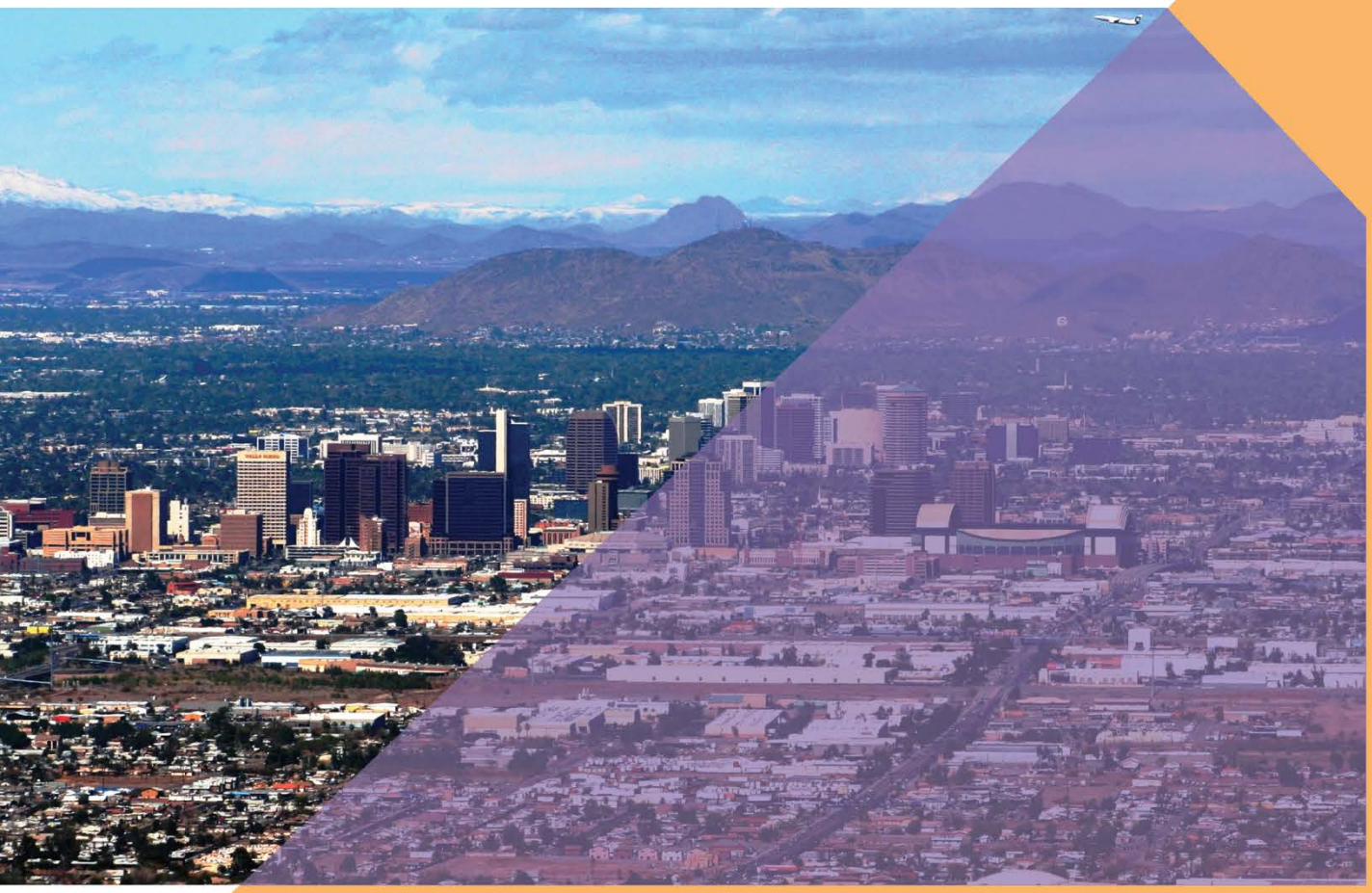
MAG Regional Freight Transportation Plan

December 2017



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Acronyms

AADT ..... Annual Average Daily Traffic
ADOT ..... Arizona Department of Transportation
ATRI ..... American Transportation Research Institute
BEA ..... Business Economic Areas
CAAG ..... Central Arizona Association of Governments
CRFC ..... Critical Rural Freight Corridors
CUFC ..... Critical Urban Freight Corridors
DOT ..... Department of Transportation
FAST ..... Fixing America's Surface Transportation
IANA ..... Intermodal Association of North America
LTL ..... Less-Than-Truckload
MAG ..... Maricopa Association of Governments
MPO ..... Metropolitan Planning Organization
MUTCD ..... Manual on Uniform Traffic Control Devices
NHFN ..... National Highway Freight Network
NPMRDS ..... National Performance Management Research Dataset
PAG ..... Pima County Association of Governments
PHFS ..... Primary Highway Freight System
SHSP ..... Strategic Highway Safety Plan
STCC ..... Standard Transportation Commodity Code
STSP ..... Strategic Transportation Safety Plan
TAZ ..... Traffic Analysis Zones
TL ..... Truck Load
UP ..... Union Pacific
VMT ..... Vehicle Miles Travelled

1 Introduction

The “Arizona Sun Corridor” megaregion, which encompasses the Phoenix and Tucson metropolitan areas, has outpaced population growth among the eleven U.S. megaregions. Approximately 85 percent of the population in Arizona resides within the Sun Corridor. The Sun Corridor’s population is projected to reach approximately 12 million people by 2050, which would place a significant strain on the transportation network that connects Maricopa, Pinal, and Pima Counties not only from a commuter perspective, but also from a freight operations and safety perspective. In 2012 the Joint Planning Advisory Committee of the Maricopa Association of Governments (MAG), the Pima County Association of Governments (PAG), and the Central Arizona Association of Governments completed the Freight Transportation Framework Study (Freight Framework) to develop a framework for strengthening the position of the region in the global supply chain. That study presented a regional freight shipper and carrier profile as well as a profile of regional freight activities, to complete a detailed evaluation of freight opportunities within the corridor.

The MAG Metropolitan Planning Organization (MPO) encompasses the heart of the Sun Corridor. According to its Regional Transportation Plan, in 2010, the MAG MPO contained approximately 63 percent of the population in Arizona, as well as nine of the ten cities in Arizona with populations greater than 100,000 people. As calculated by the 2016 MAG and Central Arizona Governments’ socioeconomic projections, by 2040, the MAG MPO is projected to increase its population by more than 51 percent over the 2015 base population, with an anticipated total of 6.5 million people. This means that the region will experience a growth of nearly 88,000 people annually through 2040.[1]

Building on the Freight Framework Study, MAG undertook preparation of this Regional Freight Transportation Plan. A central element of the plan is the identification and designation of a 21st century core roadway freight network able to support the region’s growing consumer market, aid industrial development, deliver competitive performance, provide multimodal connections, accommodate new technologies that may transform the character of transportation in the years ahead, and establish overall focus and priorities for the freight-driven investments the region needs to make.

The plan has two main sets of assessments and findings for the management of freight transportation in the MAG region. The first is situation analysis, consisting of a review of multimodal assets and freight traffic flows - particularly truck volumes, a description of clusters of freight activity, and an examination of transportation network usage and performance. Together, this analysis establishes a foundation for the second set of assessments, which defines the core roadway freight network – branded as Smart Moves, evaluates its needs for performance improvement based on MAG regional goals, and prioritizes needs by network segment. These priorities needs prove to be concentrated in four freight clusters. The plan concludes with profiles of these clusters, as preamble to small area studies that will formulate specific improvement projects and development opportunities, and serve as the implementation phase of the plan.

Stakeholder outreach was conducted throughout the study. Stakeholder input, including interviews, workshops and an online commenting tool, were used to define the network and prioritize its needs.

This plan report describes the stakeholder engagement process first, since it guided the entire process. The profile of freight facilities, constraints and needs follows next. This leads into the recommended core

[1] MAG Regional Transportation Plan, 2017.

network. The network evaluation methodology and results are then described. The plan finishes with profiles of the key industrial, logistics and manufacturing clusters and implementation strategies.

2 Stakeholder Engagement

Stakeholders were engaged throughout the process. Early in the plan development, MAG staff and consultants held interviews with agency and freight industry stakeholders. These interviews allowed input on the study goals and objectives and provided insight into freight network usage and needs.

During this time, Ideas Collide researched stakeholder opinions and preferences regarding the freight network planning process. Based on the research, Ideas Collide worked with the project team to brand and message the freight network. Reflecting stakeholder perspectives, MAG dubbed the network Smart Moves.

Ideas Collide developed a Smart Moves brochure[2] to publicize the freight planning process. MAG established a Smart Moves website that allowed the public to interactively review and comment on the draft network. In the fall of 2016 MAG met with its member agencies to review the Smart Moves concept and obtain input on the initial freight network. In December 2016, the project team met with Council of Supply Chain Professionals to review the draft freight network. The project team utilized the input received from stakeholders and the general public during this period to refine the draft network.

In spring 2017, MAG reviewed the prioritization scheme with stakeholders. In May 2017, the project team presented the evaluation methodology and initial priorities to MAG member agencies and Arizona Department of Transportation (ADOT). This coordination with ADOT included consultation regarding designation of critical urban freight corridors under the Fixing America's Surface Transportation (FAST) Act.

In August 2017, the project team presented the final evaluation results and freight network to its member agencies. The presentation also described regional industrial, logistics and manufacturing clusters and proposed associated implementation, including the intention to develop small area plans for four key clusters.

[2] The Smart Moves brochure is included in the appendix to this plan.

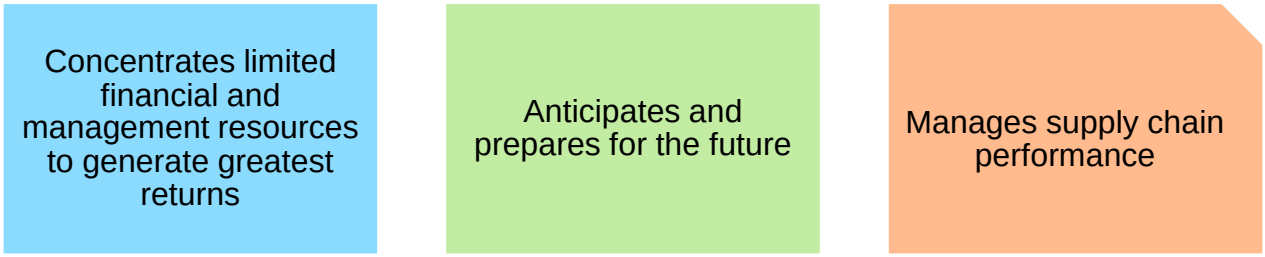
3 Defining a Core Freight Network

Freight transportation principally does two things: it provides service to industry, and it provides service to population. Population growth in the MAG region has been a major economic driver. Residents depend on household goods and increasingly they acquire them via electronic commerce and home delivery, as well from brick and mortar stores. With one-hour home delivery already available in metropolitan Phoenix, the logistics systems and staging points needed are different from what has been used in the past. Residents also depend on jobs. Phase I of the Freight Transportation Framework Study identified growth opportunities in cross-border trade coupled with distribution of westbound goods for the Intermountain and Pacific Coast markets. ADOT's Key Commerce Corridors Study emphasizes the manufacturing of so-called "traded goods"–those that are produced in the region and shipped elsewhere, sometimes to international destinations. Development objectives of both types require high-quality freight transportation systems to enable competitive time and cost to market for supply chains located in the region.

A high-quality freight system has to be multimodal in nature because supply chains use a portfolio of modal options to manage a diversity of needs. However, the connective tissue of multimodal systems is motor carriage, because the linkage from airports and rail terminals to business sites is supplied most frequently by trucks. In addition, the efficiency, flexibility and pervasiveness of trucking make it the mode of choice for the majority of supply-chain transport. The regional roadway freight network therefore provides the principal means of serving business and population, and of supporting the regional economy. A core network captures and combines the highways, arterials and connectors that are most needed to accomplish all of this.

There are three major advantages to utilizing a core network for the assurance of service and the provision of economic and multimodal support (Figure 1). The first is that it allows limited financial and management resources to be concentrated on facilities where they can generate the greatest private and social returns. This involves capital and operational investment, and policies designed to protect the network from detrimental encroachment by competing uses. The second advantage is effective preparation for the future. A 21st century system seeks to anticipate and shape (a) development in new areas and growth in old ones; (b) new supply-chain patterns; whether from resurgent manufacturing, changes in trade, or different methods of staging consumer goods; and (c) new technology, such as lower emissions vehicles, unmanned aerial vehicles, or connected and automated/autonomous vehicles that interact with infrastructure and each other. These types of technology developments have the potential to make freight activity safer, more efficient, and more acceptable in communities.

