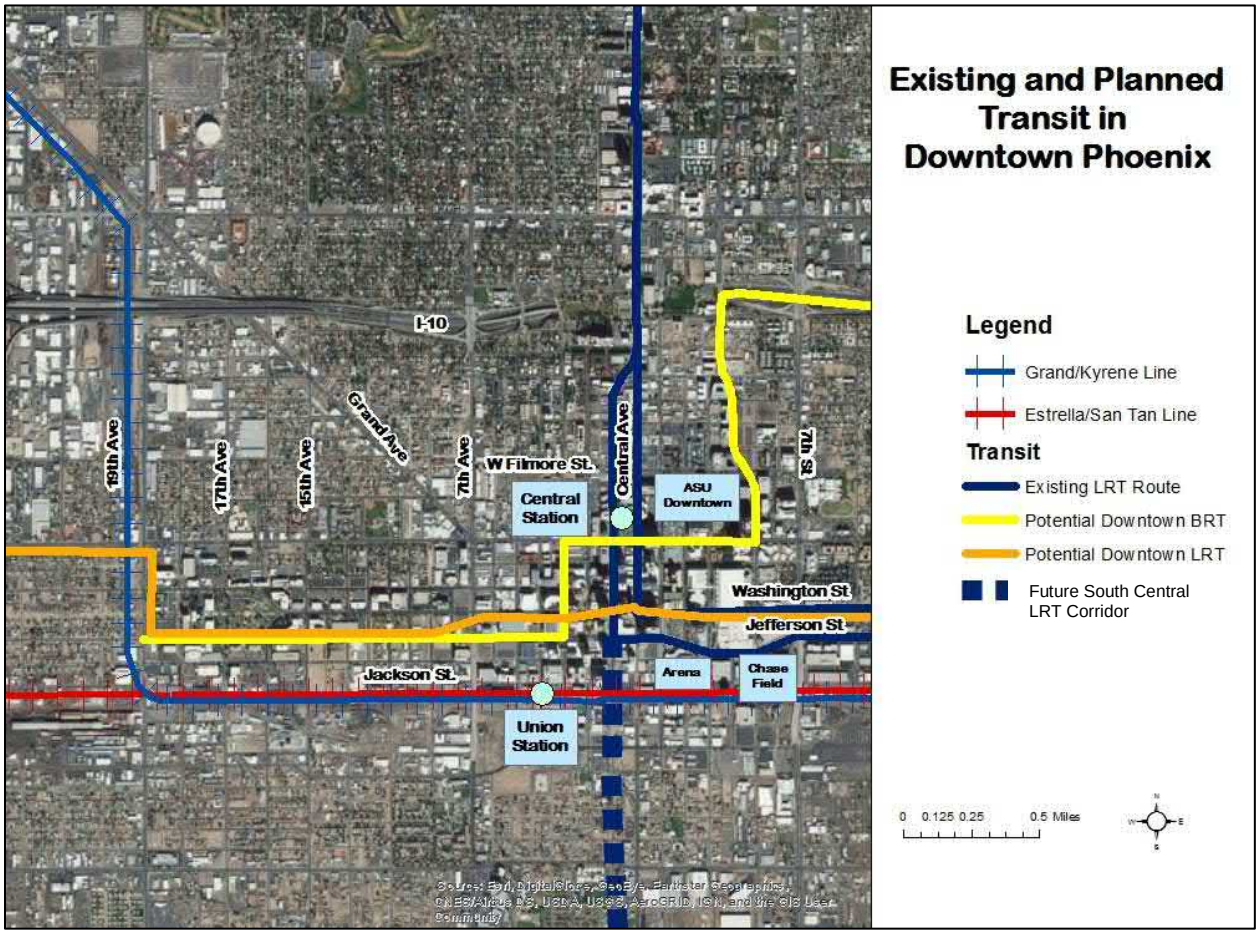
The remainder of this section describes major transit hubs within the region that could provide these intermodal centers and highlights potential opportunities and constraints that were identified in the 2010 System Study. Overall, future coordination among the transit operators and local jurisdictions could enhance opportunities for intermodal connections.

4.4.1 Transit Connections in Downtown Phoenix

The proposed commuter rail system would use the existing rail line through downtown Phoenix, which is located slightly south of the main employment hub, south of Harrison Street. While Union Station provides excellent support for train maintenance facilities, it is slightly removed from major employment centers and would benefit from a circulator of some type. A special events station location was included in the 2010 Study that was to be adjacent to Chase Field or Talking Stick Resort Arena. This potential station is not shown on the updated maps, but could be implemented if desired. Right of way would need to be required should a special event station be implemented.

Existing light rail and a planned high-capacity transit corridor are located along Jefferson Street, less than a quarter-mile away from the proposed commuter rail line. Bus routes running south of Jefferson Street operate on Central Avenue, and an extension of LRT is under construction that will connect the existing light rail network with south-central Phoenix. Central Station, a hub for all transit, is located about a quarter-mile to the north of Harrison Street on Van Buren Street and Central Avenue. The DASH, a downtown circulator bus, operates on weekdays and could be rerouted to more directly serve commuter rail riders. Figure 4-4 illustrates the many types of transit modes and activity centers existing or planned for the downtown area.

Figure 4-4: Existing and Planned Transit Modes in Downtown Phoenix



Source: MAG, AECOM; 2018.

Downtown Phoenix is unusual in that it includes two distinct employment hubs: the area in proximity to Central Avenue, and the state government complex approximately three quarters of a mile to the west between 17th and 19th Avenues. The Grand Line corridor provides an opportunity to interconnect with future high-capacity transit (the potential Phoenix West extension) at a key destination point at 19th Avenue and Jefferson Street. An objective of future evaluation may be to ensure that other commuter rail corridors can readily access the State Capitol area, and that studies for multiple modes are appropriately coordinated to ensure the most efficient connections.

Coordination with the railroads is likely to result in the identification of additional opportunities and constraints in this area. Right of way is constrained through downtown Phoenix, and

assembly of new right of way from multiple owners would be challenging. In addition, both railroads consider this segment to be part of major routes where commercial freight traffic must be maintained at certain levels. The complexity of freight operations at Harrison Yard may limit options for passenger service.

The high density of transit service and attractiveness of downtown Phoenix for employment and special events makes it a good candidate to continue to ensure efficient interconnections and coordinated planning for a future system. In addition, the City of Phoenix has been actively planning to enhance and expand the pedestrian-oriented character of this area and the integration of land use and transit planning is one strategy to meet this objective.

There is also a relationship between downtown parking policies, cost, and availability and transit use. Currently, parking costs are relatively low for a major metropolitan area and policies exist to promote the availability of parking. Some cities, such as Portland, Oregon, have taken steps to limit parking availability and raise rates to provide incentives to choose other modes.

4.4.2 Transit Connections outside Downtown Phoenix

The Phoenix metropolitan area is polycentric, with multiple high-density employment areas. Ridership forecasting suggests that destinations outside of the traditional city center of downtown Phoenix may be equal or greater attractions to riders in the region. These destinations include downtown Tempe, downtown Glendale, and the Sky Harbor Airport area, which serves not only airport travelers but an emerging employment area.

Downtown Tempe Transit Connections

The downtown Tempe station area shows slightly stronger ridership potential than downtown Phoenix, and appears to be a major destination particularly for East Valley residents. Downtown Tempe also offers a dense network of transit, a pedestrian-oriented area, and large special event venues as well as the main campus for Arizona State University. The physical distance between the existing Union Pacific Railroad rail line and existing light rail and primary bus routes is less than a half-mile. Downtown Tempe serves as a focal point for light rail, bus, and circulator service, providing opportunities to strengthen those connections. However, this area may present physical constraints to achieving these connections, with limited additional right-of-way or vacant land available. Further study will be required to implement a strategy that adds to the existing transit connections.

Downtown Glendale Transit Connections

The downtown Glendale station area is forecast to have the strongest ridership along the Grand Line Corridor outside of downtown Phoenix. This is likely due to the concentration of population and employment as well as extensive transit connections. Planning has occurred in Glendale to promote the pedestrian-oriented character of downtown, including enhancements along the Grand Avenue corridor. Additional evaluation of this station area could serve to maximize multimodal transit connections and support local planning efforts. As noted in Chapter 2, the Glendale City Council took action in late 2017 to terminate participation in the LRT extension to its downtown. This has not yet been updated in the RTP at this time but will so after completion of a Major Amendment.

Sky Harbor Airport Area Transit Connections

This area, between 36th and 44th streets in Phoenix, is an emerging focal point. Within this approximately half-mile-long area, the opportunity exists to connect commuter rail with light rail and bus transit as well as the planned Sky Train people mover system that will serve the airport.

This area is characterized by travelers going to Sky Harbor Airport, airport employees, Gateway Community College, and a growing employment center particularly along 44th Street. Additional evaluation to improve circulation within this area could address multimodal transit connections and bring together the multiple agencies planning for mobility in the area.

4.4.3 Connectivity with Inter-City Rail

The potential integration of a regional commuter rail system with intercity rail and a larger statewide rail system as envisioned in the Arizona Department of Transportation (ADOT) Statewide Rail Framework Study and more recently the ADOT APRCS will continue to be an important consideration as MAG moves forward with the planning and design of a regional commuter rail network.

The APRCS is the first phase in the proposed implementation of the State Rail Plan, linking Arizona's largest metro areas of Tucson and Phoenix. Such a line could connect intermediate locations within the region and be the starting point for later rail connections to other regions of the Southwest and beyond. The concept for rail service assumes train operation at speeds between 80 and 125 mph and a blend of intercity and commuter operations.

The highest potential level of service in the short term is commuter service from San Tan Valley to the Phoenix hub, connecting the major East Valley communities with the potential to carry major passenger loads along the Union Pacific Railroad freight line in a corridor as yet unserved by passenger rail. This phase could be divided into additional subsections to reduce capital and operating commitments in the short term or to provide additional time to develop solutions to constraints within the corridor. This is the most challenging of the phases from a construction perspective, due to the urban nature of the corridor. As commuter rail planning moves forward, operations planning with the potential inter-city rail line will become increasingly more important as both move toward implementation.

4.5 Siting of Layover and Maintenance Facilities

Commuter rail layover and maintenance facilities are required to support the commuter rail operations in the MAG region. Advance planning for these facilities is important, as the space needs and locational requirements may limit where they may be sited. For a complete description of layover and maintenance facility functions and requirements, see Appendix H: Commuter Rail Maintenance Facility Description and Evaluation. The following subsections provide an overview of each type of facility and potential locations within the planning area.

4.5.1 Layover Facility

Layover facilities (or tracks) serve the primary purpose of vehicle storage and minor vehicle cleaning and inspection. Even when a train storage and maintenance facility is provided on-line, layover facilities need to also be provided at the opposite end, or ends, of the corridor. Some trains are kept at the storage and maintenance facility and some are kept at the layover facility in order to allow trains to begin or end the service day from each end of the system. This allows equal service to be operated in both directions much sooner than if all of the trains had to start or end from one end of a corridor. The layover facility should be located near the terminal station, or stations, at the end of the line in order to minimize the travel distance between the station and the layover facility. Figure 4-5 depicts a typical layover facility site plan.

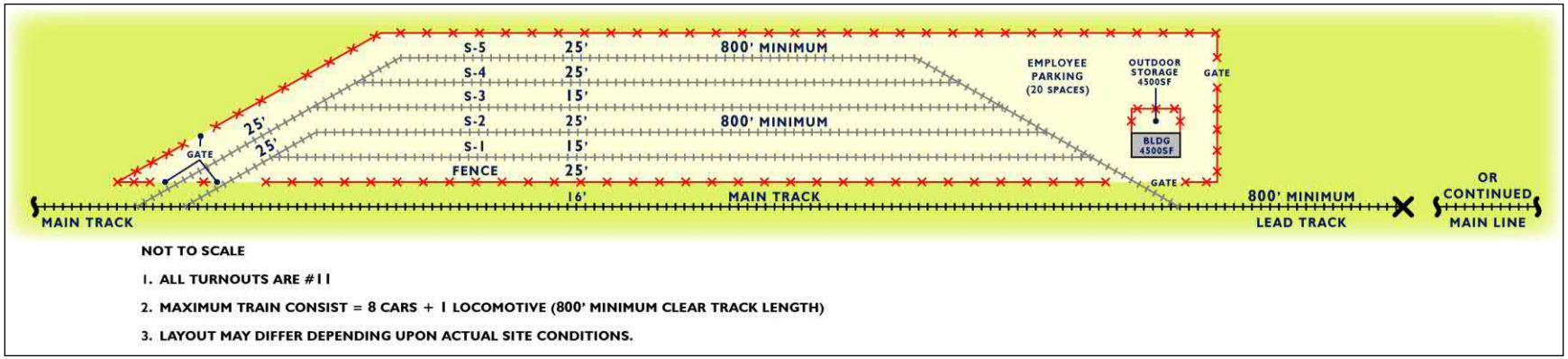
4.5.2 Maintenance Facility

Commuter rail maintenance facilities are the facilities used to repair, maintain, clean, fuel, and store commuter rail vehicles that serve a commuter rail line or system. In addition, control center

rail operations and maintenance-of-way (MOW) facilities are necessary and are often components of larger maintenance facilities. MOW includes facilities required to maintain the track, stations, signaling, bridges, at-grade crossings, and other fixed facilities along a given passenger rail corridor. The commuter rail maintenance facility would accommodate train operations and maintenance functions that involve daily, routine activities that are of short duration. A maintenance facility could either be provided on the corridor or be performed at a local BNSF Railway (BNSF) or Union Pacific Railroad facility, even if the heavy repair functions are contracted to an outside vendor. Locating the maintenance facility on-line precludes the need to constantly move vehicles to and from an off-line facility for basic, routine inspection, servicing, and maintenance. Figure 4-6 depicts a typical commuter rail maintenance facility site plan.