Figure 1: Three Major Advantages to Utilizing a Core Network



Source: WSP

The third advantage concerns supply-chain performance, which affects the attraction, retention and growth of industry, and the cost of goods to consumers. Time and cost are the crucial logistics drivers of

supply-chain performance. These factors face the greatest challenges in metropolitan environments such as Phoenix, because speeds are slower and risks are higher: from congestion and bottlenecks; from disruption due to accidents, public events, and other causes; and from facilities and development that are not well planned for contemporary freight operations. This results in diminished productivity, necessitating the use of more trucks, drivers, and other resources to move a given quantity of freight. Nevertheless, metropolitan environments are the chief consumer markets, the leading centers for manufacturing capacity, and (for related reasons) the frequent location of logistics facilities for the staging of goods. This makes them home to most of the last, first and transfer miles in a supply-chain operation, and the challenging conditions make those miles the least productive ones in the journey to market and homes. A network designed with the goal of keeping industry competitive and consumer costs down will recognize this. It will employ planning, policy, technology and investment toward that goal, and the combination will produce a system for the 21st century.

This plan documents the process of defining that system. The overarching objective is to designate a forward-looking core roadway freight network for long-term protection and investment that will attract industry and support household needs through better performance in terms of speed, reliability, cost, productivity, and safety. The network should provide rapid accessibility—within approximately fifteen minutes—to major clusters of freight generation and consumption, including future ones. It should facilitate cross-town travel so that clusters and multimodal facilities are well connected, and afford route redundancy to reduce the risk from delay and disruption. To the extent possible, the network should also anticipate the introduction of new technologies. Defining such a network will greatly facilitate freight planning in the region, particularly in establishing candidate facilities for designation as critical urban freight corridors under the Fixing America's Surface Transportation (FAST) Act.

This plan outlines the various sources of information that were used to develop the draft core freight network. The first sections describe the key physical assets of the freight transportation system and the freight volumes they support. This naturally focuses on highways, but it also covers other modes to the extent that they generate demands on roads. Next, the report discusses the economic geography served by these local freight assets, and the performance of the overall system to meet these demands. Relying on the understanding developed through these analyses, a draft core freight network was proposed. With these findings as foundation, discussions with stakeholders were held to revise and finalize network components. Finally, based on an evaluation of in accordance with system goals, investment priorities and implementation strategies were identified that support the key freight and logistics clusters.

4 Freight Infrastructure Assets

4.1 HIGHWAYS

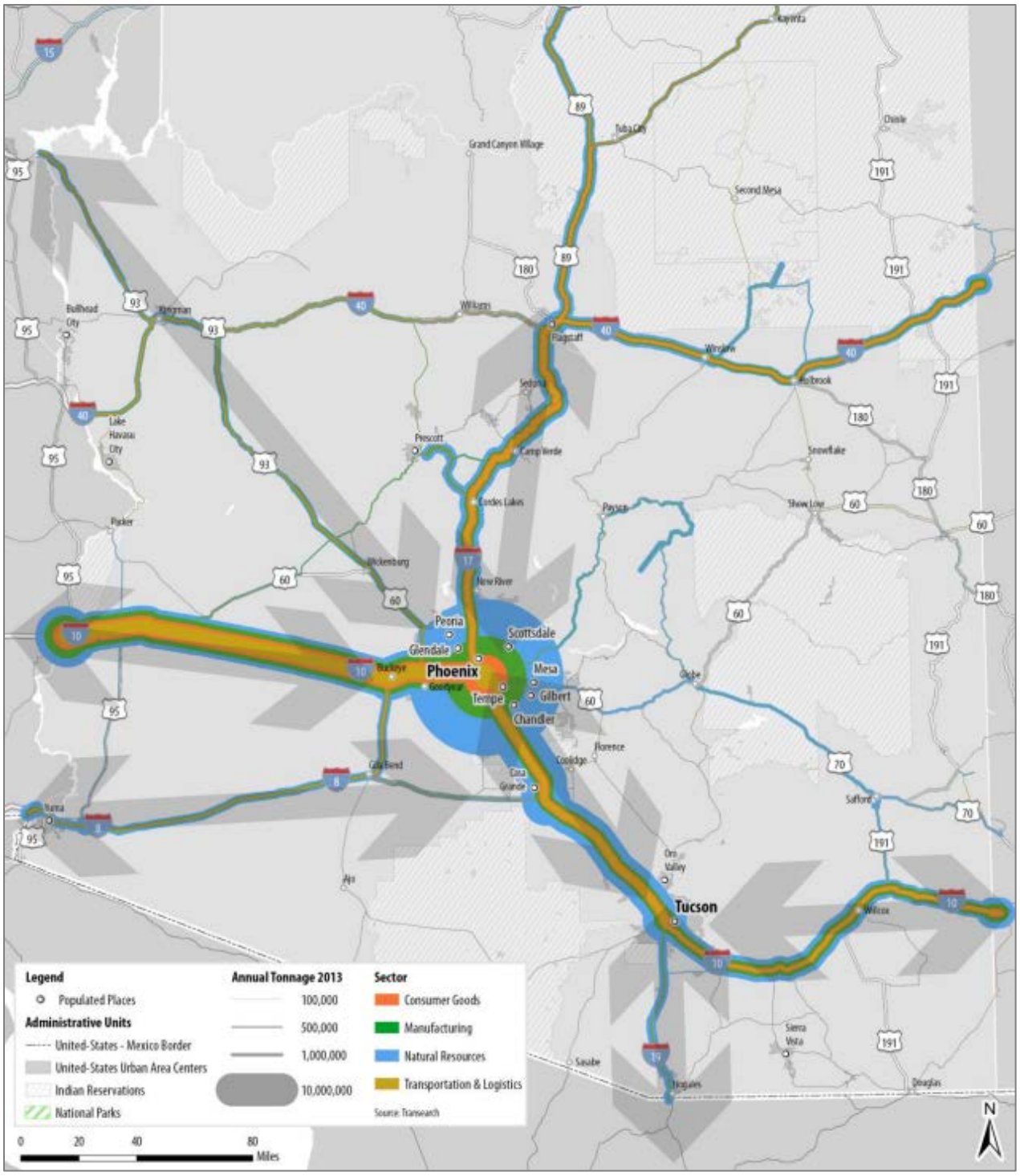
Within Arizona, the Phoenix and Tucson regions originate and terminate the majority of freight flow volumes (as can be seen in Figure 2), with most of this cargo moving primarily by trucks on the interstate highway system. Freight flows are especially concentrated around Phoenix, generally due to its large population and industrial base, and its location along major corridors. In particular, I-10 leads east and west from Phoenix, while I-17 leads north to join I-40, providing another east-west path leaving the state and connections north. South of Phoenix, I-10 connects to I-19, which facilitates the movement of goods to and from Mexico. State Route (SR) 85 runs north-south and connects I-10 to I-8, which leads to San Diego. The functional classification of MAG region roadways appears in Figure 2.

As discussed in the Arizona State Freight Plan[3], there are four economic sectors that dominate freight in the state: consumer goods, manufacturing, natural resources, and transportation and logistics. Goods movement along the interstate highway system varies across these sectors. Consumer goods are overwhelmingly carried by trucks which also employ the intermodal facilities available throughout the region. The manufacturing sector relies heavily on I-10, I-17, and I-40 to carry goods; while this sector also uses rail, the highway system carries much more by value. Distribution of natural resource flows along the highways varies by the resource: the mining industry uses I-10 and I-19; agricultural products are transported by I-10, I-8, I-19, and I-17 (to I-40), demonstrating that products are imported and exported to and from all over; the forestry industry primarily uses I-10 to get their goods to California. The transportation and logistics sector uses all major highways leading into and out of Phoenix, with I-10 being the most utilized.

California, Texas, and Mexico are major trading partners for the state of Arizona, thereby making Interstates 10 and 19 the primary corridors for inbound and outbound freight traffic. I-10 in particular is the most heavily used freight corridor in the MAG region. Trade with California and Texas comprises 68 percent of Arizona's trade with other states.

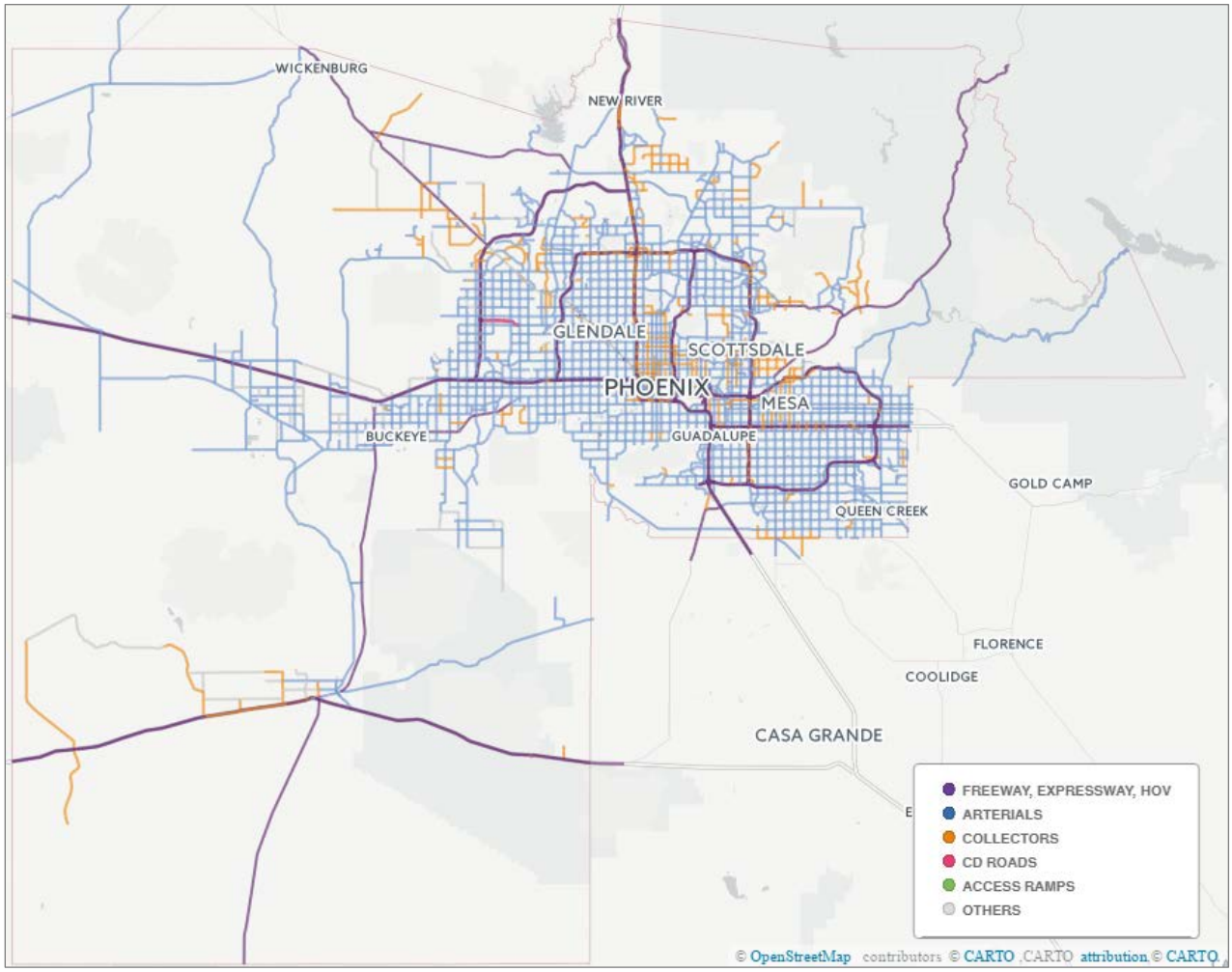
[3] CPCS, "Arizona State Freight Plan," ADOT, Dec 2015, < https://www.azdot.gov/docs/default-source/planning/State-Freight-Plan/14325-arizona-state-freight-plan-phase-3-economic-context-report.pdf?sfvrsn=2>.

Figure 2: Freight Sector Flows (Inbound, Outbound and Intra) on Arizona's Key Commerce Corridors



Source: Arizona State Freight Plan, 2016

Figure 3: Classification of MAG Roadways



Source: MAG

In an effort to determine the optimal way to produce economic benefits to the state through the development of the transportation network, ADOT commissioned a study on the Key Commerce Corridors. The report identified the six main corridors found in Table 1. The significance of each corridor includes the role the corridor plays in the freight flows within and beyond the state. These corridors and their future development should be central considerations when analyzing the freight network within the state.

Table 1: Arizona Key Commerce Corridor Export Markets

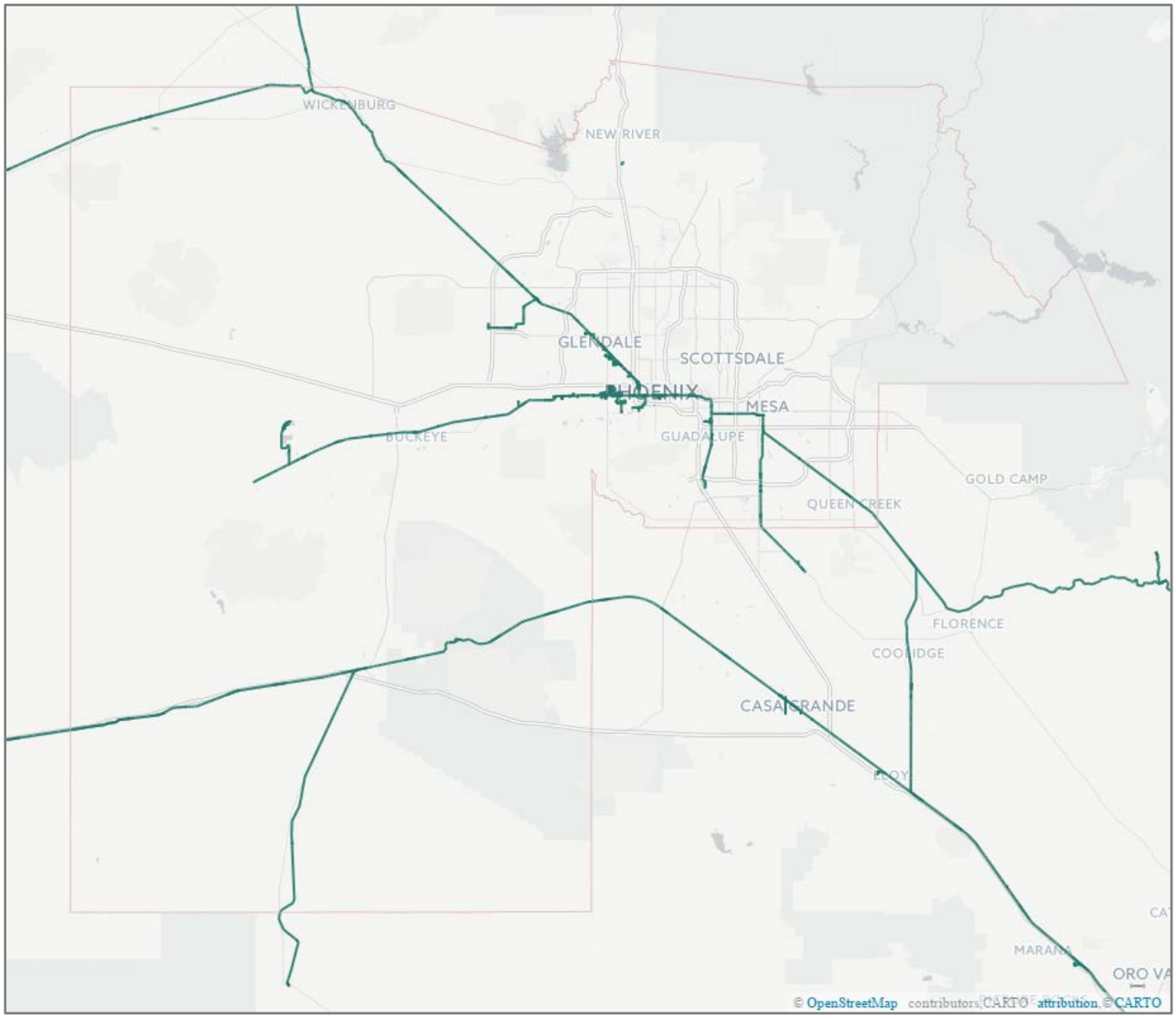
Location	Major Export Market
I-19 Nogales to Tucson Corridor	Mexico, Tucson
I-10/I-8 Tucson to Phoenix Corridor	Phoenix, Tucson, Dallas, Houston, El Paso, San Antonio, Los Angeles, San Diego
I-11 (US 93) Phoenix to Las Vegas Corridor	Phoenix, Las Vegas, Reno, Salt Lake
I-17 Phoenix to Flagstaff Corridor	Phoenix, Albuquerque, Denver
I-10 California to Phoenix Corridor	Los Angeles, San Diego, Phoenix, Tucson
I-10 Tucson to New Mexico Corridor	Phoenix, Tucson, Dallas, Houston, El Paso, San Antonio

Source: Parsons Brinckerhoff, "Arizona's Key Commerce Corridors," Arizona Department of Transportation, March 2014, https://www.azdot.gov/docs/default-source/planning/arizona-key-commerce-corridors-final-report.pdf?sfvrsn=0.

4.2 RAIL

The two primary railroads in Maricopa County are owned by Union Pacific Railroad (UP) and by BNSF. The Arizona & California Railroad (Rail America Corp) also operates on railroad located in the northwest part of the county, as shown in Figure 4. The location of these rail lines amidst the metropolitan area (which historically grew up around them) leads to a significant number of points where local roads cross rail lines at grade, as Figure 5 depicts. Grade crossings present a safety risk that is and can be mitigated in a variety of ways, and lead to traffic delays as trains pass through.

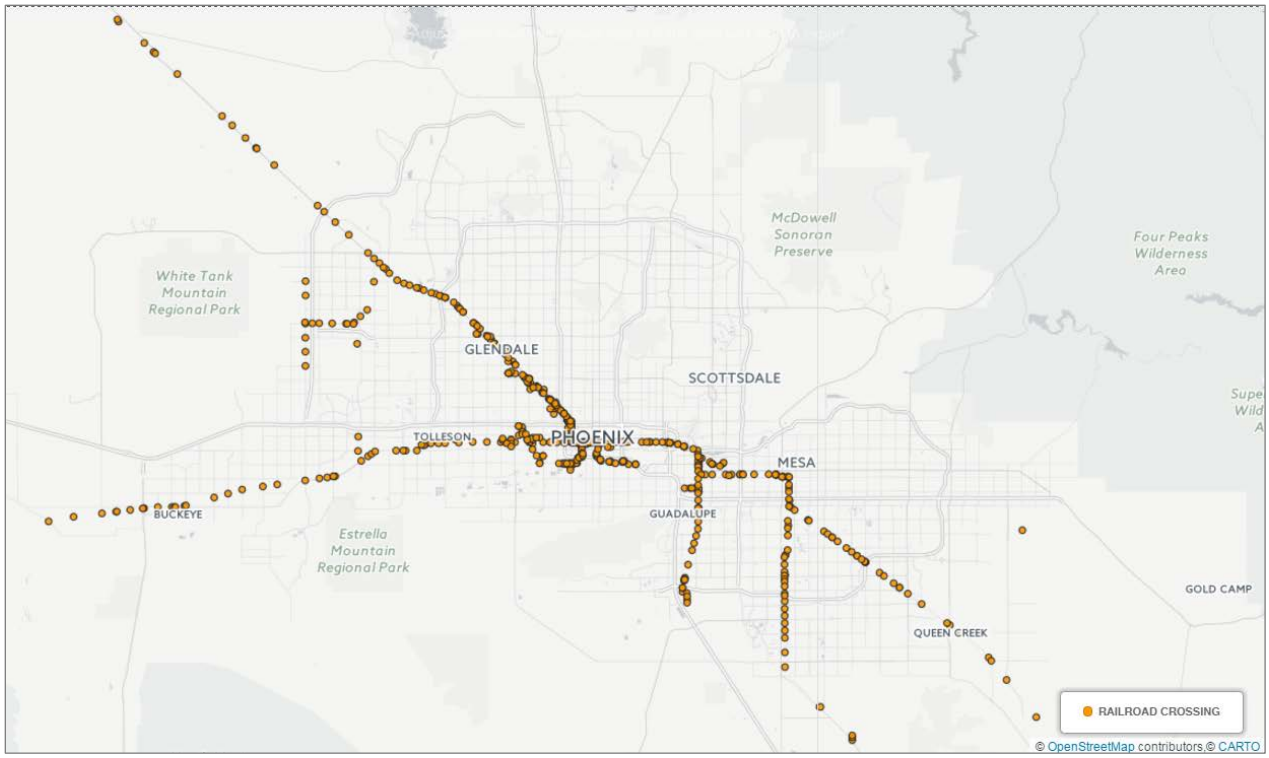
Figure 4: Active Railroads in Maricopa County



Source: Arizona Department of Transportation, Statewide Railroad Map, 2012 https://www.azdot.gov/docs/default-source/utility-and-railroad-engineeing/2012-statewide-railroad-map.pdf?sfvrsn=2; OpenStreetMap.

The UP and BNSF railroads have intermodal facilities located near their respective tracks. In addition to the railroads' facilities, the county is home to other supporting depots and container yards. Figure 5 illustrates the locations of those intermodal facilities and depots within the county (Table 2). The BNSF facility is in Glendale and can be accessed by US 60, which connects to Interstates 10 and 40. The UP facility is located in Phoenix just south of I-10 along with several other depots that are clustered in that area. This clustering can be attributed to the proximity to the railroad, which has spurs to allow for easy freight loading and unloading, and to the proximity to I-10, which is a few miles away. Roads connecting this cluster of facilities to I-10 experience significant truck traffic (as shown later in this report). All of these intermodal facilities are conveniently located to support the movement of goods to and from Mexico and between the west coast (Los Angeles and Long Beach ports) and the Eastern United States.

Figure 5: Railroad Grade Crossings



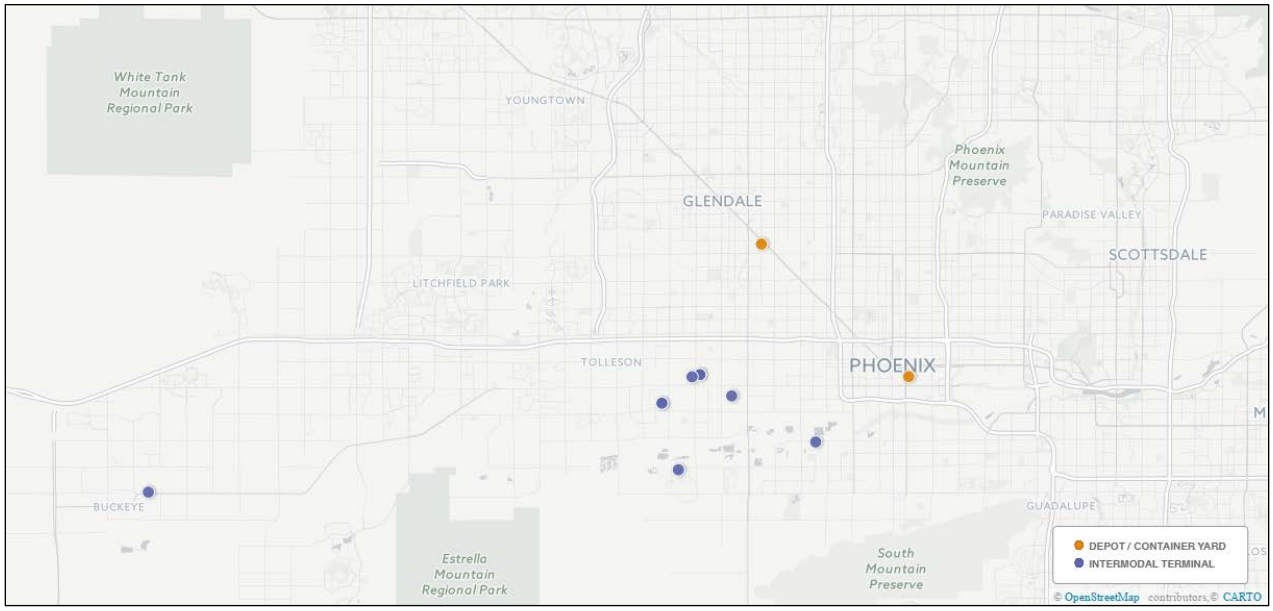
Source: Federal Railroad Administration

Table 2: Rail Intermodal Facilities in Maricopa County

Facility Name	Address	City
BNSF Phoenix – Glendale	5281 Tom Murray Rd	Glendale
UP Phoenix Express	6602 W. Grant St	Phoenix

Source: http://www.loadmatch.com/directory/terminals.cfm?city=PHX

Figure 6: Rail Intermodal and Support Facilities in Maricopa County



Source: Intermodal Association of North America, North American Intermodal Facilities Directory http://www.intermodal.org/information/directories/naifd.php; WSP Research; Mapzen; OpenStreetMap

4.3 AIR

While only 1 percent (by weight) of freight is moved by air through Arizona[4], there is growing demand for air cargo. The Phoenix Sky Harbor International Airport (PHX) is the main freight airport in Maricopa County. It is conveniently located near I-10, which facilitates the movement of cargo between the airport and the region's businesses and logistics facilities. The airport is about three miles east from downtown Phoenix, a central location that reduces drayage (truck connection) distances, allowing goods to be easily moved from the region and shipped to far locations, and vice versa. For example, Arizona produce can go from harvesting to a market in Europe within 48 hours[5], and other goods produced in the MAG region can move just as quickly.