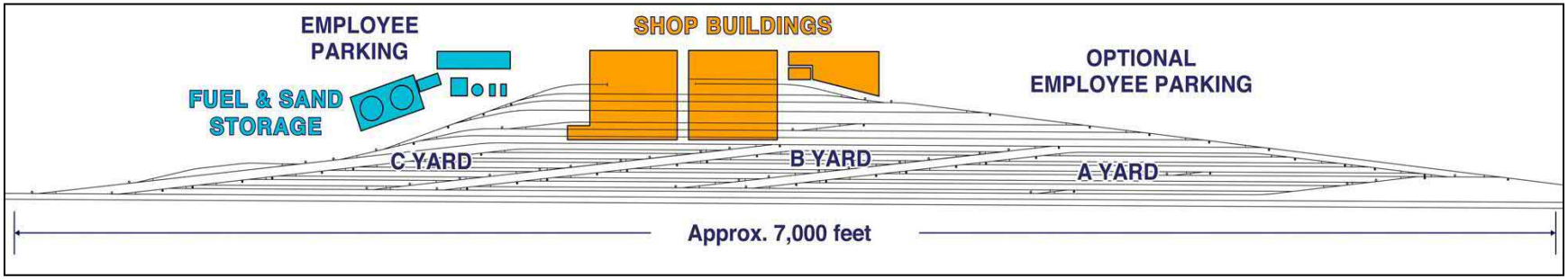
In addition to a maintenance facility that accommodates daily maintenance, a facility would also be needed to accommodate heavy maintenance that involves extensive, long-duration work on locomotives and cars. Heavy maintenance work would likely be contracted to the Union Pacific Railroad, BNSF, or to an outside vendor until such time as it becomes economical to do such work in the maintenance facility. Potential maintenance and/or layover facility locations are shown in Figure 4-7.

Figure 4-5: Typical Layover/Trail Track Facility



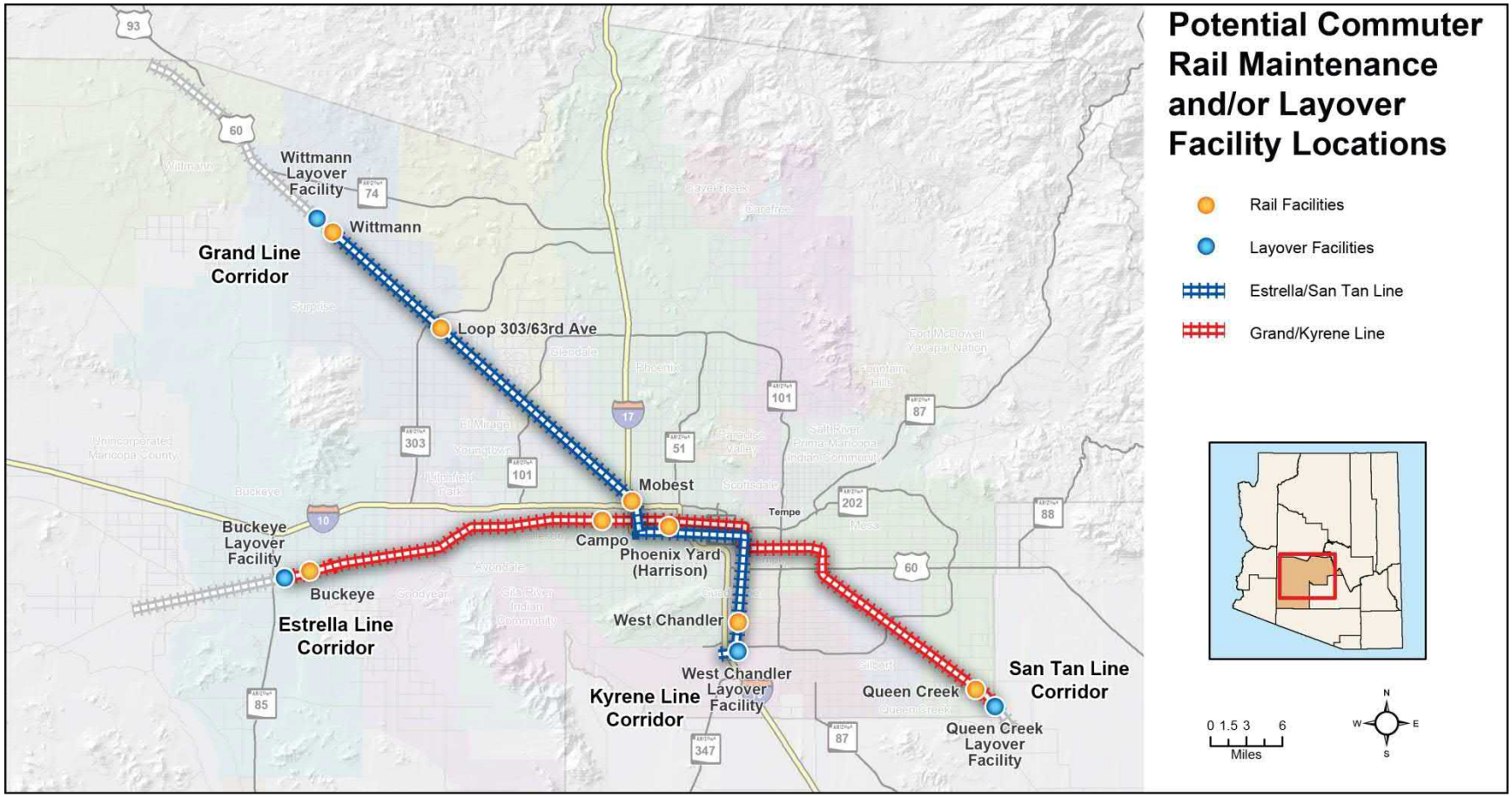
Source: AECOM, 2018.

Figure 4-6: Typical Commuter Rail Maintenance Facility Site Layout



Not to scale
Source: AECOM, 2018.

Figure 4-7: Potential Commuter Rail Maintenance and/or Layover Facility Locations



Source: AECOM, 2018.

4.6 Operations Models

As envisioned, commuter rail service in the MAG region would share right of way currently owned by the Union Pacific Railroad and BNSF, preferably utilizing the same track. To enable this, a rail access agreement of some type would be required. Railroad access agreements fall into two broad categories: Sale Agreements and Capacity Rights Agreements. A more detailed discussion of these types of agreements is provided in the MAG Commuter Rail Strategic Plan (2008) and in the 2010 Study. These agreements are assessed in this section for suitability for implementing commuter rail service in the cross-town corridors identified in this study. In addition, Section 4.7.3 identifies options for operating commuter rail service, which may be contracted with the railroads or another party.

4.6.1 Capacity Rights Agreement

Capacity Rights Agreements may be a real estate interest such as a lease or easement, or a contractual or license right. The purchaser is not acquiring the line, but rather is only acquiring the right to operate a specified number of trains. Unless conditions change, a Capacity Rights Agreement is expected to be the likely avenue for implementing commuter rail service along any of the MAG region corridors.

Two key elements of these agreements that need to be negotiated are (1) level of service and how passenger and freight service are timed to operate concurrently, and (2) capacity improvements. Appendix G: Operations Plan provides a schedule for conceptual operations that may provide a starting point for these negotiations. Actual schedules will be influenced by both the projected ridership and the level and type of freight service on the corridor. With regard to capacity improvements, parties will need to show funding commitments and agree on the timing and nature of the improvements necessary to accommodate the level of service.

Because the railroads would still own the line, most capacity improvements would be designed and constructed by the railroads, or by contractors working for the railroads. In most instances, existing railroad labor agreements require that railroad employees actually construct the improvements that tie into an existing railroad facility. Normally the agreement with the railroad contains cost estimates for all the capacity improvements, with the commuter rail agency responsible for any increases over the estimate.

Under a Capacity Rights Agreement, a railroad would continue to maintain and dispatch the rail line. The standard of maintenance required for the speed and ride quality necessary for good passenger rail service is higher than that required for freight service. Accordingly, the agreement would detail the standard of maintenance required and set the cost that would be required for maintenance. Another option would be to establish the method, or formula for allocating ongoing maintenance payments. Because the railroad use of the rail line may still be significant, these allocation formulas more evenly split maintenance costs than in sale agreements, where railroad use is less significant.

The agreement would also establish the process to be followed for identifying future capital projects. These future capital projects include capacity improvements requested by either party to the agreement, as well as capital maintenance projects such as major tie replacement and rail relay programs. The allocation formula or method of allocating these capital replacement costs is weighted to emphasize the more demanding operating requirements of passenger rail systems.

Under this scenario, dispatch of the line would remain with the railroad. Dispatch protocol (i.e., what train has priority) and compensation for dispatch services are negotiated between the agency and the railroad. All of these considerations for operations and maintenance may influence the preliminary cost estimates provided in Chapter 3.

4.6.2 Sale Agreements

Generally, a railroad would only enter into a Sale Agreement when the rail line involved is a light or moderate density (density refers to the number of trains operating on the corridor) branch line or a light density secondary main line that does not figure prominently in the railroad's current or future operations. Under a Sale Agreement the purchaser would assume greater upfront costs and liabilities, as sales costs may reach or exceed a million dollars per mile and the purchaser assumes responsibility for any environmental or other issues associated with the right-of-way. However, the owner would have greater control over timing and levels of service, dispatch, and the timing and nature of improvements.

A Sale Agreement generally will not transfer mineral or rail freight rights; the railroad will normally retain the right and obligation to serve rail freight customers on the corridor. The right and obligation to provide freight service is regulated by the Surface Transportation Board, formerly the Interstate Commerce Commission. This retained right is usually styled as a "common carrier easement," and gives the railroad a real estate, contractual, and regulatory right and obligation to continue providing rail freight service. This common carrier obligation could transfer to the new owner, but few, if any, public entities want to be burdened with the obligations and regulatory entanglements of freight rail responsibilities. The common carrier responsibilities may, however, be transferred at closing, or soon thereafter to a third party operator.

For any of the MAG region corridors to be considered as a branch that could be eligible for a Sale Agreement, the Union Pacific Railroad or BNSF would likely have determined that (1) there are no major customers along the line; or (2) service on the line is not expected to increase dramatically in significance in the future. Should any of these corridors be considered by the Union Pacific Railroad or BNSF to be candidates for a Sale Agreement in the future, the additional costs and liabilities may still make this an untenable option for a regional commuter rail agency.

However, if a statewide rail authority is identified as the appropriate governance structure for commuter rail in the region, there may be more justification for assuming greater responsibilities associated with owning the line(s). Ownership of rail lines by a statewide rail authority would require the appropriate resources needed to manage the wider array of responsibilities attendant to owning such a resource. New responsibilities would include acquiring experienced staffing, meeting federal regulations, purchasing and maintaining rolling stock and providing other necessary facilities. Potential governance options are discussed in more detail in Section 4.8.

4.6.3 Contracting Operations

One option for the operation of commuter rail service would be to contract with a private operator. Operations could be contracted to an independent contractor, such as Amtrak or a private contractor like Herzog, which operates several commuter rail systems throughout the U.S., including the New Mexico Railrunner, TRE in Dallas/Fort Worth, and the San Diego Coaster. An owner railroad – the BNSF or Union Pacific Railroad – could also operate passenger rail service under the terms of a Capacity Rights or other agreement. As of 2015,

BNSF operates passenger service for four commuter rail systems, including the Metra Chicago-Aurora Line in Illinois, the Sounder in Seattle, the Northstar in Minnesota, and Metrolink in Los Angeles.

Another option is to contract with a short line or other qualified operating entity to operate passenger service as a third party. A short line railroad is an independent company that operates shorter rail lines, typically under 100 miles. Short line and contract operators generally have lower labor, overhead, and regulatory costs than larger Class I railroads and can operate shorter lines profitably. A short line railroad or contract operating company may be contracted to operate passenger service under either a Sale or Capacity Rights Agreement.

4.6.4 Summary of Potential Agreements to Operate Commuter Rail

Further coordination with the Union Pacific Railroad and BNSF is critical to determining the appropriate approach to contractual relationships to operate commuter rail. The railroads' projections of future freight activity along the corridors would need to be integrated into the overall agreement. Table 4-2 provides a summary of the pros and cons of each type of railroad agreement for operating commuter rail.