In 2015, PHX originated 143 thousand tons and received 121 thousand tons or air cargo, for a total of 264 thousand tons[6]. A recent air cargo planning study[7] noted that freight and mail air cargo is expected to go from 256 thousand tons in 2012 to over 460 thousand tons in 2033. Based on data from 2012, FedEx and UPS represented about 65 percent of the total air cargo moving through PHX; other air cargo carriers were commercial airlines and DHL, both handling mainly international shipments. As air cargo increases to and from PHX, it is expected that truck drayage traffic along I-10 will also increase proportionately, and other interstate corridors will see increased truck traffic to a lesser degree as trucks spread out to a variety of destinations. These corridors include Interstates 8, 19, 17, and 40 as cargo is transported to/from San Diego, Mexico, and the Eastern United States, respectively.

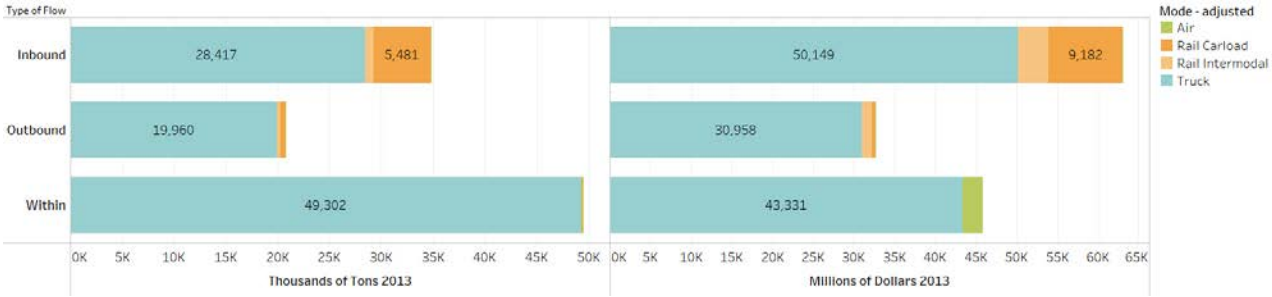
[4] Source: Arizona Forward, "Are we there yet? The Role of Transportation in Driving Arizona's Global Economy," Oct 2012, http://www.arizonaforward.org/ARE_WE_THERE_YET.pdf.
[5] Source: Arizona Forward, "Are we there yet? The Role of Transportation in Driving Arizona's Global Economy," Oct 2012, http://www.arizonaforward.org/ARE_WE_THERE_YET.pdf.
[6] Source: Phoenix Sky Harbor International Airport, 2016, "Passengers, Cargo, and Aircraft Operations At Phoenix Airports: December 2015", https://skyharbor.com/docs/default-source/pdfs/StatisticsReports/stat-jan-dec-2015.pdf.
[7] Source: InterVISTAS Consulting Group, "Phoenix Regional Air Cargo Planning Study," Phoenix Sky Harbor International Airport, Jan 2014, https://skyharbor.com/docs/default-source/default-document-library/finalreportaircargoplanningstudy.pdf?sfvrsn=2

5 Freight Context

This chapter analyzes commodity and modal flow data to describe the key freight trends and patterns for the MAG region. It relies on the 2013 Transearch database to provide a multimodal overview of freight flows to, from, and within the region, and to delve into additional detail about truck flows in particular. Transearch is produced by IHS Markit from public, private and commercial data sources, including a large, proprietary data sample from motor carriers; it also incorporates rail data from the Surface Transportation Board's Carload Waybill Sample. The result is a comprehensive description of county-to-county freight traffic flows throughout the U.S. in terms of the annual tonnage and value of goods shipped by truck, rail, water and air. It provides commodity detail at the 2-digit and 4-digit level of the Standard Transportation Commodity Code (STCC), which contains scores of commodity groups. Domestic, cross-border and the U.S. inland portion of international marine shipments are encompassed, and all traffic is forecast to 2045 in the same detail as the 2013 base year. In addition, for the MAG region commodity flows by truck are disaggregated to traffic analysis zones to improve local analysis of truck routing and traffic clusters. The Transearch data and forecast presented here are the same resource relied upon by ADOT for the Arizona state freight plan.

In 2013, the Maricopa County originated and received 105.1 million tons of freight valued at 141.8 billion dollars (see Figure 7). As can be seen in Figure 8, most of this freight was moved by truck, which accounts for 92.9 percent of tons and 87.8 percent of value. As will be seen below, the majority of these tonnages were non-metallic minerals. Rail played a specific function in bringing freight to the region, accounting for 7.2 million tons in 2013. Rail as a whole was responsible for 6.8 percent of all tonnages and 10.3 percent of value. In particular, intermodal rail freight represented 1.1 percent of all tonnages and 3.5 percent of value. Even though the air mode did not carry a large quantity of tons, it was used extensively in the movement of higher value commodities that are particularly important to the county.[8] (The air mode in the MAG Transearch data incorporates truck drayage on the ground to and from the regional airport as a stand-in for air cargo.)

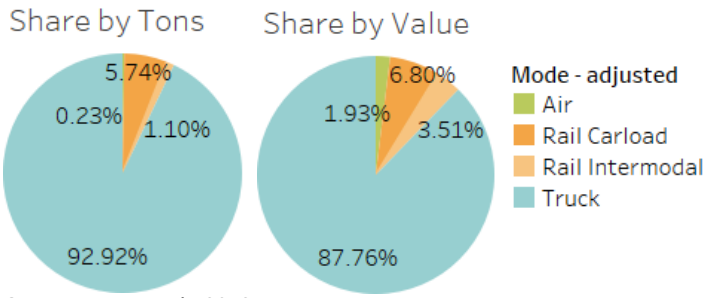
Figure 7: Freight Flow Overview, 2013



Source: Transearch, 2013

[8] For domestic shipments, the air mode considers movements of cargo by air with truck drayage. For international shipments, the air moves are separate from truck drays, but international air cargo coverage is limited to trade with Canada and Mexico.

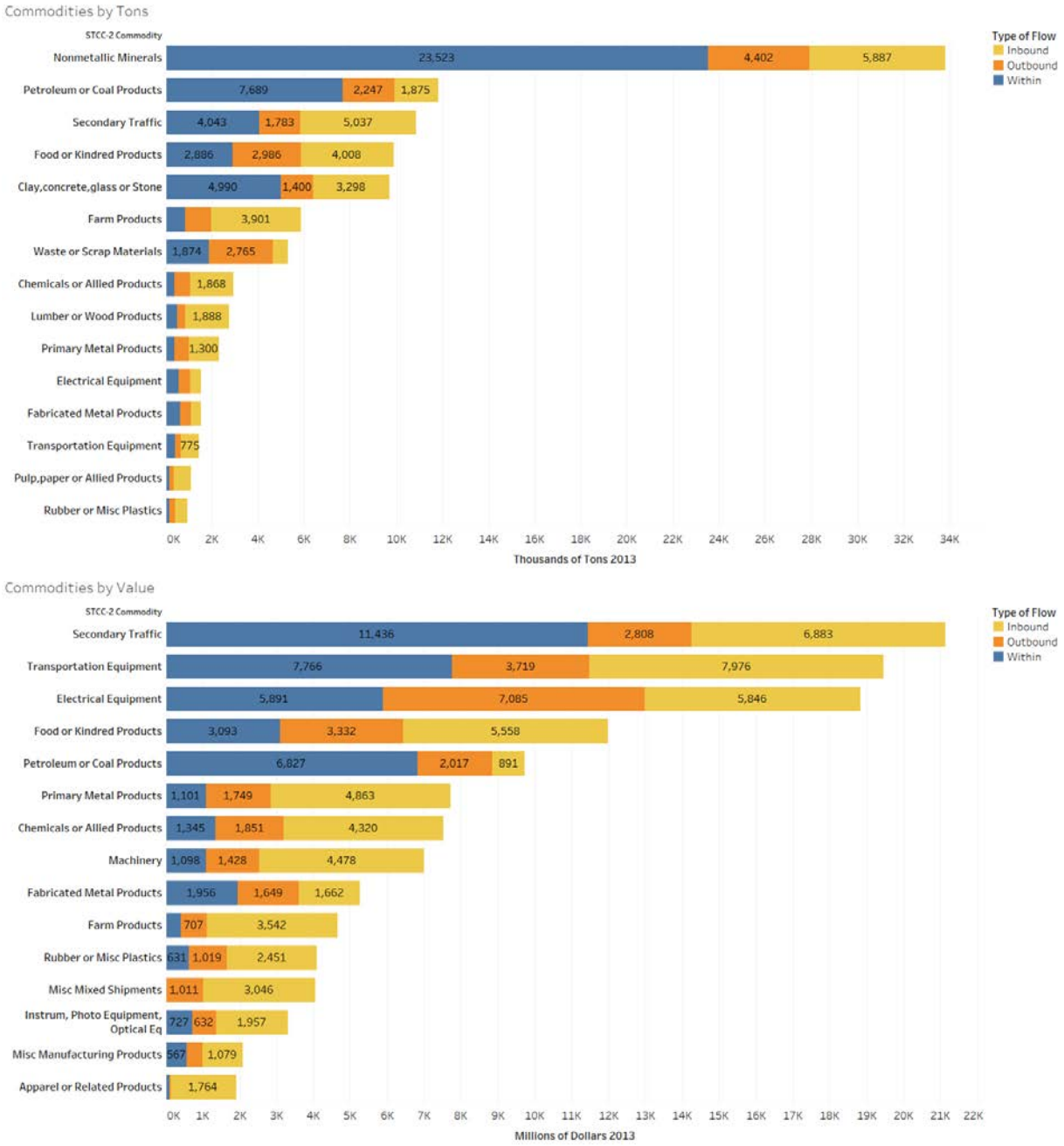
Figure 8: Mode Share, 2013



Source: Transearch, 2013

Defining a freight network requires an understating of the main commodities moved on regional roads. A breakdown of the major commodity flows in terms of physical volume (tonnage) is presented in Figure 9. The main commodity flows were 23.5 million tons of non-metallic minerals moving within Maricopa County, 7.7 million tons of petroleum or coal products moving within the county, 5.9 million tons of non-metallic minerals moving to the county, 5.0 million tons of secondary traffic moving to the county, and 5.0 million tons of clay, concrete, glass or stone products moving within the county. (Secondary traffic is mostly shipments from warehouses and distribution centers, but also reflects drayage for rail intermodal terminals.) Commodities such as non-metallic minerals and petroleum or coal products primarily have origins and destinations within the county, while farm products were shipped primarily to the county.