Table 4-2: Summary of Considerations for Passenger Rail Agency when Entering into Agreements to Operate Commuter Rail

Agreement	Potential Advantages	Potential Disadvantages
Capacity Rights Agreement	• Usually lower initial costs (compared to Sale Agreement). • Ability to contract with railroads to operate passenger service.	• Passenger rail agency has less control over the line, which makes changing service or schedules more difficult. • Railroads would continue to maintain and dispatch the lines, which limits control over train priority by passenger rail agency. • Requires identifying additional agreements to dispatch the line for commuter rail. • Difficult and complex to negotiate compensation for capacity rights, infrastructure, and maintenance. • Railroads have the ability to shut down negotiations.
Sale Agreement	• More flexibility to operate service and schedule infrastructure improvements (although freight service likely would still continue). • Greater capacity to exercise control along the corridor with dispatch and maintenance. • Freight common carrier service likely would remain with the railroad.	• Greater upfront costs to purchase. • Purchaser assumes environmental and other liabilities associated with the right of way. • Limited segments of the rail line would be considered eligible for sale by the railroad; most likely sales would not be considered where there is high freight traffic, or where existing customers or future development options might be compromised. • Need to identify additional agreements to dispatch the line and operate service, although these could be addressed in the Sale Agreement.
Contract to Operate Passenger Rail to Third Party	• Operations would be run by qualified, experienced rail operator. • Short lines or qualified contract operators typically have reduced overhead and can operate shorter lines profitably. • Railroads may prefer third party operator agreements.	• Need to identify additional agreements to dispatch the line. • May require coordination between short line or other parties if different entities are operating passenger and freight on the line.

Source: AECOM, 2018.

4.7 Governance Options

One of the most significant issues to be resolved for the implementation of commuter rail in the MAG region is the question of who would be the responsible party for managing, designing, constructing, and operating the system. A commuter rail system typically travels farther and traverses more jurisdictional boundaries than most other modes of transit service. Commuter Rail systems also fall under the primary jurisdiction of the Federal Railway Administration (FRA).

In the MAG region, this means that the commuter rail service area will expand beyond the political boundaries of existing local transit service areas. Implementation of a commuter rail system will likely require a governance structure that reflects the financial, political, and representational patterns of the areas served by commuter rail.

The following subsections describe potential governance models for consideration. It is important to note that additional legal analysis is necessary to determine the application of governance options in the State of Arizona.

4.7.1 Regional Transit Authority/District (Multi-Modal)

Regional transit authorities or districts are usually characterized by appointed boards, with representation closely aligned with area political subdivisions, and the authority to impose voter-approved taxes to balance financial resources with service demands. In many of the mature transit systems throughout the country, a regional transit authority will manage and operate several types of transit services, such as light rail, commuter rail, bus, streetcar, etc. Valley Metro is the existing Regional Public Transportation Authority (RPTA) for the Phoenix metropolitan area; however, it currently does not have the authority and jurisdiction to manage commuter rail.

4.7.2 Regional Rail Authority/District (Single-Purpose)

A new regional transit authority or district could conceptually be a single provider of commuter rail service with its own board and all or some of the following functions: planning, design, construction, operations and maintenance. A new regional authority can be formed in one of two ways: (1) by a legislative statute at the state level that defines and grants authority to a district; or (2) by a direct popular vote of the electorate in which voters opt-in to form a regional transit district. Like a regional transit authority responsible for multi-modal services, a single-purpose regional rail authority is also usually characterized by an appointed board with representation closely aligned with area political subdivisions, and ideally has the authority to impose voter-approved taxes for balancing financial resources with service demands.

4.7.3 Joint Powers Authority

A Joint Powers Authority (JPA) is a common governance model for commuter rail transit operations. A JPA is an institution permitted under the laws of some states whereby two or more public authorities can operate collectively. A JPA is distinct from the member authorities and has separate operating boards of directors that can be given any of the powers inherent in all of the participating agencies. Unlike a new transit district, which would have its own source of funding as a taxing entity, a JPA relies on funding through its constituent members. A JPA can have legal standing at the state level or can be a partnership entered into between its constituent members via intergovernmental agreements at the local or regional level.

The rationale for forming JPAs to govern commuter rail systems varies. In some cases, a JPA is formed during the planning and design phases of commuter rail, while in other cases a JPA is

formed to take over governance from another agency, such as a state department of transportation.

4.7.4 Division of State Department of Transportation

The provision of regional transportation services by state agencies is more common in small states with one dominant metropolitan area. Both Boston, Massachusetts and Baltimore, Maryland are examples of commuter rail systems that are planned and operated by a state department of transportation.

4.7.5 Division of Metropolitan Planning Organization

While Metropolitan Planning Organizations (MPOs) generally play a significant role in the planning for regional commuter rail service, they are usually not the entity responsible for the governance and administration of commuter rail service. One exception to this was New Mexico's Rail Runner Express where the Mid-Region Council of Governments was the agency responsible for implementation and initial operation of this service. Initial funding was from state-issued bonds through the New Mexico Department of Transportation. Now in operation, the Rio Metro Regional Transit District serves as the administrative entity responsible for the oversight, maintenance, and day to day operations of the New Mexico Rail Runner Express on behalf of the New Mexico Department of Transportation. Within the MAG region, MAG, with responsibilities for long-range multimodal transportation planning, has initiated the preliminary planning of commuter rail service.

4.7.6 Examples of Governance Models in Other Regions

Generally, the institutional arrangements for regional or commuter rail service throughout the country range from state-run regional rail operations, to large single-purpose regional rail authorities that extend service into multiple political jurisdictions, to regional transit authorities that are responsible for multimodal services, to sub-regional agreements between cities to contribute to the management of a rail service in a common corridor.

There are several new commuter rail systems currently in operation or being considered across the country. From these networks, there is a wealth of information and experience on which to draw for the analysis of possible governance structures.

The more mature systems (often called "legacy systems") are significantly larger in size than the newer ones, primarily because they have built ridership as the region has grown around them. Each has been a catalyst for successful service in corridors or in the region. Ridership has followed, growing steadily as the train became a preferred commuter option for local residents. In many of these locations, commuter rail was added after the regional urban form and transportation network had already been established. This has required close coordination among regional and local jurisdictions, the railroads, private businesses, and residents in order to be successful. Regional agencies such as the MPO or the transit agency have often taken the lead in initiating this coordination.

Table 4-3 illustrates the array of institutional arrangements that characterize typical commuter rail governance structures throughout the U.S.

Table 4-3: Existing Governance Models

Governance Structure	Governing Authority/District	Commuter Rail Service Description
Regional Transit Authority/District (Multi-Modal)	Sound Transit District, Washington	Sounder between Seattle and Everett and Seattle and Tacoma
	Tri-County Metropolitan District, Oregon	Westside Express Service (WES) between Wilsonville, Tualatin, Tigard and Beaverton
Regional Rail Authority/District (Single-Purpose)	Sonoma-Marin Area Rail Transit, California	Planned commuter rail between Cloverdale in Sonoma County and the San Francisco-bound ferry terminal in Larkspur, Marin County (initial phase to open in 2017 with future stations planned to open in 2018)
Joint Powers Authority	Peninsula Corridor Joint Powers Board, California	Caltrain between San Francisco, San Jose, and Gilroy
	South Florida Regional Transportation Authority, Florida	Tri-Rail between Miami, Fort Lauderdale and West Palm Beach
	Virginia Railway Express, Virginia	Virginia Railway Express (VRE) two lines connecting Washington, DC to Manassas and Fredericksburg
Division of State Department of Transportation	Maryland Transit Administration	Maryland Area Regional Commuter (MARC) between Maryland and Union Station in Washington, DC, operating three commuter rail lines
Division of Metropolitan Planning Organization	New Mexico Mid-Region Council of Governments, New Mexico (initially)	Rail Runner Express between Albuquerque, Santa Fe, and Belen

Source: AECOM, 2018.

4.7.7 Key Considerations for Governance Models

Based on a review of existing commuter rail system governance structures listed above, it is clear that there is no single appropriate structure for governing a commuter rail system.

However, based on the decisions regarding governance made in the most recent commuter rail projects, two key factors are likely to determine the success of a governance structure. These factors include the ability of the institutional arrangement to (1) balance local control with the need for regional system performance, and (2) provide stable funding opportunities. With these factors in mind, a set of typical responsibilities for the entity that manages the system may include:

- Provide a seamless transportation service;
- Raise funds from a variety of sources including fares, local/state/federal transit or rail programs, private developers, etc.;
- Coordinate with other transit providers regarding schedules, public information and integrated fare systems;
- Participate in priority-setting in RTP process;
- Facilitate growth of the network and provide transit options in off-peak periods;
- Develop long-range plans for system development;
- Coordinate with the private freight railways;

- Coordinate with the FRA;
- Manage operations and maintenance (often through contracts with private operators); and
- Build ridership by encouraging development at stations.

These responsibilities require the close working relationship among existing transit operators and the cities served by the network.

4.7.8 Potential Governance Structures in the MAG Region

The existing structure of transit service providers in the Phoenix metropolitan region is a complex mix of historical operations such as the City of Phoenix transit system, as well as the RPTA known as Valley Metro, and Valley Metro Rail Inc. (operating the region's LRT system). In 1993, the RPTA Board adopted the name Valley Metro as the identity for the regional transit system in the Phoenix metropolitan area. Under the Valley Metro brand, local governments joined to fund the Valley-wide transit system that operates today. Valley Metro RPTA Board member agencies include Avondale, Buckeye, Chandler, El Mirage, Fountain Hills, Gilbert, Glendale, Goodyear, Maricopa County, Mesa, Peoria, Phoenix, Scottsdale, Surprise, Tempe, Tolleson, Wickenburg, and Youngtown. In 2002, Valley Metro Rail Inc., a nonprofit, public corporation was formed and is charged with the design, construction, and operation of the region's 66-mile high-capacity transit system. Valley Metro Rail Board member cities include Phoenix, Tempe, Mesa, Glendale, and Chandler.

Defining appropriate governance structures for a commuter rail system would depend upon opportunities that arise for cooperation and use of railroad right of way. This could be for one commuter rail project or a series of projects. It would require all of the major transportation providers and funding partners (including the City of Phoenix, Valley Metro, MAG, and ADOT, at a minimum) to participate at some level to determine the most appropriate governance structure for the design, construction, and operation of a mode of transport new to the region. ADOT has initiated some governance planning options between the MAG and PAG regions through its 2017 ADOT Passenger Rail Study – Tucson to Phoenix.

The options described above could all be appropriate institutional structures for regional commuter rail, based on both the national experience and the local situation in the Phoenix metropolitan area. Each option and how it could be applied is summarized below.

Regional Transit Authority/District (Multi-Modal): Under its current organization, Valley Metro RPTA does not have the authority and/or jurisdiction to operate commuter rail within the region. Therefore, should the MAG region consider this model for the implementation of commuter rail, it would likely entail a revision to the current agency which was authorized in 1985 by the State Legislature.

Regional Rail Authority/District (Single-Purpose): The application of a newly formed regional rail authority with the sole purpose of implementing commuter rail in the MAG region would involve membership by Maricopa County and potentially other counties if service is expanded in the future, or if intercity rail would be included as part of the commuter rail program. The more expansive a commuter rail network, the more a regional rail authority/district makes sense because funding a larger system could be spread over a greater number of residents. If only one or two lines develop, the efficiency gained through one authority/agency is not as great. Because commuter rail is the only transit mode regulated by FRA, a clear benefit of one single-purpose entity would be the ability of this entity to the focus on one, FRA-regulated service.

Joint Powers Authority: In the MAG region, a JPA would be formed by aggregating authorities from two or more cities, towns, Indian tribes, counties, councils of governments, metropolitan planning organizations, metropolitan public transit authorities or regional public transportation authorities, entering into an agreement to establish a joint powers commuter rail authority. For example, an agency could enter into an agreement with the cities to be served by commuter rail to form a JPA responsible for the design, construction, and operation of commuter rail service. The mission of an agency could be expanded, building upon the existing staff resources that are currently focused on light rail services, for example. In this case, each of the partner agencies would be responsible for providing project funding, rather than funding coming from a single taxing authority, as is the case with a regional district. Depending on the structure of the JPA, individual jurisdictions may tax their constituents or rely on annual appropriations.

Another option may be for those jurisdictions that would be served by commuter rail, but are not currently within the boundaries of an agency or participants on an agency's board to form one or more regional transit districts that could enter into a JPA with the agency for the purposes of implementing commuter rail. This governance model is the most flexible, as it can be formed to fit whatever combined structure makes the most sense locally. However, a JPA would not generate any new taxing authority, and would likely need a strong leader to identify and further a common vision among the member entities. The board of directors of the JPA would be comprised of persons appointed by the governing bodies of the authorities that are members of the commuter rail authority. Without a defined funding source, a JPA would have to depend on annual funding commitments from member agencies, which could fluctuate year to year.

Division of the Arizona Department of Transportation: While this model is primarily found in smaller states with a single metropolitan area, it may have an application in the MAG region, particularly in conjunction with a state-sponsored intercity rail connection between Tucson and Phoenix and a statewide passenger rail system. ADOT developed a Statewide Rail Framework Study in which it considered the establishment of a state rail organization that would be empowered to negotiate with railroads for a unified statewide passenger rail system. Further, determining the responsible agency for regional or statewide rail operation, governance, and oversight is a key implementation element that would need to be addressed and identified. It should be noted that there are often equity decisions associated with statewide funding or governance discussions. These often focus on urban versus rural issues, but can be geographic as well. In the case of Arizona with two large metropolitan areas, equity between urban regions could also come into play.