Figure 9: Top 15 Commodities by Flow Type, 2013



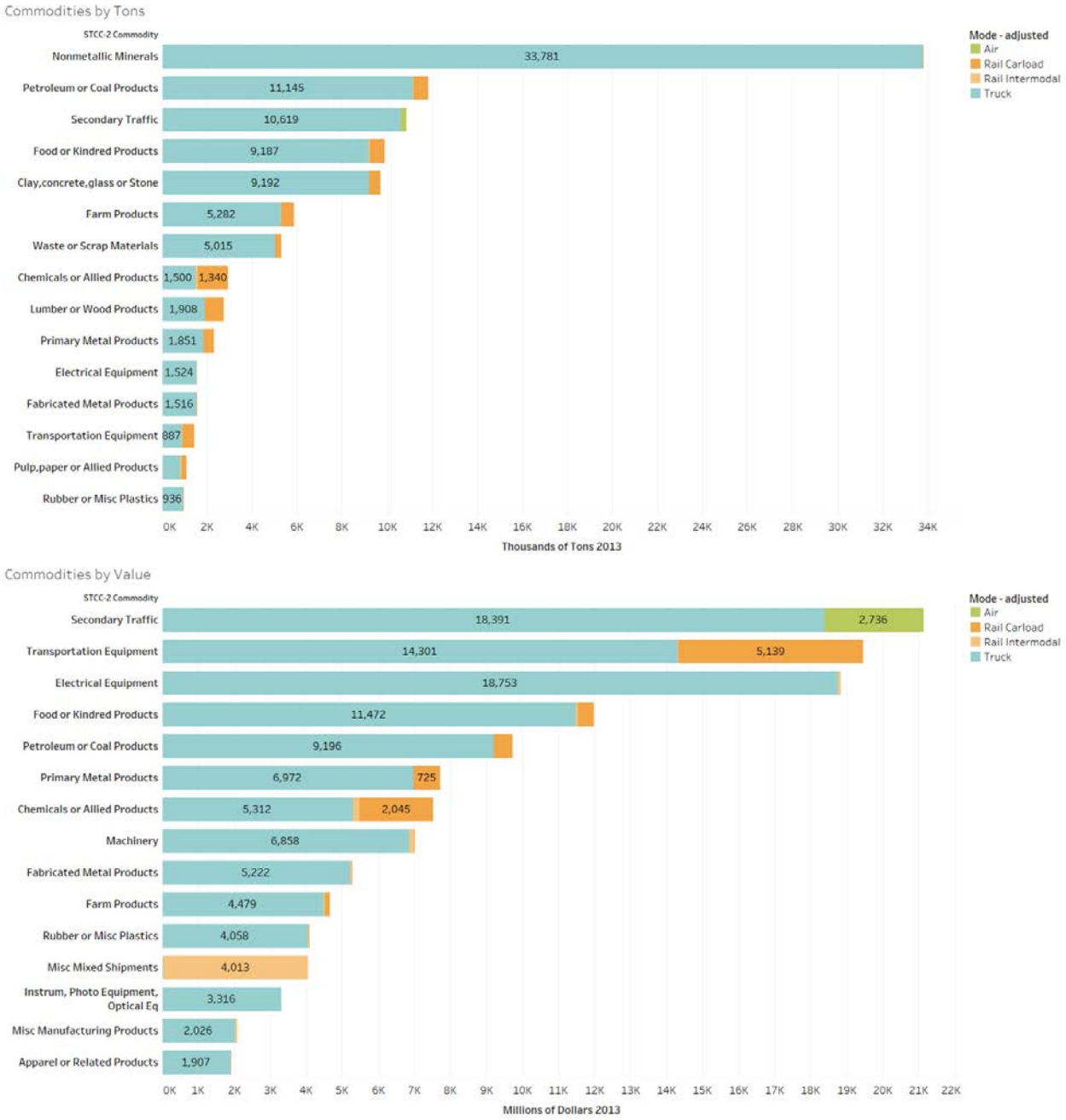
Source: Transearch, 2013

As can be seen in Figure 9, Maricopa County produces several high-value commodities such as electrical and transportation equipment. Petroleum or coal products are some of the commodities where the county originated more shipments in value terms than it received. Transportation equipment, machinery, primary metal products, and farm products are some of the commodities that are predominantly delivered to the county. Electrical equipment, the most valuable commodity within the county by value per ton, is relatively balanced with respect to origins and destinations within the county. This information should be taken into account when designating critical routes that connect to industry clusters that might not generate high amounts of tonnage (and therefore truck trips), but nonetheless are responsible for a high proportion of

the value shipped. The value of the shipment can be interpreted as relating to the value of the goods to the broader economy and consumers. These shipments in particular are especially costly to encumber with congestion and unreliability in the network.

For these 15 top commodities, Figure 10 shows the breakdown of flows by mode. In terms of tonnage, trucking is by far the dominant mode, except for chemical or allied products which are equally distributed between truck and rail modes. Other commodities transported by rain include lumber or wood products, farm products, mixed shipments and food or kindred products.

Figure 10: Top 15 Commodities by Mode, 2013



Source: Transearch, 2013

5.1 TRUCKING DETAIL

The Transearch database offers additional details about freight moving by truck. Table 3 shows total truck activity broken down by service type: less-than-truckload (LTL), truckload (TL), and private (PVT). LTL service represents trucks that carry smaller shipments (the industry average is around 1,000 pounds) for multiple customers simultaneously, and involves consolidation and deconsolidation at cross-dock terminals. TL service represents trucks that are hired by a specific shipper to carry only their products, between specific origins and destinations. These could represent urban deliveries to stores or interstate shipments, for example. Finally, Transearch uses unique data sources to estimate private trucking activity, which involves vehicles owned by the shippers themselves; the Walmart fleet is one of the largest in the country and offers a familiar example of private trucking.

As can be seen in Table 3, the majority of truck shipments (61.9 percent) have both an origin and destination within Maricopa County. Private trucks are used with a higher frequency in this local market segment than elsewhere, as is typical around the country. Inbound shipments represent 21.3 percent of truck shipments, while outbound shipments represent the remaining 16.9 percent. There are more inbound shipments than outbound shipments because of the structure of the local economy. Inbound shipments are primarily products for local consumption, which tend to be higher in value. On average, inbound shipments have a value of $1,800/ton while outbound shipments have a value of $1,560/ton. Higher value goods tend to be transported by LTL service, which on average have value of $3,600/ton.

Table 3: Truck Flow Overview, 2013

		Tons	Units	M USD	% Tons	% of Units	% of USD
Within	Truck L-T-L	217,945	34,613	1,124	0.2%	0.4%	0.9%
	Truck PVT	20,310,302	2,091,030	15,062	20.7%	25.9%	11.8%
	Truck Truckload	28,996,326	2,858,864	29,638	29.6%	35.5%	23.3%
	Subtotal	49,524,573	4,984,507	45,824	50.6%	61.9%	36.0%
Inbound	Truck L-T-L	399,380	21,643	1,048	0.4%	0.3%	0.8%
	Truck NEC	1,855,851	131,921	6,220	1.9%	1.6%	4.9%
	Truck PVT	10,977,196	651,415	15,072	11.2%	8.1%	11.9%
	Truck Truckload	15,194,167	910,084	27,913	15.5%	11.3%	21.9%
	Subtotal	28,426,593	1,715,063	50,254	29.0%	21.3%	39.5%
Outbound	Truck L-T-L	291,228	16,157	1,128	0.3%	0.2%	0.9%
	Truck NEC	347,034	31,309	3,005	0.4%	0.4%	2.4%
	Truck PVT	8,004,889	533,204	8,726	8.2%	6.6%	6.9%
	Truck Truckload	11,329,168	778,142	18,239	11.6%	9.7%	14.3%
	Subtotal	19,972,319	1,358,811	31,098	20.4%	16.9%	24.5%
Grand Total		97,923,485	8,058,382	127,175	100.0%	100.0%	100.0%

Source: Transearch 2013

Inbound and outbound trucks tend to be larger, carrying more tons, than local shipments within the county, and have cargo that is more valuable. A higher proportion of shipments within Maricopa County are performed by smaller single-unit trucks. An average 'within' truck shipment carries approximately 10 tons, while an inbound shipment carries 16.6 tons and an outbound shipment carries 14.7 tons. The weight that trucks carry does not appear to depend on the type of service being provided. LTL trucks carry on average 12.5 tons, private trucks carry on average 11.9 tons, and TL trucks carry on average 12.2 tons. Truckload service represents the largest share of truck shipments, accounting for 57 percent of shipments within Maricopa County, 72 percent of inbound shipments, and 69 percent of outbound shipments.

The types of truck used are shown in Table 4. Dry vans were used in 34 percent of within shipments, 45 percent of inbound shipments, and 38 percent of outbound shipments. Flatbed trucks typically play a significant role supplying the construction trade and were used primarily for within shipments.

Table 4: Truck Type, 2013

	Within		Inbound		Outbound		Total	
	Units	% of Units	Units	% of Units	Units	% of Units	Units	% of Units
Auto	33,808	0.7%	7,930	0.5%	10,492	0.8%	52,230	0.6%
Bulk	826,955	16.6%	311,850	18.2%	258,124	19.0%	1,396,928	17.3%
Dry Van	1,669,061	33.5%	771,325	45.0%	509,815	37.5%	2,950,202	36.6%
Flat	1,292,257	25.9%	207,137	12.1%	262,818	19.3%	1,762,213	21.9%
Livestock	675	0.0%	2,445	0.1%	2,813	0.2%	5,933	0.1%
Reefer	257,125	5.2%	197,302	11.5%	134,129	9.9%	588,557	7.3%
Specialty	292,682	5.9%	77,799	4.5%	55,789	4.1%	426,270	5.3%
Tank	611,944	12.3%	139,274	8.1%	124,831	9.2%	876,048	10.9%
Total	4,984,507	100.0%	1,715,063	100.0%	1,358,811	100.0%	8,058,382	100.0%

Source: Transearch 2013

The largest trading partner for Maricopa County is outside of the state is southern California (as can be seen in Table 5 and Table 6). Around 19.1 percent of inbound shipments and 15.8 percent of outbound shipments involve southern California. Many consumer goods imported to Maricopa County enter through the ports in the San Pedro Bay (Los Angeles and Long Beach), which is the primary gateway for imports from Asia. Within Arizona, other counties that receive and ship freight to Maricopa County including: Pinal, Yavapai, Graham and Coconino. In terms of interstate markets, Maricopa County receives a substantial amount of tons from the San Francisco BEA,[9] which includes the Port of Oakland, another key international gateway into the United States. The main interstate recipients of freight originating from Maricopa County are Las Vegas BEA, San Francisco BEA, and San Diego BEA.

[9] BEAs represent metropolitan markets defined as Business Economic Areas.

Table 5: Top 15 Origin Cities Shipping Freight to MAG Region

	Truck L-T-L		Truck PVT		Truck Truckload		Grand Total	
	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons
Pinal County, AZ	3,662	0.9%	2,290,287	20.9%	3,161,442	20.8%	5,455,392	20.5%
California Portion of Los Angeles BEA	87,036	21.8%	2,479,103	22.6%	2,506,893	16.5%	5,073,032	19.1%
San Francisco, CA BEA	34,430	8.6%	846,812	7.7%	881,423	5.8%	1,762,665	6.6%
Pima County, AZ	11,182	2.8%	555,797	5.1%	733,240	4.8%	1,300,219	4.9%
Yavapai County, AZ	1,452	0.4%	436,967	4.0%	342,419	2.3%	780,838	2.9%
Graham County, AZ	92	0.0%	198,532	1.8%	368,054	2.4%	566,678	2.1%
Coconino County, AZ	3,697	0.9%	226,833	2.1%	280,419	1.8%	510,949	1.9%
Gila County, AZ	201	0.1%	217,311	2.0%	250,599	1.6%	468,112	1.8%
New Mexico Portion of Albuquerque BEA	3,465	0.9%	202,419	1.8%	225,057	1.5%	430,941	1.6%
Los Angeles County, CA	7,166	1.8%	176,491	1.6%	245,683	1.6%	429,339	1.6%
Fresno, CA BEA	6,768	1.7%	165,297	1.5%	242,384	1.6%	414,449	1.6%
Texas Portion of Dallas BEA	15,495	3.9%	131,948	1.2%	257,648	1.7%	405,092	1.5%
Utah Portion of Salt Lake City BEA	10,239	2.6%	143,150	1.3%	245,562	1.6%	398,951	1.5%
San Diego, CA BEA	6,910	1.7%	182,634	1.7%	189,194	1.2%	378,738	1.4%
Yuma County, AZ	1,752	0.4%	143,893	1.3%	224,981	1.5%	370,627	1.4%
Total All Origins	399,380	100.0%	10,977,196	100.0%	15,194,167	100.0%	26,570,742	100.0%

Source: Transearch 2013

Table 6: Top 15 Destination Cities Receiving Freight from MAG Region

	Truck L-T-L		Truck PVT		Truck Truckload		Grand Total	
	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons
Pinal County, AZ	6,748	2.3%	1,314,275	16.4%	2,137,278	18.9%	3,458,301	17.6%
California Portion of Los Angeles BEA	61,452	21.1%	1,204,973	15.1%	1,833,240	16.2%	3,099,665	15.8%
Yavapai County, AZ	2,729	0.9%	733,679	9.2%	1,156,588	10.2%	1,892,997	9.6%
Pima County, AZ	10,370	3.6%	591,428	7.4%	755,246	6.7%	1,357,045	6.9%
Nevada Portion of Las Vegas BEA	12,897	4.4%	356,780	4.5%	477,298	4.2%	846,975	4.3%
San Francisco, CA BEA	17,432	6.0%	228,624	2.9%	382,134	3.4%	628,190	3.2%
San Diego, CA BEA	8,290	2.8%	226,029	2.8%	338,506	3.0%	572,824	2.9%
Coconino County, AZ	2,006	0.7%	235,272	2.9%	258,828	2.3%	496,107	2.5%
Cochise County, AZ	762	0.3%	199,221	2.5%	226,909	2.0%	426,892	2.2%
Detroit, MI BEA	1,054	0.4%	388,388	4.9%	24,705	0.2%	414,146	2.1%
Gila County, AZ	1,115	0.4%	165,864	2.1%	207,359	1.8%	374,338	1.9%
Colorado Portion of Denver BEA	9,846	3.4%	151,691	1.9%	186,734	1.6%	348,271	1.8%
Utah Portion of Salt Lake City BEA	7,592	2.6%	105,187	1.3%	198,679	1.8%	311,458	1.6%
Mohave County, AZ	2,305	0.8%	125,508	1.6%	170,256	1.5%	298,069	1.5%
Los Angeles County, CA	6,746	2.3%	117,469	1.5%	135,466	1.2%	259,681	1.3%
Total All Destinations	291,228	100.0%	8,004,889	100.0%	11,329,168	100.0%	19,625,285	100.0%

Source: Transearch 2013

Table 7 and Table 8 summarize the origins and destinations of shipments at a state level. Around 38.3 percent of shipments heading to Maricopa County originated in Arizona. The in-state fraction is higher for outbound trips—around 46.7 percent are destined to a county in Arizona. Many of these shipments will rely extensively on state routes and arterials. For interstate shipments, California is the most important origin of truck shipments outside of the state, representing almost four times more tons per year than

Texas, the second largest originator of interstate tons. A similar pattern is observed in outbound shipments (Table 8), although interstate shipments overall play a smaller role than intra-state shipments.