Division of a Metropolitan Planning Organization: This governance model would require expanding the charter of MAG to include the operation of commuter rail, which is currently not described in the charter. This expansion would require a clarification in state law and the creation of an operational division of MAG. Another consideration is that the commuter rail service area would all operate within the MAG region, but intercity rail would extend beyond MAG region.

Table 4-4 summarizes the potential advantages and disadvantages of theses governance structures.

Table 4-4: Potential Governance Structures

Governance Structure Option	Potential Advantages	Potential Disadvantages
Regional Transit Authority/ District (Multi-Modal)	• One transit service provider would create greater efficiencies and coordination between all transit modes to help ensure integrated regional system.	• May lack focus as Valley Metro has focused on bus and paratransit services to date. A new mode could lead to the agency becoming less focused on its existing services. • May be a cumbersome political process to expand taxing authority to outlying areas (e.g., could create an issue of taxing equity), particularly if services are expanded to Pinal County. • Would present a learning curve for Valley Metro to manage a rail program, especially a FRA rail program.
Regional Rail Authority/ District (Single-Purpose)	• Single focus on commuter rail and FRA, rather than competition for resources being distributed among transit modes. • With creation of new taxing district, all funding partners would be equally represented from the outset. • Could be added to Valley Metro organizational responsibilities.	• Would require close coordination with Valley Metro to ensure integrated regional transit system. • Adds another entity to the mix. • If formed by popular vote, would be unable to serve jurisdictions which do not vote to join, leaving gaps in representation/service. • Cost and start-up time to form new authority may be greater.
Joint Powers Authority	• Would provide maximum flexibility in the formation and responsibilities of a governing body. • Does not require legislative authority. • If Valley Metro mission is expanded, JPA will benefit from similar rail expertise with LRT.	• May result in potential overlapping responsibilities among or within representative entities. • Each participating entity would be required to secure its own funding source through annual appropriations or voter-approved taxes, which may result in less-stable funding. • May start “turf war” between entities if a new JPA is formed. • Would present a learning curve as LRT and commuter rail have different regulatory environments, operating characteristics and institutional arrangements and serve different travel markets. • Would require “unwinding provisions” if one or more forming entities desire to withdraw.
Division of State Department of Transportation	• A state agency could apply for funding from federal programs that a local entity may not be able to obtain. • Could empower single railroad negotiator and greater coordination for unified statewide passenger rail service.	• ADOT has not traditionally been an operator of systems, and there could be an institutional learning curve. • May rely primarily on state legislative appropriations. • May bring into question equity between regions of the state. • Increases state influence over local/regional decisions. • Typically state departments of transportations are focused on highway projects and issues.

Table 4-4: Potential Governance Structures

Governance Structure Option	Potential Advantages	Potential Disadvantages
Division of Metropolitan Planning Organization	• MAG could continue its role as lead implementation agency and pass-through funding entity.	• Could require continued/greater collaboration and coordination among existing transit authorities. • Northern Pinal County (City of Maricopa, Florence, Queen Creek, and Apache Junction) are now part of MAG. However, unless limited to commuter rail operations (which are proposed to serve norther Pinal County), some Pinal County jurisdictions would be involved in other modal planning for the region. This may add confusion within the MAG and CAG transportation planning processes. • Would require expansion of MAG charter. • MPOs typically don't have an operations mindset. Would require establishment of new operational division within MAG.

Source: AECOM, 2018.

4.8 Funding Options

The initial step to develop a funding implementation strategy is to gauge possible or probable funding options from governments at the federal, state, regional, and local levels. The policy positions of the involved agencies and possible implementation responsibilities should be thoroughly considered, as should those of other local entities included in the project area. Frequently the focus is on funding sources for the capital investment needs to implement service. The expansion of the MAG charger would require a clarification in state law and would add to the responsibilities of the agency including the creation of an operational division of MAG. It should not be forgotten that, ultimately, the more critical financial issue at the local level is the annual requirement for local funds to meet ongoing operating and maintenance costs, which potentially could be addressed during future sales tax initiatives.

4.8.1 Federal Funds

While federal funds for commuter rail projects are fairly limited, there are several potential sources of funding for both capital and operating costs. The future spending levels for these federal programs are primarily subject to federal transportation legislation, known as the Fixing America's Surface Transportation (FAST) Act. The FAST Act authorizes federal funding for highway, highway and motor vehicle safety, public transportation, motor carrier safety, hazardous materials safety, rail, research, technology, and statistics programs for a period of five years, through the year 2020. Funding authorized by the FAST Act includes both formula and grant monies to be used at the discretion of states and MPOs. It should be noted that federal funding projections described below come from the MAG 2040 RTP (September 2017) and are dependent on a variety of factors including congressional authorization and the competitive nature of some funding sources. These anticipated funding levels are based on the current authorization and previous funding levels. Transit funding can be extremely partisan in nature, so future funding levels can fluctuate with changes in administrations.

According to the MAG 2040 RTP (pg. 8-8), a total of $7.0 billion is anticipated from federal funding programs for the construction of transportation projects in the MAG region between FY 2018 and FY 2040. These forecasted funds have been committed to specific projects and do not include commuter rail projects. Since the passage of the Intermodal Surface Transportation Efficiency Act of 1991, the U.S. Department of Transportation (USDOT) has permitted wide state discretion in assigning portions of "conventional" highway funds to the flexible funding pool, thus widening the funds potentially available for transit projects. The use of these funds for purposes of commuter rail could decrease funding for future LRT and bus projects, as well as street and highway projects. However, as mentioned above, higher federal allocations than anticipated in the RTP may provide opportunities to utilize federal funds for commuter rail. The MAG region should continue its planning efforts with the intent of moving quickly to take advantage of any new funding opportunities that might be available through New Starts or other federal transit funding programs.

FTA Section 5307/5340 Funds

The FTA 5307 Urbanized Area Formula Funding program makes federal resources available to urbanized areas for transit capital, planning, job access, and reverse commute projects, as well as operating expenses in certain circumstances in urbanized areas. Funding is apportioned on the basis of legislative formulas. For areas with populations of 200,000 and more, like the MAG region, the formula would be based on a combination of fixed guideway revenue vehicle miles and fixed guideway route miles, as well as population and population density within a specific urbanized area. This caveat is especially important for potential commuter rail lines that would extend between two urbanized areas such as the Estrella Line that connects the Phoenix-Mesa and Avondale-Goodyear urbanized areas.

As described in the MAG 2040 RTP (pg. 8-8), this funding source is expected to generate $1.4 billion for transit development in the MAG Region from FY 2018 through FY 2040. However, it should be noted that this source of funding has become more at-risk under the current administration.

FTA Section 5309 New Starts Funds

The FTA 5309 New Starts Program is the federal government’s primary financial resource for supporting locally planned, implemented, and operated major transit capital investments. Transit 5309 funds are available for the capital costs associated with New Starts commuter rail projects through discretionary grants from the FTA. New Starts funds are limited and the program is extremely competitive, with the national demand for funding far exceeding the supply of funds available. While this federal program can fund up to 80 percent of the capital cost of a project, the average New Starts project receives about 50 percent of its funding from the New Starts program.

These funds are granted at the discretion of the FTA and projects applying for New Starts funds must follow a very stringent planning and project development process. New Starts project evaluations and ratings are based on a number of criteria including the local financial commitment, project mobility improvements, environmental benefits, cost effectiveness, and transit supportive land use patterns. Federal funding for transit can be extremely partisan in nature, so future funding levels can change with changes in administrations.

As described in the MAG 2040 RTP (pg. 8-8), over the planning horizon, it is estimated that $2.0 billion in 5309 funds for bus and rail transit projects will be made available to the MAG Region from the FTA, during FY 2018 through FY 2040.

Congestion Mitigation and Air Quality Funds

Congestion Mitigation and Air Quality (CMAQ) funds are available through the FHWA and FTA for projects that improve air quality in areas that do not meet clean air standards, otherwise known as nonattainment areas. Within the Phoenix Metropolitan area, MAG is designated as the lead air quality planning organization per A.R.S § 49-406. Projects may include a wide variety of highway, transit and alternate mode projects that assist nonattainment areas in complying with the National Ambient Air Quality Standards. As more areas of the state go into nonattainment, or they grow, MAG stands to lose some a portion of CMAQ funding. This has slowly started to occur with the addition of the Sun Corridor Metropolitan Planning Organization (SCMPO) and the Sierra Vista Metropolitan Planning Organization (SVMPO) to the state which qualifies for CMAQ funding for the first time. Transit projects account for just over one-third of the CMAQ funding in the MAG region, but as congestion levels and air quality issues worsen in other areas, there will be a smaller share dedicated to the MAG region. The CMAQ Funds may be used for a variety of transit needs including new or expanded transit service, new vehicles (including replacements), and could be used for commuter rail.

As described in the MAG 2040 RTP (pg. 8-7), MAG CMAQ funds are projected to generate $1.4 billion from FY 2018 through FY 2040.

Surface Transportation Block Grant Program Funds

The Surface Transportation Block Grant Program (STBGP) in the FAST Act, formerly Surface Transportation Program under MAP-21) provides flexible funding that may be used by states and localities for a broad range of surface transportation capital needs, including highway, transit or street projects. STBG funds are the most flexible federal transportation funds. The STBG promotes flexibility in State and local transportation decisions and provides flexible funding to best address State and local transportation needs. As under MAP-21, the FAST Act directs FHWA to apportion funding as a lump sum for each State then divide that total among apportioned programs. The MAG 2040 RTP currently allocates the region's share of these funds to arterial street projects.

As described in the MAG 2040 RTP, during the period from FY 2018 through FY 2040, it is estimated that $1.4 billion will be available from STBG funds.

Federal Railroad Administration Section 130 Funds

Federal Railroad Administration funding may be available to improve at-grade railroad crossings to support safe automobile and commuter/freight rail travel within the corridor. The FRA 130 Program's intent is to eliminate hazards at public highway-railroad grade crossings. In FY 2016, $350 million was allocated nationwide under FAST Act authorization (although this number varies between $230 and $245 million between FY 2017 and FY 2020).

The FRA has designated ADOT to award funding for the Section 130 program. Grade crossing safety improvement projects are evaluated by ADOT on behalf of FRA. Grade separations, safety equipment or other grade-crossing components may be eligible costs within an infrastructure improvement adjacent or intersecting the state highway system.

Federal Railroad Administration High-Speed Intercity Passenger Rail Funds

The High-Speed Intercity Passenger Rail (HSIPR) program was designed to invest federal funding via competitive grants in an efficient High-Speed/Intercity Passenger Rail network. In 2008 Congress appropriated $10.6 billion for High-Speed Intercity Passenger Rail and then in

2009, Congress rescinded $400 million of the $10.6 billion previously appropriated and rejected the Administration's requests for additional funding. Succeeding Congresses have also not responded to requests for HSIPR funding. Congress's creation, then abandonment, of the HSIPR program illustrates the challenges of funding major construction projects that take years to complete without a stable source of financing. At the beginning, the federal and state governments lacked the expertise and program framework to implement the program. Now that the expertise and program framework have been developed, they are at risk of disappearing due to the lack of continued funding.

The MAG region should continue to coordinate with ADOT's statewide rail planning efforts to pursue longer term opportunities for commuter and intercity rail programs if they present themselves in the future. However, the region should not hold high hopes for attracting federal funding for high-speed intercity rail, and should focus on funding commuter rail with more stable federal funding sources.

Federal Railroad Administration Positive Train Control Funding

The Positive Train Control (PTC) Grant Program will fund the installation of PTC systems required under 49 U.S.C. 20157 that include, but are not limited to, back office systems; wayside, communications, and onboard hardware equipment; and, spectrum acquisition. Under this grant program, the intended outcomes and benefits of the funded projects are accelerated implementation, increased interoperability, and improved reliability of PTC systems. This program is being jointly administered by FRA and FTA. In FY 2017 up to $199 million from the Mass Transit Account of the Highway Trust Fund was authorized by section 3028 of the FAST Act to assist in financing the installation of PTC systems.

These funds could be used to address some crossing improvements of at-grade commuter or freight rail crossings, but would not fund the implementation of commuter rail.

4.8.2 State Funds

State funding sources for commuter rail could come from a variety of potential sources as described below.

Arizona Highway Users Revenue Fund

ADOT is funded through two primary sources including the Highway Users Revenue Fund (HURF) and federal transportation funds. The HURF is an allocation and programming accounting framework funded with motor fuel excise taxes, truck fees, vehicle registration fees and taxes, and other miscellaneous charges and fees. These funds represent the primary source of revenues available to the ADOT for highway construction and improvements and other expenses. HURF funds are allocated through a number of statewide, regional, and local programs.

From the ADOT HURF allocation, state statutes provide that 12.6 percent of the HURF funds flowing to ADOT are earmarked for the MAG Region and the region comprising the Pima Association of Governments (PAG), which includes metropolitan Tucson. In addition, the State Transportation Board has established a policy that another 2.6 percent of ADOT HURF funds would be allocated to the two regions. These funds are divided into 75 percent for the MAG Region and 25 percent for the PAG Region. These funds are referred to as "15 percent funds." In addition, a 37 percent share of ADOT Discretionary Funds is targeted to the MAG Region.

According to the Arizona Constitution, HURF funds can only be used on highways and streets. Therefore, in order to use HURF funds for commuter rail projects, the Arizona Constitution would need to be changed to allow use of these funds for transit projects. Additionally, as fuel economy increases with electric vehicles and through other advances, HURF revenues will continue to become smaller. In other states, vehicle license taxes are used, but those are included as part of the HURF in Arizona.

Statewide Transportation Acceleration Needs Account

In 2006, the Arizona State Legislature established the Statewide Transportation Acceleration Needs (STAN) account as a separate account within the State Highway Fund to provide a new vehicle for directed and accelerated funding of key transportation improvements. The State Transportation Board uses funds in the STAN Account of the State Highway Fund to pay for certain costs for the construction or reconstruction of freeways, state highways, bridges, and interchanges that are in a RTP or the long-range statewide transportation plan. The STAN account was a potential source of transit funding in the recent past, however it is not considered to be a reliable funding source in the future as funding is currently focused on roadway projects.

The STAN account would not be considered as a source of revenue for future commuter rail except in conjunction with highway improvements that may be directly related to the project(s).

Potential New State Funding Sources

New state funding streams could include general fund appropriations for commuter rail as well as funding and/or acquisition of railroad right of way as part of a comprehensive statewide rail program. ADOT also is expected to continue to play an important part in the implementation of commuter rail and intercity passenger rail, both because of its expertise and interest in innovative transit strategies and because of the possibility of state funding for both capital and operations and maintenance.

The State of Arizona may appropriate funds for commuter rail service from its general fund. These funds may be made up of revenues from a number of sources including state sales taxes, property taxes and income taxes. In addition, the state could dedicate new funds to a comprehensive statewide rail system that unifies commuter rail and intercity rail. One component of the ADOT Passenger Rail Study – Tucson to Phoenix is the construction of intercity rail in the Sun Corridor Megapolitan that would connect to the MAG commuter rail systems. Like many other state departments of transportation around the nation, ADOT could also pursue the acquisition of, or access to, rail corridors from private railroad companies such as BNSF and Union Pacific Railroad as ‘vital state intermodal corridors’. Both BNSF and Union Pacific Railroad, however, diligently protect the current and future viability and capacity of their rail corridor assets. The corridors in the Phoenix area are important to the railroads, especially the Union Pacific Railroad corridors.

A vehicle miles traveled (VMT) tax would charge motorists a fee based on the number of miles driven rather than on fuel consumption, which is becoming a declining source of transportation revenues as vehicles become more fuel efficient. A VMT tax would require the installation of an onboard tracking device in vehicles to identify the locations where vehicles travel. While the idea of a VMT tax is increasingly being discussed among elected officials, it does not currently have widespread political support primarily due to privacy concerns.

The State of Oregon developed VMT-based pilot programs in 2006 and 2012, and in 2013 passed Senate Bill 810 establishing the nation's first mileage-based (or road usage) revenue

program for light vehicles. On July 1, 2015, OReGO, a per-mile driving fee, was launched, capping participation at 5,000 vehicles. OReGO volunteers pay a road usage charge set at 1.5 cents per mile for the amount of miles they drive, instead of the fuel tax. Volunteers receive credits on their bill for the fuel tax they pay at the pump.

Colorado began discussing a VMT tax in 2007, and conducted the Colorado Mileage-Based User Fee study in 2011. In the spring of 2016, the Colorado Department of Transportation set up a 100-person pilot program between late fall and the spring of 2017. California also completed a nine-month pilot program in March 2017, called Road Charge, to test the collection of road maintenance costs based on the number of miles a vehicle drives. More than 5,000 volunteer vehicles tested various road charging methods to compare how the performance of each concept measures against criteria.

4.8.3 Regional and Local Funds

Local transportation funding mechanisms can include any tax or fee presently authorized for local use (e.g., sales tax, property tax, service fees, fines and forfeitures). In practice, only the sales tax is currently employed as an exclusive transportation funding vehicle, such as the existing Maricopa County half-cent sales tax program authorized by Proposition 400.

Existing Maricopa County Transportation Excise Tax

Proposition 300, which proposed a one-half cent sales tax for purpose of constructing the freeway network went before the voters in October 8, 1985. Proposition 300, known as the Maricopa County Transportation Excise Tax, passed with 72 percent voting in favor.

The major funding source for the RTP is the half-cent sales tax for transportation that was approved through Proposition 400. On November 2, 2004, the voters of Maricopa County passed Proposition 400, which authorized the continuation of the existing half-cent sales tax for transportation in the region. This action provides a 20-year extension of the half-cent sales tax collection through calendar year 2025 to implement projects and programs identified in the MAG RTP. The results of the Proposition 400 vote in Maricopa County dedicated approximately one-third of the half-cent sales tax at the regional to transit investments. The current MAG RTP reflects this significant increase in transportation funding, with expanded transit plans and programs. The use of transit funds must be separately accounted for based on allocations to: (1) light rail transit, (2) capital costs for other transit, and (3) operation and maintenance costs for other transit.

House Bill 2456 addressed the allocation of revenues from the collection of sales tax monies among the eligible transportation modes funded through Proposition 400. The legislation creates three “firewalls”, which prohibit the transfer of half-cent funding allocations from one transportation mode to another. The proceeds from the Prop 400 tax is unlikely to be utilized for commuter rail implementation as the funds are already programmed and committed to transit projects identified in the RTP. Continued expansion and improvement of the region’s transportation infrastructure will require the extension of Proposition 400 in order to fund investments after 2025. Technical studies, including this effort, are being conducted by MAG to better inform policy questions about the purpose of a tax extension.

Additional Local/Regional Funding Sources

Throughout the United States, sales taxes are the most common source of funding for local and regional transit services. As was the case in 2004, Maricopa County has the authority to place

an initiative on the ballot for voters to authorize a sales tax specifically for transportation purposes. A potential sales tax program to specifically to fund commuter rail, however, should consider the jurisdictional boundaries of the commuter rail system and the likely beneficiaries in the region.

Additional or alternative local taxes, with voter approval, could include one or a combination of the following revenue streams:

- **Payroll tax.** In Portland, Oregon, TriMet receives approximately 60 percent of its operating revenue from 0.7437 percent (up from the initial 0.63 percent) payroll and self-employment taxes that are collected and administered by the State Department of Revenue. In 2003, the State Legislature provided TriMet with the authority to increase the tax rate over ten years to help pay for new transit service throughout the region. In 2015, the TriMet Board approved, an increase in the employer and self-employment tax rate by 1/10th of one percent, phased-in over 10-years, beginning January 1, 2016. The rate continues to increase annually by 1/100 of a percent. In FY 2015, receipts from payroll taxes totaled approximately $273 million.
- **Vehicle rental tax.** In Pittsburgh, Pennsylvania, Allegheny County has enacted a $2 rental car fee to help support regional transit services provided by Port Authority Transit Services. Currently in Arizona, the rental-vehicle surcharge must be used only for the reimbursement of the amount of Arizona vehicle license tax imposed on rental vehicles. Any surcharge collected in excess of the vehicle license tax must be remitted to ADOT to be deposited in the Highway User Revenue Fund.
- **Local gas tax.** In South Florida, each county served by the South Florida Regional Transit Authority is required to dedicate $2.67 million to the authority annually. This funding may come from each county's share of the ninth-cent fuel tax, the local option fuel tax, or any other source of local gas taxes or other nonfederal funds available to the counties. In Arizona, the statewide gas tax of $0.18 per gallon has not increased since 1991.
- **Vehicle license tax or registration fee.** In Seattle, Washington, the "car tab tax" is a motor vehicle excise tax collected by the Washington State Department of Licensing as part of vehicle license renewals in the Sound Transit District. The voter-approved 0.3 percent (increased to 1.1 percent in 2016, but will be reduced to 0.8 percent in 2028) motor vehicle excise tax is one funding source for the construction and operation of the regional mass transit system. In 2015, receipts from the vehicle excise tax totaled approximately $75.6 million. Another example of a vehicle registration fee to fund transit can be found in South Florida. The Florida State Legislature has authorized the levy of an annual $2 vehicle registration or renewal tax for the counties served by the South Florida Regional Transit Authority.
- **Property Taxes**. Property taxes are used in other areas of the country and could be used for transit; however, this has been unpopular in Arizona as it has been opposed particularly by the business community. Property taxes were initially discussed as part of the Proposition 300 discussions but were not used because of this.

Other examples of local funding approaches include resident impact fees, driver's license fees, and hotel occupancy taxes.

Public Value Capture

Current federal, state, regional, and local funds that have traditionally been used for transportation projects in Maricopa County have been dedicated to the implementation of the 20-year transit program identified in the RTP. Due to the considerable cost involved in implementing a regional commuter rail system, the region could consider other funding mechanisms such as value capture.

Value capture mechanisms are used to indirectly capture some of the economic benefits derived by the private sector from the development and operation of a transit corridor. Building near a transit stop is not only good for the transit system; it is good for property owners and interested developers. Residential and commercial projects near transit typically appreciate in value more rapidly than other projects. As demand for scarce properties near transit stops increases, this trend will continue. As a result, development near transit stops increases tax revenues. As the value of property near transit appreciates, property taxes collected by local governments also increase.

Value capture techniques used throughout the United States include:

Benefits Assessment Districts – assessment charges imposed on property owners in a designated area, based on the specific benefits to those properties, as generated by the transit facilities. An example of this technique is Portland, Oregon's Transit Revitalization Investment District (TRID). The TRID model is able to calculate job creation, housing development and income results for each district. The revenues above a certain amount from property taxes, business license fees, system development charges and other revenues within the boundaries of a TRID district are used to pay for bonds that fund transit improvements, subsidize operating costs and other public benefits such as housing within the TRID district. The revenue sources and amounts from each can vary from TRID district to district. The Transit Revitalization Investment District has been used by Portland, Oregon to fund their streetcar system. Arizona state law does not authorize the use of Benefits Assessment Districts for commuter rail capital projects. These districts have not previously been used in Arizona for transit purposes, but could be further investigated as a public value capture mechanism.

Tax Increment Financing – incremental property tax receipts (above a pre-determined base) which can be attributed to infrastructure improvements, such as transit facilities. These incremental receipts will typically be captured through a redevelopment agency (which could dedicate some of its own tax increment funds for transit facilities in a designated redevelopment area), or through the establishment of infrastructure financing districts. Arizona currently does not have a state law authorizing the use of Tax Increment Financing.

4.8.4 Public-Private Partnerships

Increasingly, transportation agencies are turning to the private sector to improve the efficiency of designing and building major transit projects and to help meet the financial demands of projects. Considered to be an innovative financing mechanism, a public-private partnership is described by FTA as a contract wherein a single private entity, typically a consortium of private companies, is responsible and financially liable for performing all or a significant number of functions in connection with a project. Advantages to forming a public-private partnership can include cost savings; cost predictability, additional expertise from the private sector with regard to finance, reduced project completion time, and greater private sector investment. Additionally, a public agency could potentially spread the cost of a project over a greater period of time. The FTA has invested in several projects designed to promote private-sector investment in transit,

but to date there has not been many successful examples. Through the Public-Private Partnerships (PPP) Pilot Program (Penta-P), FTA is currently exploring how private sector funding could be integrated into the New Starts program, as leveraging private financing sources is viewed by some as a possible key component of increased transit funding.

Disadvantages of public-private partnerships may include the disincentive for private companies to assume risk for design, construction, financing, and even operations and maintenance. Other challenges may include the establishment of long-term contracts, procurement that may be too long and costly, the use of more expensive private sector capital, and perceived loss of public sector control. Finally, federal transportation rulemaking can have an effect on how common public-private partnerships become with changes in administrations. While there has been a growing desire to leverage local funding to help pay for large projects, the details of what is allowed or what is required could change with the change in administrations.

The following delivery methods can be used as part of a public-private partnership which could include private funding for design, construction, operations, and/or maintenance:

- Design/Build – private sector designs and builds but public entity operates and maintains (this has become a most common alternative delivery method for ADOT to date).
- Design/Build/Maintain – private sector designs, builds, and maintains system but public entity operates (this type was used by ADOT on the South Mountain Freeway to reduce the cost to taxpayers without sacrificing quality, as the developer will be responsible for maintaining the freeway after construction).
- Design/Build/Operate – private sector designs, builds, and operates over a specified period of time while public entity gets title to system.
- Design/Build/Operate/Maintain – private sector builds and operates over a specified period; at end of period, operations and maintenance revert to public entity.

An example of a successful public-private partnership project is the New Jersey Riverline, a Design/Build/Operate/Maintain-type partnership, which is an LRT system operating 34 miles and serves 17 communities. The service was procured outside of the FTA process and financing was not required.