Table 7: Top 10 States Originating Truck Shipments Destined to MAG Region

	Truck L-T-L		Truck PVT		Truck Truckload		Grand Total	
	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons
Arizona	29,768	7.5%	4,285,574	39.0%	5,857,711	38.6%	10,173,053	38.3%
California	147,729	37.0%	4,061,165	37.0%	4,384,341	28.9%	8,593,236	32.3%
Texas	51,670	12.9%	557,259	5.1%	1,082,677	7.1%	1,691,605	6.4%
New Mexico	5,970	1.5%	424,271	3.9%	445,478	2.9%	875,718	3.3%
Utah	10,750	2.7%	159,244	1.5%	275,493	1.8%	445,487	1.7%
Washington	10,053	2.5%	129,618	1.2%	282,965	1.9%	422,636	1.6%
Oregon	12,305	3.1%	137,698	1.3%	267,466	1.8%	417,470	1.6%
Colorado	7,436	1.9%	122,276	1.1%	217,702	1.4%	347,414	1.3%
Nevada	14,729	3.7%	95,614	0.9%	196,003	1.3%	306,347	1.2%
Wyoming	363	0.1%	149,262	1.4%	155,829	1.0%	305,455	1.1%
Grand Total	399,380	100.0%	10,977,196	100.0%	15,194,167	100.0%	26,570,742	100.0%

Source: Transearch 2013

Table 8: Top 10 States Receiving Truck Freight Originated from MAG Region

	Truck L-T-L		Truck PVT		Truck Truckload		Grand Total	
	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons	Tons	% of Tons
Arizona	32,518	11.2%	3,727,971	46.6%	5,407,048	47.7%	9,167,537	46.7%
California	101,120	34.7%	1,863,592	23.3%	2,871,504	25.3%	4,836,216	24.6%
Texas	35,225	12.1%	342,373	4.3%	562,292	5.0%	939,890	4.8%
Nevada	15,187	5.2%	389,639	4.9%	522,824	4.6%	927,650	4.7%
New Mexico	11,886	4.1%	184,760	2.3%	280,260	2.5%	476,905	2.4%
Michigan	1,572	0.5%	401,642	5.0%	35,645	0.3%	438,859	2.2%
Colorado	10,574	3.6%	183,279	2.3%	214,380	1.9%	408,233	2.1%
Utah	8,435	2.9%	126,423	1.6%	234,438	2.1%	369,295	1.9%
Washington	9,037	3.1%	79,149	1.0%	137,819	1.2%	226,005	1.2%
Oregon	6,115	2.1%	44,613	0.6%	110,061	1.0%	160,790	0.8%
Grand Total	291,228	100.0%	8,004,889	100.0%	11,329,168	100.0%	19,625,285	100.0%

Source: Transearch 2013

5.2 TRUCK FORECAST

Truck shipments are forecast to see robust growth out to 2045, according to Transearch estimates. Tons are projected to grow at 2.3 percent per year on average, leading to a doubling of truck trips from 8.1 million in 2013 to 16.2 million in 2045. These large increases in freight activity will have substantial impacts on the roadway network as discussed below. In real terms, value shipped by trucking is expected to grow more quickly than tonnage, at 3.5 percent per year, leading to almost a tripling of the value

shipped by truck by 2045. As can be seen in Table 9, units, tons, and value are expected to grow much quicker for inbound shipments than for outbound shipments. Within shipments are expected to grow the slowest, at 1.5 percent per year on average.

Table 9: Forecasted Growth of Tons, Units and Value, 2013 to 2045

		2013	2045	Average Rate of Growth 2013 to 2045
Inbound	Tons	28,426,593	93,117,997	3.8%
	Units	1,715,063	5,234,826	3.5%
	M USD	50,254	159,197	3.7%
Outbound	Tons	19,972,319	37,445,154	2.0%
	Units	1,358,811	2,859,972	2.4%
	M USD	31,098	94,986	3.6%
Within	Tons	49,524,573	74,752,997	1.3%
	Units	4,984,507	8,136,213	1.5%
	M USD	45,824	122,524	3.1%
Total Related to Maricopa County	Tons	97,923,485	205,316,149	2.3%
	Units	8,058,382	16,231,010	2.2%
	M USD	127,175	376,707	3.5%

Source: Transearch 2013

The truck type that is expected to grow the quickest is Dry Van, at roughly 3.2 percent per year (see Table 10). This will result in an increase from 3 million trips in 2013 to 8 million trips in 2045. Dry vans are the most versatile kind of truck equipment and tend to handle most consumer goods, so this projection (like the faster growth for inbound shipping) can be viewed as particularly related to population.

Table 10: Forecasted Growth of Truck Shipments by Vehicle Type, 2013 to 2045

	Units 2013	Units 2045	Average Rate of Growth 2013 to 2045
Auto	52,230	86,812	1.6%
Bulk	1,396,928	2,323,560	1.6%
Dry Van	2,950,202	7,971,219	3.2%
Flat	1,762,213	2,873,368	1.5%
Livestock	5,933	8,826	1.2%
Reefer	588,557	1,198,290	2.2%
Specialty	426,270	905,754	2.4%
Tank	876,048	863,180	0.0%
Total	8,058,382	16,231,010	2.2%

Source: Transearch 2013

In 2013, exports (by truck to international destinations) accounted for only 340 million tons, less than half of imports which totaled 740 million tons (Table 11). However, exports are expected to grow at an exceptional rate of 7.5 percent per year, leading exports to overcome imports by 2045 when exports are expected to reach 3.4 billion tons. Imports are also expected to grow quickly in tons, at 4.5 percent per year, but not as fast as exports.

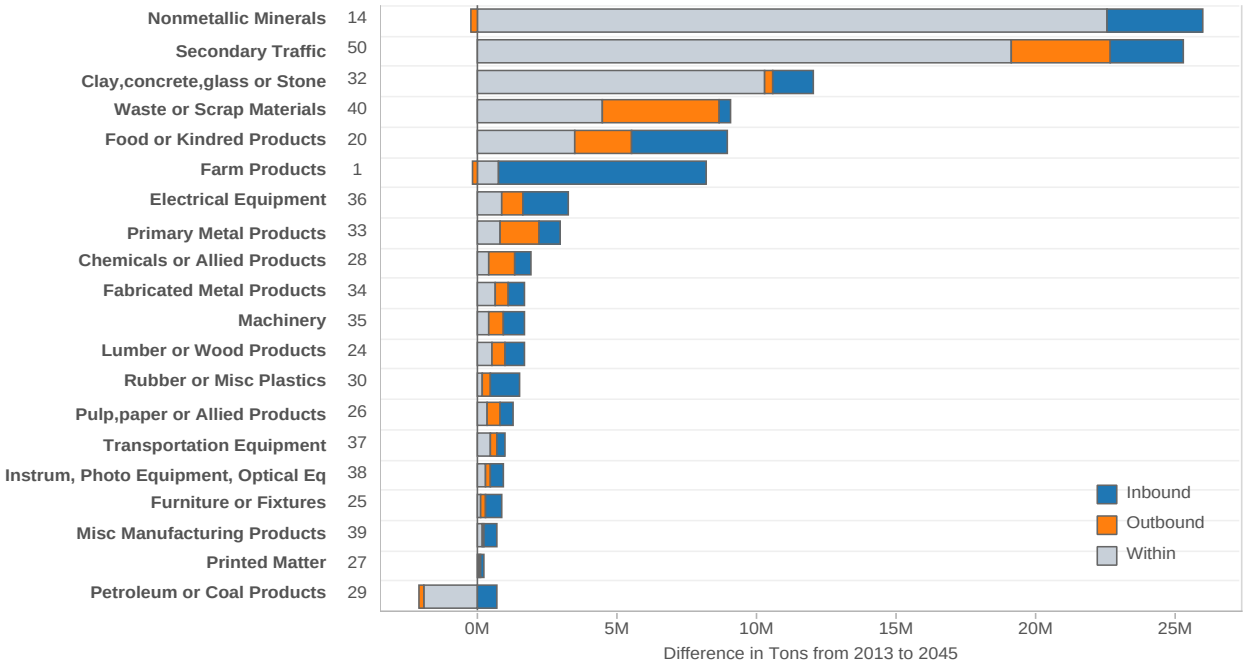
Table 11: Forecasted Growth in Tons and Value Shipped by Truck by Trade Type, 2013 to 2045

	Tons			M USD		
	2013	2045	Average Growth Rate 2013 to 2045	2013	2045	Average Growth Rate 2013 to 2045
Domestic	94,639,373	187,782,150	2.2%	110,988	292,413	3.1%
Export	342,891	3,429,026	7.5%	891	9,917	7.8%
Import	738,335	3,037,219	4.5%	6,072	24,799	4.5%
NAFTA	2,202,885	11,067,754	5.2%	9,225	49,577	5.4%
Total	97,923,485	205,316,149	2.3%	127,175	376,707	3.5%

Source: Transearch 2013

Modal forecasts for trucking are driven by the expected growth of production and consumption in each commodity and Figure 11 show how truck shipments of specific commodities are forecasted to change. Shipments within Maricopa County of non-metallic minerals, secondary traffic (which represents shipments from distribution centers as well air and rail intermodal drayage), clay/concrete, and waste/ scrap are expected to drive much of the growth in trucking over the coming decades. This is a population-centric profile reflecting construction and household consumption - and most of the increases in the tonnages of these commodities will be shipments within Maricopa County. Farm Products are expected to increase rapidly in absolute terms, but only for inbound shipments. The only commodity group that is expected to decrease is petroleum and coal products, where demographic factors, clean energy and fuel efficiency will affect demand.

Figure 11: Top Growing Commodities (STCC) Shipped by Truck by Tonnage, 2013 - 2045

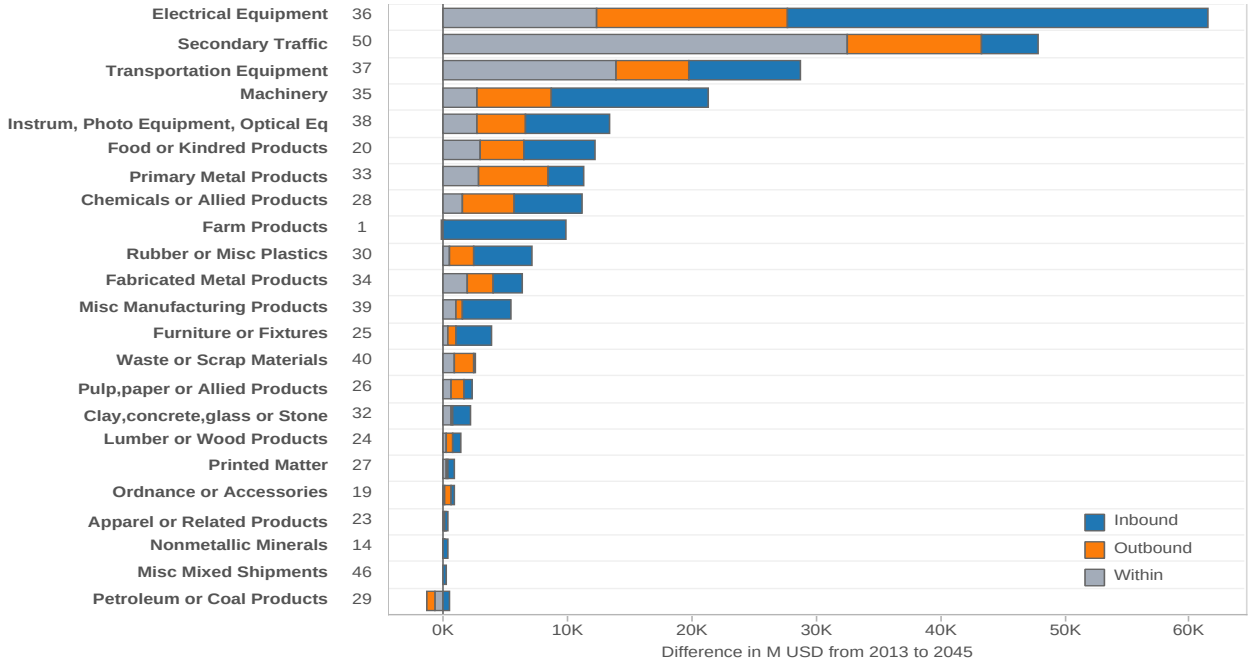


Source: Transearch 2013

Note: Commodities not shown are forecasted to see minimal growth over this time horizon.