Table 4-5 through Table 4-8 lists the federal, state, local and private funding sources and their relative viability for use in the System Study corridors.

Table 4-5: Potential Commuter Rail Funding Source (Federal)

Fund Source	Capital and/or Operations	Viability
Federal Funding		
FTA Section 5307	Supports transportation capital costs including preventive maintenance	Low. The MAG region's allocation is currently programmed to support a host of other transit projects; future funds could be allocated to commuter rail. This is an annual programming allocated by formula; if and when commuter rail is added to the region, commuter rail funding allocations would enter into the formula calculation.
FTA Section 5309 New Starts	Supports transportation capital	Moderate. The application of Section 5309 is feasible, but the New Starts alternatives analysis planning requirements will require significant evaluation and time. While New Starts regulations have been relaxed in recent years, federal funding for transit can be extremely partisan in nature, so future funding levels can change with changes in administrations.
Congestion Mitigation and Air Quality (CMAQ) Funds	Supports transportation capital uses only	Low. A commuter rail project application will contend with many other capital projects in the MAG region.
Surface Transportation Block Grant Program (STBG, formerly Surface Transportation Program) Funds	Supports transportation capital uses only	Moderate. A commuter rail project application will contend with many other capital projects in the MAG region, but this is the most flexible federal funding in the region.
Federal Railroad Administration Section 130	Supports transportation capital uses only, primarily for the use of improving grade crossings.	Low. Arizona's allocation of Section 130 funding is relatively small and may likely only support a portion of a safety improvement project.
Federal Railroad Administration High Speed Intercity Passenger Rail (HSIPR) Program	Supports Consolidated Rail Infrastructure and Safety Improvements, Federal-State Partnership for State of Good Repair, and Restoration and Enhancement Grants uses	Low. May only address some intercity components of commuter rail or related rail projects.
Federal Railroad Administration PTC Funding	Supports commuter railroads with PTC implementation	Low. May address some crossing improvements of at-grade commuter or freight rail crossings.

Source: AECOM, 2018.

Table 4-6: Potential Commuter Rail Funding Source (State)

Fund Source	Capital and/or Operations	Viability
State Funding		
Highway User Revenue Fund (HURF) (including Vehicle License Tax or VLT)	Supports transportation capital uses only	Low. Funding is driven by fuel taxes and vehicle license taxes. In order to use HURF (A.R.S. § 28-6533), changes to state statute would be required as they are only available for highway projects. As fuel economy increases with electric vehicles and other advances, HURF revenues will continue to become smaller. In other states, VLTs are used, but those are included as part of the HURF in Arizona.
Statewide Transportation Acceleration Needs (STAN) Account	Supports transportation capital and/or operations	Low. The STAN account was a potential source of transit funding in the past, however it is not considered to be a reliable funding source in the future as this is currently only available for highway projects.
New Dedicated Statewide Transportation Funding (e.g. statewide tax)	Supports transportation capital and/or operations	Low. Unclear if new tax would be considered viable in the future, as there is a low likelihood of passing a new statewide tax. Any new taxes would likely be included as part of an extension to Proposition 400.
Vehicle Miles Travelled (VMT) tax (Could also be done regionally or locally, rather than at the state level)	Supports capital and/or operations	Moderate. Typically used for roadway maintenance. Commonly unpopular with voters because of perceived invasion of privacy. Would be considered to be a more equitable funding alternative to a gas tax.

Source: AECOM, 2018.

Table 4-7: Potential Commuter Rail Funding Source (Local or Regional)

Fund Source	Capital and/or Operations	Viability
Local or Regional Funding		
Maricopa County Transportation Excise Tax (Sales Tax)	Supports capital and/or operations	Moderate. Although the revenue generated from the current tax (Proposition 400) is programmed, future proposition(s) to provide funding beyond 2026 are expected.
Payroll Tax	Potentially support capital and/or operations	Low. Existing state, and potentially federal, tax codes must be modified to support these uses.
Motor Vehicle Sales Tax	Potentially support capital and/or operations	Low. The MAG region's allocation is already programmed. The revenue generated from the tax may not be a sustainable source of funding in the future.
Vehicle Rental Tax	Supports capital and/or operations	Low. Special uses for the surcharges collected for this tax will require county, and possibly state, law modification for the purpose of commuter rail.
Local Gas Tax	Potentially supports capital and/or operations	Low. The MAG region's allocation is currently programmed. The revenue generated from the tax may not be a sustainable source of funding in the future. Proposed legislation in the 2017 legislative session would increase the statewide gas tax by $.10 per gallon. The increase would be allocated to the construction or maintenance of transportation infrastructure. It is to be voted on in 2018.
Vehicle License Tax (VLT) by District	Supports capital and/or operations	Moderate. The VLT by district concept would require significant political support since it has not been implemented. State and/or County tax codes will likely require modification to authorize districts and uses.
Property Taxes	Supports capital and/or operations	Low. Property taxes could be used for transit, but this has been unpopular in Arizona.
Tax Increment Financing (TIF)	Supports capital and/or operations	Low. TIF funds are used for transit in other states; however, current Arizona state law does not allow for the use of TIF funds.

Source: AECOM, 2018.

Table 4-8: Potential Commuter Rail Funding Source (Private)

Fund Source	Capital and/or Operations	Viability
Private Funding		
Public Value Capture: Benefits Assessment Districts	Potentially support capital and/or operating uses	Low. Setting up the finance mechanism for such a public investment will require State and County statute or code modification.
Public Value Capture: Tax Increment Financing	Potentially support capital and/or operating uses	Low. The authorization of such a mechanism will require political support and new State legislation.
Public-private partnerships (P3)	Potentially support capital and/or operating uses	Moderate. Many entities are investigating new P3 opportunities. This approach is being used in other cities and it continues to be more viable. With the passage of HB 2396, ADOT has the legal authority to explore these options.

Source: AECOM, 2018.

4.8.5 Summary of Funding Approaches in Other Cities

Peer cities and regions that have implemented commuter rail systems have used a variety of funding sources and mechanisms. Recently developed commuter rail systems are built with a combination of federal funding, state budget commitments, and local tax monies. The Rail Runner Express in New Mexico is an anomaly, in that state and local sources funded the capital costs of commuter rail (exclusive of federal funding, although CMAQ funding contributes to operating costs), and thus the system was built more quickly than other recent commuter rail systems.

Denver's Regional Transportation District (RTD) has been very aggressive at looking for innovative financing options for delivering the FasTracks program within the general scope, timeframe, and financial capacity approved by voters in 2004. The district utilized(PPP) to implement many of the FasTracks projects including Denver Union Station, North Metro, and I-225 corridors, as well as three projects that have been collectively accepted by the FTA as part of its public-private partnership pilot program (the East Corridor, Gold Line and commuter rail maintenance facility). The PPP Project comprises elements of Design, Build, Finance, Operation and Maintenance (DBFOM). The project is being delivered and operated under a form of concession agreement that RTD has entered into with a lead business entity "Concessionaire" that was selected through a competitive proposal process. The P3 has allowed RTD to partner with a private company or consortium to Design-Build-Operate-Maintain-Finance the East Corridor (which opened in 2016), Gold Line (in testing in 2018) and commuter rail maintenance facility (opened in 2015) projects under a single contract. In the P3, RTD will retain all assets while shifting much of the risk of providing the projects to the private partner or consortium. In return, RTD will make lease payments to the private partner, allowing the agency to spread out large upfront costs over a longer period of time. Table 4-9 provides a summary of peer city approaches to funding.

Table 4-9: Comparison of Commuter Rail Facilities and Transit Funding

State: County	Operating Authority	Commuter Rail Facility	Key Funding Sources (inclusive of all transit services provided by operating authority)
Colorado: Denver	Regional Transportation District (RTD)	FasTracks	Dedicated Regional Sales Tax; Federal Funding (Section 5309 New Starts program); Private Contributions
Utah: Weber, Davis, and Salt Lake	Utah Transit Authority	FrontRunner	Dedicated Local Sales Tax; Federal Funding (Section 5309 New Starts program)
Texas: Tarrant and Dallas	The Fort Worth Transportation Authority (The T)/Dallas Area Rapid Transit	Trinity Railway Express	Dedicated Local Sales Tax; Federal Funding (CMAQ)
California: San Diego	San Diego Metropolitan Transit System	The San Diego Coast Express Rail (COASTER)	Dedicated Local Sales Tax
New Mexico: Valencia, Bernalillo, and Sandoval	Rio Metro	Rail Runner	Funded by the State of New Mexico; Federal Funding (CMAQ), Dedicated Local Sales Tax.
Minnesota: Anoka, Benton, Hennepin, and Sherburne	Minnesota Department of Transportation (MnDOT) and the Northstar Corridor Development Authority	Northstar	Various dedicated funding for counties in Minnesota (only 17% of Northstar construction costs from local governments/transit agencies); State Funding; Federal Funding (Section 5309 New Starts program).
Texas: Tarrant	Trinity Metro (Fort Worth)	TEX Rail	Dedicated Local Sales Tax; New Starts Program
Texas: Denton	Denton County Transportation Authority	A-Train	Dedicated Local Sales Tax; Allocated portion of Toll Road Concessionaire Payment

Source: AECOM, 2018.

4.9 Liability, Insurance, and Indemnification

Every commuter rail system in North America operates in whole or in part on an existing freight railroad corridor, often on existing freight railroad tracks. It would be an understatement to say railroads are very concerned about incurring additional liability exposure due to commuter rail operation. Railroads are *extremely* concerned and no meaningful discussions dealing with access to a railroad corridor can proceed very far without assurances being made to the railroad that they are protected fully concerning liability and indemnification. It is also crucial that the entire arrangement of operating passenger trains on freight tracks is completely covered by adequate insurance coverage.

This section will briefly explain and define key terms, outline the standard or typical railroad position on the various elements of liability, indemnification, and insurance, and then describe Arizona law and any perceived hurdles to meeting the standard railroad requirements on liability, indemnification, and insurance.

4.9.1 Basic Terms Defined

Liability

Liability is one of the most significant words in law: liability means legal responsibility for one's acts or omissions. Failure of an entity to meet that responsibility leaves the entity open to a lawsuit and damages for any resulting loss. In order to win a lawsuit, a party must prove the legal liability of the defendant. This normally requires evidence of the duty to act, the failure to fulfill that duty, and the connection of that failure to some injury or harm.

In addition to liability due to a failure to act, one party can assume liability on behalf of another via a contract, called *contractual liability*.

Negligence

The concept of negligence passed from Great Britain to the United States as states adopted the common law of Great Britain. British common law implies a promise to exercise care or skill in the all activities. The obligation to exercise care, whether express or implied, formed the origins of the modern concept of the duty to act reasonably. A key element of this duty to act reasonably is the “reasonable person” standard. Hundreds of articles have been written about what is a reasonable person, and what is the appropriate reasonable person standard. In brief, a reasonable person is a hypothetical person in general society who exercises average care, skill, and judgment in any given situation. The decision whether negligence is present involves judging whether the conduct is comparable to that of a reasonable person under similar circumstances. In most cases, persons with greater than average skills, or with special duties to society, are held to a higher standard of care. For example, a railroad engineer operating a train is held to a higher standard of care than is an ordinary person.

Although there have been many developments and evolution of negligence law, the basic concepts have remained the same for several centuries.

Gross, Wanton, Willful Negligence

Gross, wanton, willful negligence is a very important concept in coming to an agreement with the railroads. Gross negligence is a conscious and voluntary disregard of the need to use reasonable care, which is likely to cause foreseeable grave injury or harm to persons, property, or both. It is conduct that is extreme when compared with ordinary negligence, which is a mere failure to exercise reasonable care. Ordinary negligence and gross negligence differ in degree of inattention; it is a “carelessness in reckless disregard” for the safety or lives of others, which is so great it appears to be a conscious violation of other people's rights to safety. It is more than simple inadvertence, but it is just shy of being intentionally “evil”. Negligence and gross negligence both differ from willful and wanton conduct, which is conduct that is reasonably considered to cause injury. This distinction is important since a finding of willful and wanton misconduct often supports a recovery of punitive damages while gross negligence often does not.

Willful and wanton negligence is an act that must have been intentional, or the act must have been committed under circumstances exhibiting a reckless disregard for the safety of others. This could be a failure, after knowledge of impending danger, to exercise ordinary care to prevent it. This could also be a failure to discover the danger through recklessness or carelessness when it could have been discovered by the exercise of ordinary care. Willful and wanton conduct may mean acting consciously in disregard of or acting with a reckless indifference to the consequences, when a person is aware of the conduct and is also aware,

from knowledge of existing circumstances and conditions that the conduct would probably result in injury. Willful is a course of action which shows actual or deliberate intention to harm or which, if not intentional, shows an utter indifference to or conscious disregard of a person's own safety and the safety of others. In summary, it is a reckless disregard for the consequences of one's behavior. A wanton act is one done in heedless disregard for the life, limbs, health, safety, reputation, or property rights of another individual. Such an act is more than negligence or gross negligence; it is equivalent in its results to an act of willful misconduct.

Indemnification

In a business arrangement, one party may agree to assume some or all the risks associated with a transaction or other endeavor. It is the result of one party assuming contractual liability for the endeavor. An indemnity agreement is a promise by one party to assume liability on behalf of someone else. In a typical Railroad indemnity agreement, the state (or other governmental entity) agrees that if the railroad is sued by a third party because of the state's otherwise negligence, the state will indemnify (or reimburse) the railroad for costs that result from the third party's lawsuit. An indemnity agreement is also called a “hold harmless agreement”. An indemnification clause is simply a promise by the other party to cover losses that they, without the agreement, would be responsible for. Key words that appear in most agreements are “indemnify”, “hold harmless”, and “defend”. Indemnify and hold harmless mean the same thing — to make whole after causing a loss. The word defend relates to responsibility for defending from lawsuits, and isn’t present in an indemnification provision if the indemnified party prefers to defend its own lawsuits (although the indemnifying party may be required to pay for it).

Punitive Damages

Actual, or compensatory, damages are the costs most associated with costs directly related to the damages suffered or incurred. Costs such as lost wages, medical bills, and even pain and suffering are clear examples of actual damages. Punitive damages, on the other hand, are not based on actual damages, but are meant to punish the defendant for outrageous misconduct and to deter the defendant and others from similar misbehavior in the future. Punitive damages are a way of punishing a defendant in a lawsuit and are based on the theory that the interest of society and the individual harmed can best be met by imposing additional damages, or costs, on the defendant. Since the 1970s, punitive damages have been criticized by U.S. business (including railroads) and insurance groups which allege that exorbitant punitive damage awards have driven up the cost of doing business.

The nature of the wrongdoing that justifies punitive damages is variable and imprecise. The usual terms that characterize conduct justifying these damages include bad faith, fraud, malice, oppression, outrageous, violent wanton, wicked, and reckless. These aggravating circumstances typically refer to situations in which the defendant acted intentionally, maliciously, or with utter disregard for the rights and interests of the plaintiff. Cases that are reported in the popular press that cite very high awards usually involve punitive damages.

Sovereign Immunity

Sovereign immunity is always raised by governmental entities in dealing with railroads, with the hope or belief that immunity will limit government’s exposure in case of an accident or other damaging event. Sovereign immunity is another legal concept that dates back to English common law. It is a concept that precludes bringing a suit against the sovereign government without the government's consent. The doctrine of sovereign immunity originated with the maxim that “the King can do no wrong". The United States has sovereign immunity, and most

states have adopted, in one form or another, sovereign immunity also. Sovereign immunity is commonly linked to some form of tort cap statutes that does allow law suits against governmental entities, but limits the amount of damages that may be awarded. For reasons detailed in Section 3.3 on railroads position, it is not necessary to detail the possible role sovereign immunity plays in Arizona.

Insurance

Insurance is defined as “a practice or arrangement by which a company or government agency provides a guarantee of compensation for specified loss, damage, illness, or death in return for payment of a premium”. Insurance is most commonly evidenced by an insurance policy (like an automobile or homeowner’s policy) with set conditions and policy limits. While this is relatively easy to understand, what needs further explanation is the level, or amount, of insurance that is required, specifically as it relates to freight railroads, and the levels of insurance that they require the operators of passenger railroads. Before 1997, insurance limits were, for the most part, individually negotiated with each agreement/railroad. The Amtrak Reform and Accountability Act of 1997 established an aggregate award cap of $200 million to all rail passengers, against all defendants, for all claims (including claims for punitive damages) arising from a single accident or incident. It is such an important piece of legislation; it is worth citing in full.

Figure 4-8: Limitations on Passenger Transportation Liability

49 U.S. Code § 28103 - Limitations on rail passenger transportation liability

(a) Limitations.

(1) Notwithstanding any other statutory or common law or public policy, or the nature of the conduct giving rise to damages or liability, in a claim for personal injury to a passenger, death of a passenger, or damage to property of a passenger arising from or in connection with the provision of rail passenger transportation, or from or in connection with any rail passenger transportation operations over or rail passenger transportation use of right-of-way or facilities owned, leased, or maintained by any high-speed railroad authority or operator, any commuter authority or operator, any rail carrier, or any State, punitive damages, to the extent permitted by applicable State law, may be awarded in connection with any such claim only if the plaintiff establishes by clear and convincing evidence that the harm that is the subject of the action was the result of conduct carried out by the defendant with a conscious, flagrant indifference to the rights or safety of others. If, in any case wherein death was caused, the law of the place where the act or omission complained of occurred provides, or has been construed to provide, for damages only punitive in nature, this paragraph shall not apply.

(2) The aggregate allowable awards to all rail passengers, against all defendants, for all claims, including claims for punitive damages, arising from a single accident or incident, shall not exceed $200,000,000.

(b) Contractual Obligations.—

A provider of rail passenger transportation may enter into contracts that allocate financial responsibility for claims.

(c) Mandatory Coverage.—

Amtrak shall maintain a total minimum liability coverage for claims through insurance and self-insurance of at least $200,000,000 per accident or incident.

(d) Effect on Other Laws.—

This section shall not affect the damages that may be recovered under the Act of April 27, 1908 (45 U.S.C. 51 et seq.; popularly known as the “Federal Employers’ Liability Act”) or under any workers compensation Act.

(e) Definition.—For purposes of this section—

(1) the term “claim” means a claim made—

(A) against Amtrak, any high-speed railroad authority or operator, any commuter authority or operator, any rail carrier, or any State; or

(B) against an officer, employee, affiliate engaged in railroad operations, or agent, of Amtrak, any high-speed railroad authority or operator, any commuter authority or operator, any rail carrier, or any State;

(2) the term “punitive damages” means damages awarded against any person or entity to punish or deter such person or entity, or others, from engaging in similar behavior in the future; and

(3) the term “rail carrier” includes a person providing excursion, scenic, or museum train service, and an owner or operator of a privately owned rail passenger car.

(Added Pub. L. 105–134, title I, § 161(a), Dec. 2, 1997, 111 Stat. 2577.)

Under section 11415 of the FAST Act, the USDOT issued its required inflation adjusted index for the cap, or limitation, on damages to $294,278,983 (usually referenced as a rounded $295,000,000).

One term not mentioned in the statute relating to insurance is self-insured retention, or SIR. A SIR is the amount of the coverage limits that may be handled by the policy holder before the actual insurance policy levels apply. In many respects, it is similar to a deductible amount that would apply to a homeowner policy or automobile policy. For example, if there is a $10,000,000 coverage limit the first $1,000,000 will be covered directly by a SIR, funded by the policy holder.

4.9.2 Railroad Position

Liability and Indemnification

All railroad negotiations are unique, governed by their own set of circumstances and situation. However, railroads have been consistent in their requirements on liability and indemnification. Railroads take the position that they do not want *any* additional liability due to passenger rail operations on their corridor. The position is informally referred to as a "but for" standard. "But for" liability is the freight railroad's requirement that the passenger rail system must bear all losses of any and every party (i.e., freight railroad, itself or third-parties) that would not have occurred if the passenger rail system had never arrived on the corridor. This "but for" standard applies regardless of what party is at fault. It covers the railroad's own negligence, gross negligence, and even wanton and/or willful negligence. It bears repeating and emphasizing that the "but for" standard is uniformly required in all railroad agreements. Railroads require that they are fully indemnified. Several decades ago railroads would accept indemnification from a potential passenger rail operator "to the fullest extent allowed by law". Over the past several decades, however, railroads have begun to more seriously review and study just how extensive this offered indemnification was.

Railroads place little or no confidence that a state's sovereign immunity and/or tort cap limits will protect the railroad in the event of an accident or other occurrence that results in damages. The railroad's concern is that if an accident: (1) is especially extensive; (2) has facts that indicate clearly negligent behavior; (3) receives widespread attention and media coverage; and (4) has a compelling humanitarian narrative, judges and/or juries will find or manufacture a way to circumvent sovereign immunity or the tort cap. Railroads therefore do not allow the state or other governmental entity to rely exclusively on sovereign immunity.

Many states limit, or prohibit, public entities from indemnifying a party against their own negligence, much less a party's own gross, wanton or willful negligence. This prohibition is based on public policy grounds. It is argued that it is just bad public policy for government to indemnify a private party against that private party's own negligence, especially that party's own gross, wanton or willful negligence. 49 U.S.C. § 28103 cited (shown in Figure 4-8) does appear to pre-empt state law limits on indemnification against punitive damages, but that provision has not yet been tested in the courts. Recent trends indicate that some railroads will not even begin serious negotiations on business points in a potential agreement until all issues associated with liability are resolved.

Punitive Damages

As discussed previously, many large damage awards involve punitive damages. Punitive damages are at play only in the most outrageous of bad situations. Even with full and complete indemnification, railroads are concerned that if punitive damages are involved, based on such

outrageous actions, courts, judges, and/or juries would find some way to avoid the indemnification language and reach back to the railroad. As mentioned above, although the previously cited 49 U.S.C. § 28103 appears to override a state prohibition on limiting indemnification on punitive damages, railroads now examine if punitive damages are even allowed under state law. If state law does allow punitive damages, railroads explore if possible to exempt punitive damages related to an incident involving a railroad and the passenger rail system.

In Colorado, with the Denver Regional Transportation District (RTD) rail project, in agreements signed in 2010, the railroad required a change in state law to address punitive damages. The applicable statute, C.R.S. 24-10-114, was amended so that "a railroad operating in interstate commerce that sells to a public entity or allows the public entity to use such railroad's property or tracks for the provision of public passenger rail service shall not be liable either directly or by indemnification for punitive or exemplary damages for damages for outrageous conduct to any person for any accident or injury arising out of the operation and maintenance of the public passenger rail service by a public entity."

In summary, railroads take liability and indemnification very seriously. Even in circumstances where, operationally, shared use of a freight rail corridor is feasible, with real benefits for the railroad, liability and indemnification may negate the railroad's desire to continue negotiations. Informal discussions were undertaken with both railroads involved in the Phoenix area on these issues. Neither railroad was willing to comment officially for attribution on these issues.

Insurance

Even with full and complete indemnification, all railroads also require that the contractual obligation on indemnification be supported and backed by insurance. The insurance must be written with a reputable insurance firm, usually required to be approved by the railroad.

As noted in 5.2.7, the federal statue on limitations on rail passenger liability (49 U.S.C. § 28103), initially set at $200,000,000 and with the recent inflation adjustment by DOT now at nearly $295,000,000, arguably sets the upper limits on the level of insurance. However, some railroads now are seeking even higher insurance limits. One reason is that 49 U.S.C. § 28103 does not apply to non-passenger claims; for example, claims by motor vehicle drivers and passengers involved in grade-crossing accidents.

As part of this study informal discussions were conducted with legal representatives of both railroads, seeking any additional input or guidance on their position regarding liability, indemnification, and/or insurance. They declined to give any specific, for attribution, opinions, other than stating that they will of course insist on an enforceable "but for" standard, with full indemnification and insurance at the present time. They also declined to specify insurance levels. One railroad indicated they would take an independent review of Arizona law on many issues, including indemnification for another party's negligence and the application under Arizona law of punitive damages.

4.9.3 Arizona Law

The Federal Railroad Administration (FRA) within the USDOT is now the primary safety regulator of US railroads. State law, however, still plays a key role in the contractual arrangements that communities make with host railroads to implement passenger rail operations (mostly commuter rail) on federally regulated railroads corridors. The corridors involved in this study update fall into this category. An initial review of Arizona law, and

interviews in the fall of 2017 with Arizona municipal and private railroad attorneys, revealed the following.

Arizona "Gift Clause"

First, there has been some concern expressed that the Arizona Constitution's "gift clause" would prohibit a community from coming to an agreement with a railroad. Article 9 Section 7 of the Arizona Constitution reads as follows:

> *Neither the state, nor any county, city, town, municipality, or other subdivision of the state shall ever give or loan its credit in the aid of, or make any donation or grant, by subsidy or otherwise, to any individual, association, or corporation, or become a subscriber to, or a shareholder in, any company or corporation, or become a joint owner with any person, company, or corporation.*

Arizona, like many Western U.S. states, enacted laws, or by constitution, prohibited the state or any governmental entity, from granting money or other benefits to private individuals, corporations and others, without receiving something of real value in return. The impetus for this prohibition in Arizona, again, like in most states, was to stop the practice of states from granting heavy incentives, or outright payments, to railroads as an inducement to locate in a community or area. In more recent times this has been an issue for communities wishing to attract businesses to the area or employing other economic development efforts. Communities have responded to this requirement by asserting that the value received from an increased tax base, increased tourism, for example, is sufficient to justify the tax breaks or other incentives.

However, modern railroad transactions should not run afoul of the gift clause. An agreement to acquire rights on an existing railroad corridor involves real demonstrable rights, such as an easement to build and operate a passenger rail system, or rights to actually operate on the railroad's existing infrastructure. This may have been enabled by Arizona's 2009 public-private partnership (P3) law.