Looking at forecasts in terms of tonnage is useful to distill the sectors that are expected to place the highest demands on the infrastructure and other resources, such as energy. Tonnage relates more closely to truck trips. On the other hand, looking at forecasts in terms of value provides a better picture about the sectors of the economy that will place greater demands on the freight system in the future. This information is summarized in Figure 12, which shows that electrical equipment, transportation equipment, machinery, and instruments will drive much of the growth in value moving forward. Growth in shipments from distribution centers (secondary traffic) will occur primarily within Maricopa County.

Figure 12: Top Growing Commodities (STCC) Shipped by Truck by Value, 2013 - 2045



Source: Transearch 2013

Note: Commodities not shown are forecasted to see minimal growth over this time horizon.

6 Industrial, Logistics and Manufacturing Clusters

The definition of a freight network depends critically on the spatial distribution of economic activity in the region. While previous chapters discussed freight flows by different commodity types, this chapter delves into additional sources of information to uncover the specific industries in the MAG region that demand freight transportation. The freight network should seek to connect clusters of these industries so that products can access a wide range of local, domestic and international markets. The MAG region has several industrial clusters that are critical generators of local employment and revenues. Ensuring that these clusters remain competitive and grow is a key economic development priority of the region. The freight network should also serve the needs of the logistics sector as it brings consumer goods to the people of the region. For goods that are shipped into the region, which is a large proportion, the prices that residents pay at stores are affected by logistics costs. Therefore, the freight network should be responsive to the location of these diverse sets of economic activities.

In order to understand the spatial distribution of economic activity it is necessary to consider various sources of information, because no data source exists that perfectly describes the shipping activity of individual firms. Truck Annual Average Daily Traffic (AADT) estimates from local roadside classification counts and demand models provide an idea of the routes and corridors that are used more intensively by trucks, but they don't describe where trucks actually travel to or from. The American Transportation Research Institute (ATRI) truck route data (presented below) contains valuable information about the origins and destinations of a specific set of truck shipments, but these findings cannot be interpreted as necessarily representative because they only capture trucks with satellite tracking devices that participate in the ATRI program. These tend to be large fleets engaged in longer distance trucking and some rail intermodal drayage, which represent a subset of all trucking activity. The Transearch route assignment (presented further below) provides another perspective; it covers a large set of commodity flows and utilizes selection logic that mirrors the routing software motor carriers use to dispatch their trucks. In that sense, it offers a strong estimate, but the routes nevertheless derive from a model.

A key source of information that complements the analyses described so far is looking at the different uses of land throughout the region. This chapter discusses where industrial and logistics activity is concentrated, focusing on the specific clusters that have been identified previously, and allows the network to support the interdependencies between firms. Finally, data is also mapped that shows the location of area that has the potential to be developed. This is essential to ensure that the freight network can accommodate future growth in economic activity and freight movement.

6.1 EXISTING INDUSTRIAL CLUSTERS

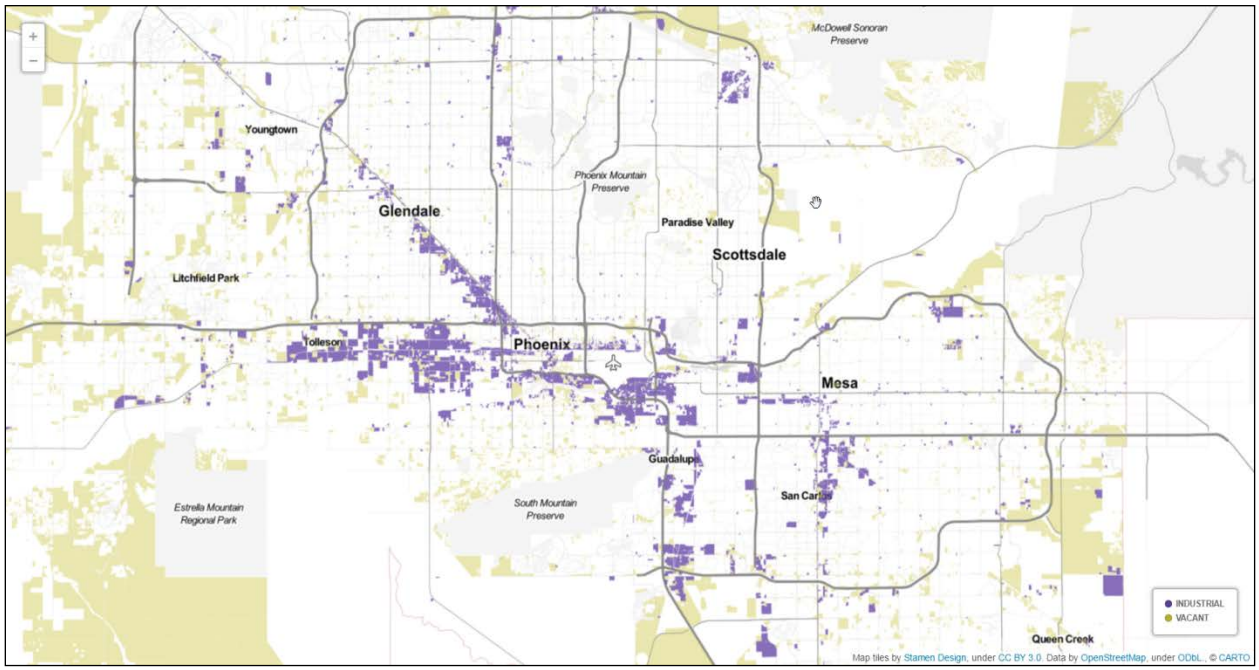
Robust industrial clusters help drive the economic prosperity of the MAG region. In this analysis, a cluster is defined as a geographic concentration of industrial and logistics establishments where business is conducted, jobs are located, and freight is generated and consumed. These establishments are engaged in the production and distribution of goods by a variety of means. They account for the principal freight-dependent sectors of the regional economy, with the exception of the retail trade. Freight is a lifeline to the retail business and the population it serves, but because retail districts frequently are situated alongside residential areas where trucks may not be welcome, this analysis considers them separately (under commercial land use, below). Data presented in this section was provided by MAG and is of two types: land use data for areas classified as industrial, and business establishment data for freight-dependent types: manufacturing, construction, resource-dependent activities, and transportation and distribution.

Underlying the location of industries is an ecosystem of interrelations between firms. While this analysis does not delve into such relationships, it is important to recognize their existence for two reasons: first, because a major function of the freight network is to support them, and second because businesses in these groups tend to attract others and create growth. Related firms that co-locate in advantageous areas can leverage embedded strengths in the existing infrastructure, businesses, and services to increase their competitiveness. Often this occurs through regional specializations, where firms pool knowledge and resources to achieve a competitive advantage relative to isolated firms.

Figure 13 shows the distribution of industrial land throughout the MAG region. A previous internal MAG study has already segmented this land into the following industry clusters

- Deer Valley: Cluster in the northeast quadrant of the interchange between I-17 and Loop 101.
- North I-17 Corridor: Cluster along I-17, roughly from Union Hills Drive to Northern Avenue.
- Grand Avenue: Cluster along Grand Avenue from Camelback Road to I-10
- South Southwest Phoenix: Corridor immediately south of I-10 between 1st Avenue and 83rd Avenue.
- Sky Harbor Area: Area bounded by the South Southwest Phoenix Cluster on the west, and SR-143. This cluster contains a high proportion of economic activity related to Sky Harbor International Airport. On the north, this corridor is bounded by I-10 and in the south it is bounded by Southern Avenue.
- New Loop 202 Corridor: This is a sub-cluster located within the South Southwest Phoenix Cluster, between 52nd Avenue and 63rd Avenue. This Cluster is home to Knight Transportation, FedEx, and Black Horse Carriers

Figure 13: Industrial Areas, MAG Region

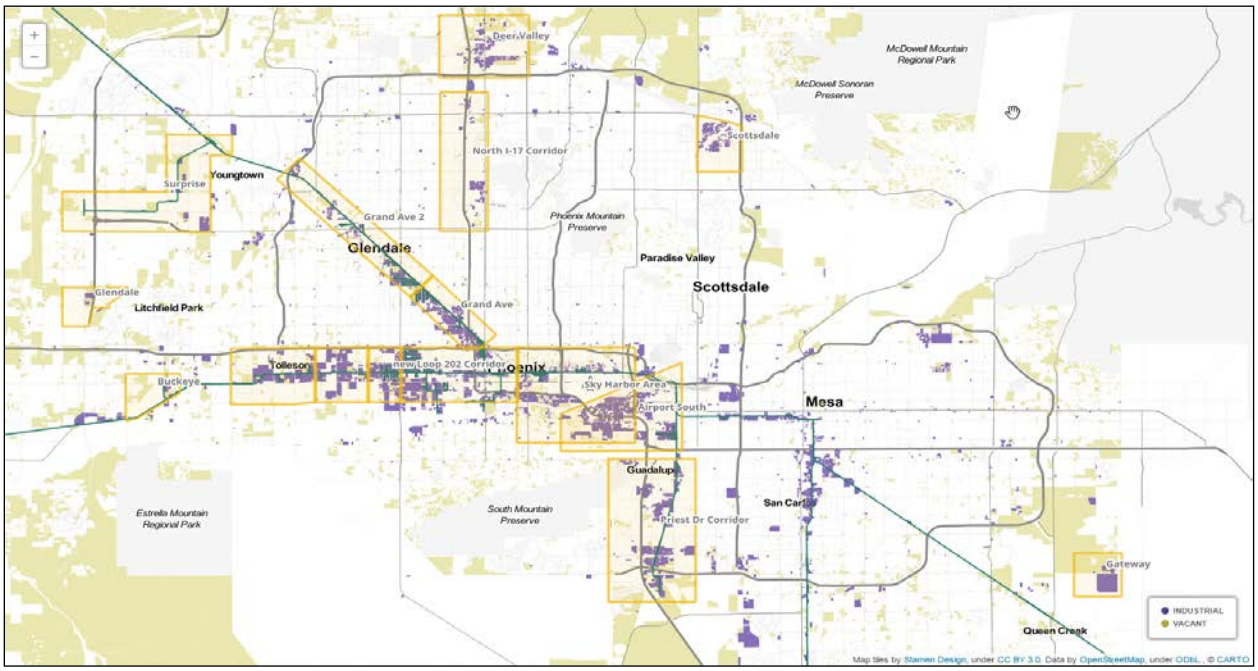


Source: MAG

In Figure 14 the regional industrial clusters are shown with the industrial land areas. A closer map of these clusters can be found in Figure 15. As can be seen, industrial uses have overwhelmingly located

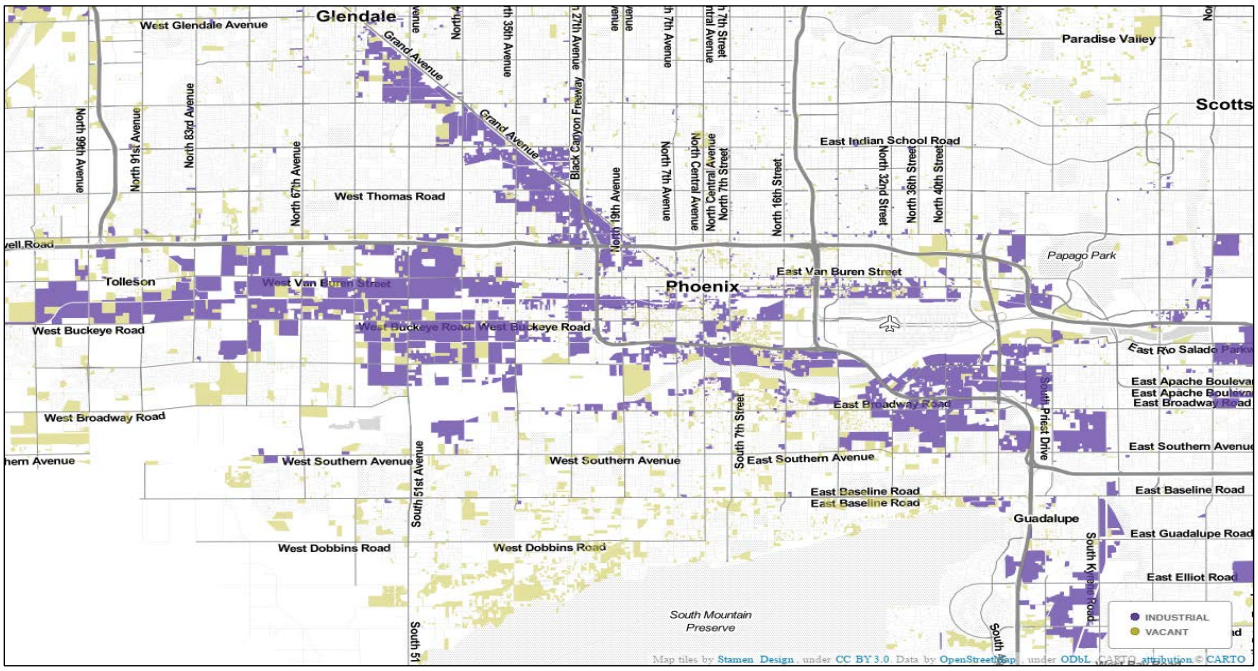
along key regional highways and interstates. The freight network should prioritize roads that provide access to these industrial lands, particularly the clusters identified above.