Liability and Indemnification

Arizona does not prohibit a governmental entity from contractually assuming the liability of another, which is what the railroads want to see. While Arizona does not prohibit the award of punitive damages, the standard to award punitive damages is quite high. Arizona courts typically use the term "evil mind' to emphasize this high standard of proof. Actions must be the product of an "evil mind", evidenced by either purposefully injuring someone, or although not intending to cause injury, there was a conscious pursuit of a course of conduct with knowledge that it created a substantial risk of significant harm to others. Punitive damages are recoverable in a bad faith action when, *and only when*, the facts establish that the conduct was aggravated, outrageous, malicious or fraudulent. An "evil mind" must be proved by clear and convincing evidence. When motives are shown to be so improper, *or* the actions and conduct is so oppressive, outrageous or intolerable that such an "evil mind" may be inferred, punitive damages may be awarded. Even with this very high standard of proof, the railroads may insist on legislative relief from the imposition of punitive damages. Without direct negotiations with the railroads it is not possible to predict with 100% accuracy the position they will take, but the reference to the legislative change enacted in Colorado as an example of the way to mitigate the problem with punitive damages is likely to occur. Enacting such legislation may be difficult, and likely only to occur after actual railroad negotiations commence and the parameters of needed statutory changes are known.

Insurance

One disappointing element in dealing with balancing risk against insurance is that regardless of the many risk mitigating factors that railroads will insist on, the requirement for indemnification and insurance is not affected. For example, the implementation of PTC is now mandated for all passenger commuter systems. PTC is a significant leap forward in increasing passenger rail safety, and of course reducing risk. Additionally, at least one Western U.S. railroad has consistently insisted on a minimum of 50 feet clearance between any freight track and any passenger track. This also reduces the risk of a freight/passenger accident occurring on a railroad corridor. Again, referring to the "but for" standard, the railroad will not tolerate *any* additional risk or liability, not matter how remote.

4.9.4 Conclusions of Liability, Insurance, and Indemnification

Railroads, when considering proposed passenger rail projects, obviously look to determine if there is:

- Political support for the passenger rail project;
- Actual financial resources, or planned resources, to build and operate the passenger rail project; and,
- A sensible and realistic infrastructure improvement plan to accommodate the planned passenger rail operations.

When considering passenger operations on a railroad corridor, freight railroads consistently insist that they are completely relieved of any responsibility or liability for accidents or other incidents that result in injuries or damages. Assuming the three above criteria are met on a preliminary basis, railroads may still not enter serious discussions until the governmental entity demonstrates the willingness and legal ability to accept the rather high liability, indemnification, and insurance conditions.

These liability, indemnification, and insurance concepts should provide the background necessary to engage the railroads in discussions, if the other business parameters of passenger rail project are viable.

4.10 Implementation Steps

4.10.1 Near-Term Implementation Steps (2018-2022)

This section outlines the near-term (within the next five years) implementation steps to advance this System Study Update. MAG's Commuter Rail Strategic Plan (2008) laid out key initial implementation steps and those were further advanced by the 2010 System Study. This section builds upon those concepts based on more detailed operations planning that has occurred through this planning process.

Periodic Ridership Forecasting Updates. MAG continually updates socioeconomic data assumptions for the region; therefore, it is recommended to re-run the MAG model approximately twice a year with the latest socioeconomic data to generate updated commuter rail boardings estimates.

Coordination with the Railroads. Further coordination with the BNSF and Union Pacific Railroad is critical to understanding the feasibility of sharing the corridor, and defining train

schedules, operational constraints, and needed capacity improvements. To enable this coordination, the following key efforts should be completed:

- **Establish state-level point of contact and communication protocols**. Union Pacific Railroad has indicated a preference to work through one point of contact on issues pertaining to its rail lines in Arizona. In addition to commuter rail, ADOT has been engaged in intercity rail planning between Tucson and the Phoenix metropolitan area and a Statewide Rail Framework Study, both of which have involved Union Pacific Railroad and BNSF. ADOT has been identified as a logical point of contact going forward through their participation in the Project Management Team reviewing the commuter rail planning process. Communication protocols should be established to facilitate continuing stakeholder input and awareness of efforts to further rail planning efforts with both the Union Pacific Railroad and BNSF.
- **Develop partnership to investigate options in accordance with an MOU**. A conceptual framework for a Memorandum of Understanding (MOU) with the railroads is attached as Appendix J: Conceptual Memorandum of Understanding. This MOU would address key points of negotiation such as determining compensation, capacity improvements, and level of service (see Appendix J as well as MAG Commuter Rail Strategic Plan). It is expected that resolution of these issues will require further modeling and investigation by the railroads based on the conceptual operating plan outlined in this study as well as ongoing discussions. For the Union Pacific Railroad, BNSF, and other parties to commit the resources and efforts required to make substantive progress on these, it is likely that a funding commitment to furthering commuter rail must first be identified and be demonstrated.
- **Passage of enabling legislation relative to liability and indemnification**. Careful review of Arizona state law must be monitored to determine if legislation changes or additional legislation is required to facilitate passenger rail operations in freight rail corridors similar to legislation passed in Minnesota, Virginia, New Mexico, and Colorado. Progress on this issue may facilitate more effective coordination with the railroads, as this would be an important issue to the Union Pacific Railroad BNSF.
- **Advance the design and operating concepts**. The 2010 System Study, along with the Grand Avenue Corridor Development Plan and the Yuma West Corridor Development Plan, provides plan drawings which may be further developed in coordination with the Union Pacific Railroad and BNSF. The railroads likely will opt to conduct their own modeling and assessment of the infrastructure improvements that would be required. This information would be used to form the basis for any long-term agreement with the Union Pacific Railroad and BNSF.

Coordination of Infrastructure Improvements with the Railroads, ADOT and Local Jurisdictions. The implementation of commuter rail service in the MAG region will require close coordination with the Union Pacific Railroad, BNSF, ADOT, and local jurisdictions. Specifically, the BNSF is planning a number of freight rail infrastructure improvements that would reduce freight activity into downtown Phoenix and thereby free up space on the rail mainline for commuter rail in the Grand Line Corridor. Similarly, ADOT and local jurisdictions are planning for extensive roadway upgrades throughout the region that may improve the viability and safety of System Study corridors for both freight and passenger rail service.

Identify Funding Commitments. To advance commuter rail it is critical to define new revenue streams that would be dedicated to development and ongoing operation of the commuter rail

system. As previously discussed, a phased approach and cost-sharing agreements may segment or defer expenditures.

A cost-sharing approach among the entities may facilitate the use of different funding sources for the capital costs of commuter rail implementation. An example of a cost-sharing approach is outlined in Table 4-10.

Table 4-10: Potential Cost-Sharing Approach to Commuter Rail Implementation

Potential Cost-Sharing Partners				
	Commuter Rail Authority or JPA	**Local Jurisdictions**	**ADOT**	**Union Pacific Railroad and/or BNSF**
1) Potential areas of responsibility	• Overall responsibility for the construction of the system. • Overall responsibility for coordination with Union Pacific Railroad and BNSF on maintaining freight service during and after construction.	• Partner on development of station areas • Partner on improvements in at-grade crossings that increase public safety.	• Partner on improvements in at-grade crossings that increase public safety. • Partner on utility relocation or other efforts that may be coordinated with programmed road improvements.	• Implementation of positive train control may predate commuter rail (Although not necessarily cost-sharing, these independent efforts may reduce overall cost estimates.) • Partner on development of sidings, bridges, and improvements in at-grade crossings that also benefit freight service.

Source: AECOM, 2018.

Initiate process for Federal funding. The process for FTA New Starts funding requires completion of Alternatives Analysis and NEPA compliance. Local match funding should be evaluated prior to initiating this process with FTA.

Develop and Implement Governance Plan. Options for governance of a commuter rail system are described in Section 4.8 and were discussed with interested stakeholders during the MAG Commuter Rail Governance Workshop. Through these discussions, no final recommendations were made on a governance structure that would be appropriate for the MAG region at this time. It was determined that multiple options exist and could work for the governance of commuter rail within the MAG region. There are several factors that need to be considered before such a recommendation can be made which include but are not limited to securing funding, understanding the political landscape, the appetite of citizens for commuter rail service, and the relationships with partner railroads.

Preserve Future Options. Planning studies may identify and preserve rights of way in developing and underdeveloped areas for multimodal transportation corridors to include roadway and rail transit. The System Study Update corridors are assumed to occur within the

existing railroad right of way and thus right of way acquisition requirements have not been identified for the implementation of the corridors.

Local Planning Efforts. A successful commuter rail system will require a collaboration of all participants – primarily the local governments as the development regulator and financial partner, the transit agency as the transit infrastructure builder, and the Union Pacific Railroad and BNSF as the railroad right-of-way owners. Prior to securing project financing, local governments within the corridor can take steps to lay the foundation for commuter rail implementation. The following is a list of such actions:

- Partner with the Union Pacific Railroad, BNSF, and ADOT to upgrade existing at-grade railroad crossings along System Study corridors.
- Control regulatory actions within station areas, including the planning, zoning, and development permitting process, to facilitate the development of commuter rail stations.
- Use other implementation tools such as infrastructure construction (e.g., streets and utilities), land purchase and assembly, and creation of urban design guidelines to facilitate transit-supportive development.

Table 4-11 summarizes the near-term implementation steps, including the step, potential responsible parties, and timeframe.

Table 4-11: Summary of Near-Term Implementation Steps

Item	Responsible Party	Partners	Timeframe
1) Periodic Ridership Forecasting Updates • MAG to re-run the MAG ridership forecasting model with the latest socioeconomic data to generate updated commuter rail ridership estimates.	• MAG	• Local	Ongoing
2) Coordination with Railroads • Maintain points of contact and communication protocols. • Develop partnership to investigate options for determining compensation, capacity improvements, and level of service. • Advance design and operating concepts. Plan drawings should be further developed in coordination with the Union Pacific Railroad and BNSF to form the basis for any long-term agreement with railroads.	• ADOT • MAG • Railroads	• Local • Valley Metro	Ongoing
3) Local Planning Efforts. Prior to securing project financing, local governments can take steps to lay the foundation for commuter rail implementation, including: • Partner with the Union Pacific Railroad, BNSF, and ADOT to upgrade existing at-grade railroad crossings along System Study corridors. • Control regulatory actions within station areas, including the planning, zoning, and development permitting process, to facilitate the development of commuter rail stations. • Use other implementation tools such as infrastructure construction (for example, streets and utilities), land purchase and assembly, and creation of urban design guidelines to facilitate transit-supportive development.	• Local	• MAG • ADOT	Ongoing
4) Address Enabling Legislation regarding Liability and Indemnification. • Progress on this issue may facilitate more effective coordination with railroads.	• ADOT	• MAG • Railroads	2018-2022

Item	Responsible Party	Partners	Timeframe
5) Coordination of Infrastructure Improvements with the Railroads, ADOT and Local Jurisdictions. • BNSF is planning freight rail infrastructure improvements that would reduce freight activity into downtown Phoenix and thereby free up space on the rail mainline. • ADOT and local jurisdictions are planning for extensive roadway upgrades throughout the region that may improve the viability and safety of corridors for both freight and passenger rail service.	• MAG • Local • ADOT	• Railroads • Valley Metro	Ongoing
6) Identify Funding Commitments. • Define new revenue streams that would be dedicated to development and ongoing operation of the commuter rail system. • A phased approach and cost-sharing agreements may segment or defer expenditures.	• MAG • ADOT • Legislature	• Local	2018-2022
7) Develop and Implement Governance Plan. Potential approaches include: • Form of a new Commuter Rail Authority, • Designation of an existing agency as the Commuter Rail Authority, or • Establishment of a new JPA with a provision for representation appropriate to the corridor or system to be implemented.	• MAG • ADOT	• Valley Metro • Local	Following identification of local funding commitments
8) Initiate Process for Federal Funding. • Process for FTA New Starts funding requires completion of Alternatives Analysis and NEPA compliance. • Local match funding should be identified prior to initiating this process with FTA.	• MAG	• Local	Following identification of local funding commitments
9) Preserve Future Options. • Commuter rail corridors are assumed to occur within the existing railroad right of way; however right of way preservation of future commuter rail extensions may reduce the costs for growing a future regional system.	• Commuter Rail Authority or JPA	• Local • Railroads • MAG • CAG • ADOT	Ongoing

Source: AECOM, 2018.

4.10.2 Longer-Term Implementation Steps

The identification of funding commitments and determination of the appropriate governance structure for commuter rail, which are likely to influence each other, will set the stage for moving into the next level of investment in commuter rail in the region. With progress on these key steps, the region will be in a position to move forward on other recommendations as described below.

Formalize partnership with the railroads. Following the development of a public/private MOU with the Union Pacific Railroad and BNSF, detailed agreements must be negotiated to define funding and the parameters to implement commuter rail facilities and services that will mutually benefit the public and private sector interests.

Secure Funding Sources. Secure sources of funding including federal, state, regional and local public funding, as well as private sector participation. Federal funds should be obtained following the completion of the National Environmental Policy Act (NEPA) process, FTA New Starts requirements and the identification of local funding commitments.

Design, construct, and operate initial commuter rail system. The implementation of the system would be contingent upon the realization of a partnership agreement with the Union Pacific Railroad and BNSF and funding commitments.

Continue planning to develop seamless transportation system and meet regional sustainability goals. As the commuter rail system develops and expands, regional planning must occur to ensure efficient systems and intermodal connections.

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