Figure 14: Industrial Clusters, Urbanized Areas of MAG Region



Source: MAG

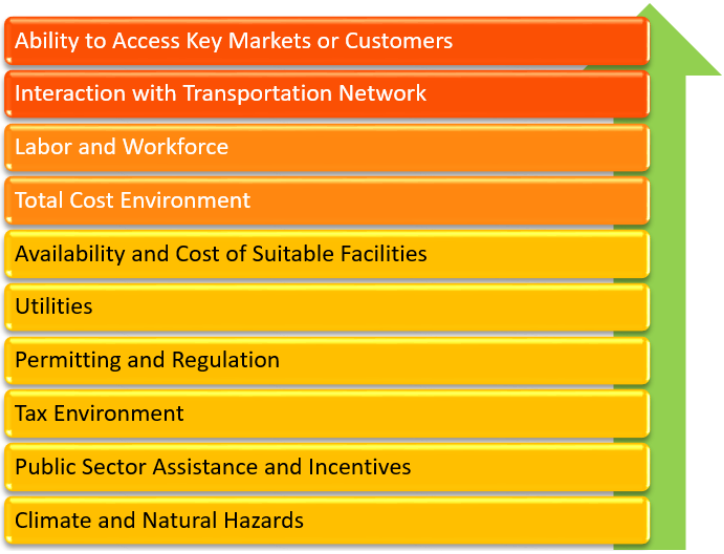
Figure 15: Industrial Area, South Southwest Phoenix and I-10 Corridor



Source: MAG

Many factors influence the location decisions of different industries. Figure 16 shows the factors that influence the location of freight and logistics facilities (including warehouses, distribution centers, and terminals), listed by importance. In this figure, the ability to access markets and customers is ranked by firms as their highest priority, followed by their interaction with the transportation network; access to vendors and suppliers is incorporated in these elements. For manufacturing firms, the criteria are similar, but the availability and quality of the labor force tends to rank higher, and supplier location for the sourcing of production inputs can have a stronger influence.

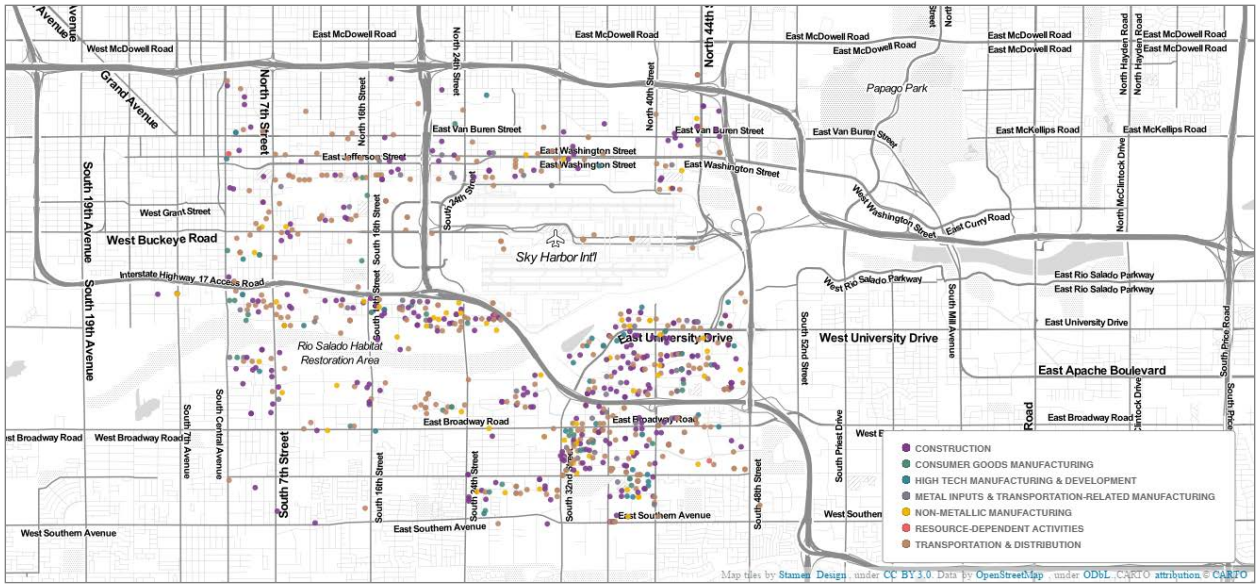
Figure 16: Freight and Logistics Facility Location Criteria



Source: National Freight Cooperative Research Program Report 13 "Freight Facility Location Selection: A Guide for Public Officials"

Employment data was surveyed to identify the types of industries located in two of the key clusters identified above. Figure 17 shows the industries in the Sky Harbor Area cluster. There exists a high concentration of industrial firms between East University Drive and East Roeser Road. These appear to be primarily related to Transportation and Distribution and Construction. A portion of the Transportation and Distribution firms will be facilities for handling shipments passing through Sky Harbor International Airport, although the airport is next to a large warehousing district extending a long way west, which suggests more than one factor is at play. Along I-17 there also appear to be a large number of firms, particularly those involved in distribution activities. Outside of these higher concentration locations, there are many firms located adjacent to Sky Harbor International Airport. The freight network includes adequate access to these locations.

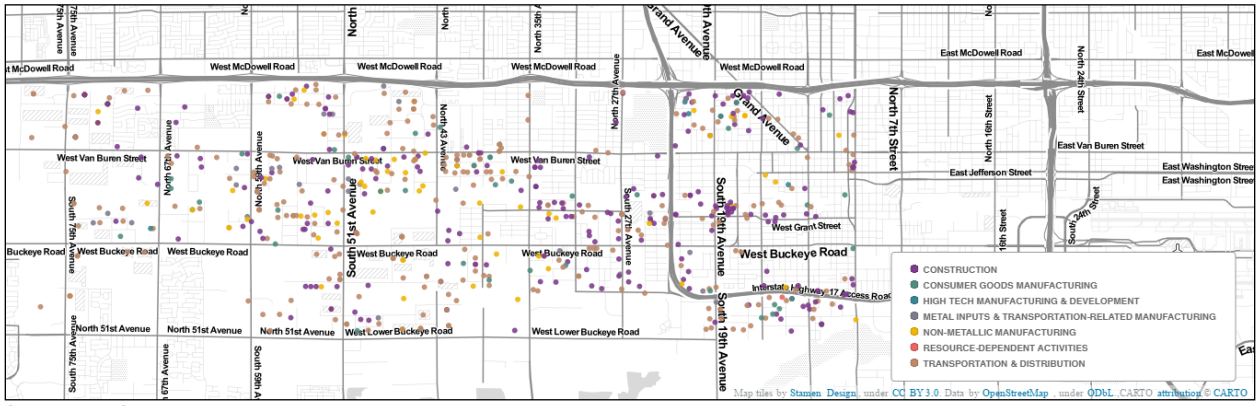
Figure 17: Industrial Uses Adjacent to Sky Harbor International Airport



Source: MAG

The industries located in the South Southwest Phoenix Cluster are shown in Figure 18. The main types of industries located here are non-metallic manufacturing (which indicates various forms of chemicals, paper and printing, and plastics), construction, and transportation and distribution.

Figure 18: Industrial Uses in South Southwest Phoenix

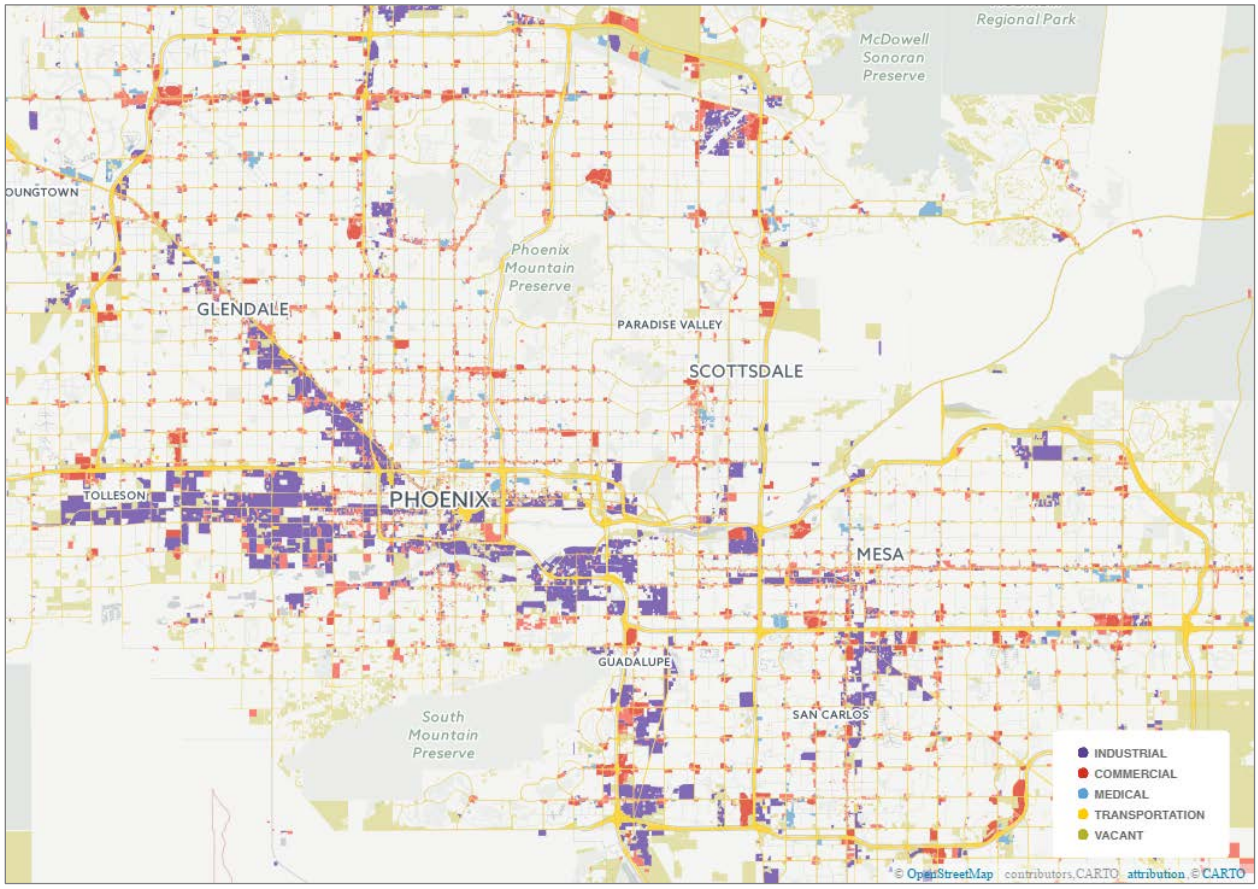


Source: MAG

6.2 COMMERCIAL AND NON-INDUSTRIAL LAND USES

Industrial warehouses and distribution centers include those that supply consumer goods to the retail sector. Because the residents of the MAG region depend on this sector for everyday supplies – food, fuel, clothing, and much more besides - concentrations of the retail trade are crucial areas that the core freight network must be able to serve. They are largely but not entirely destination points, because the rise of retail home delivery is causing stores as well as warehouses to function as fulfillment centers that ship goods into residential neighborhoods. Retailing encompasses shops and malls, but also the restaurants and drinking establishments that are another channel by which food and beverages reach the population. Commercial land use designations capture these locations and are an effective way to display them. Figure 19 shows the distribution of commercial land uses in the region, as well as three others: transportation and medical use, and vacant land. Transportation is needed to round out the capture of logistics activity, although transit facilities are part of this designation; hospital and clinics require continuous supplies of medicines, equipment, linens and food that the freight system must provide. Vacant land is important for future development, as discussed below.

Figure 19: Commercial and Other Uses of Land, Phoenix Metropolitan Region



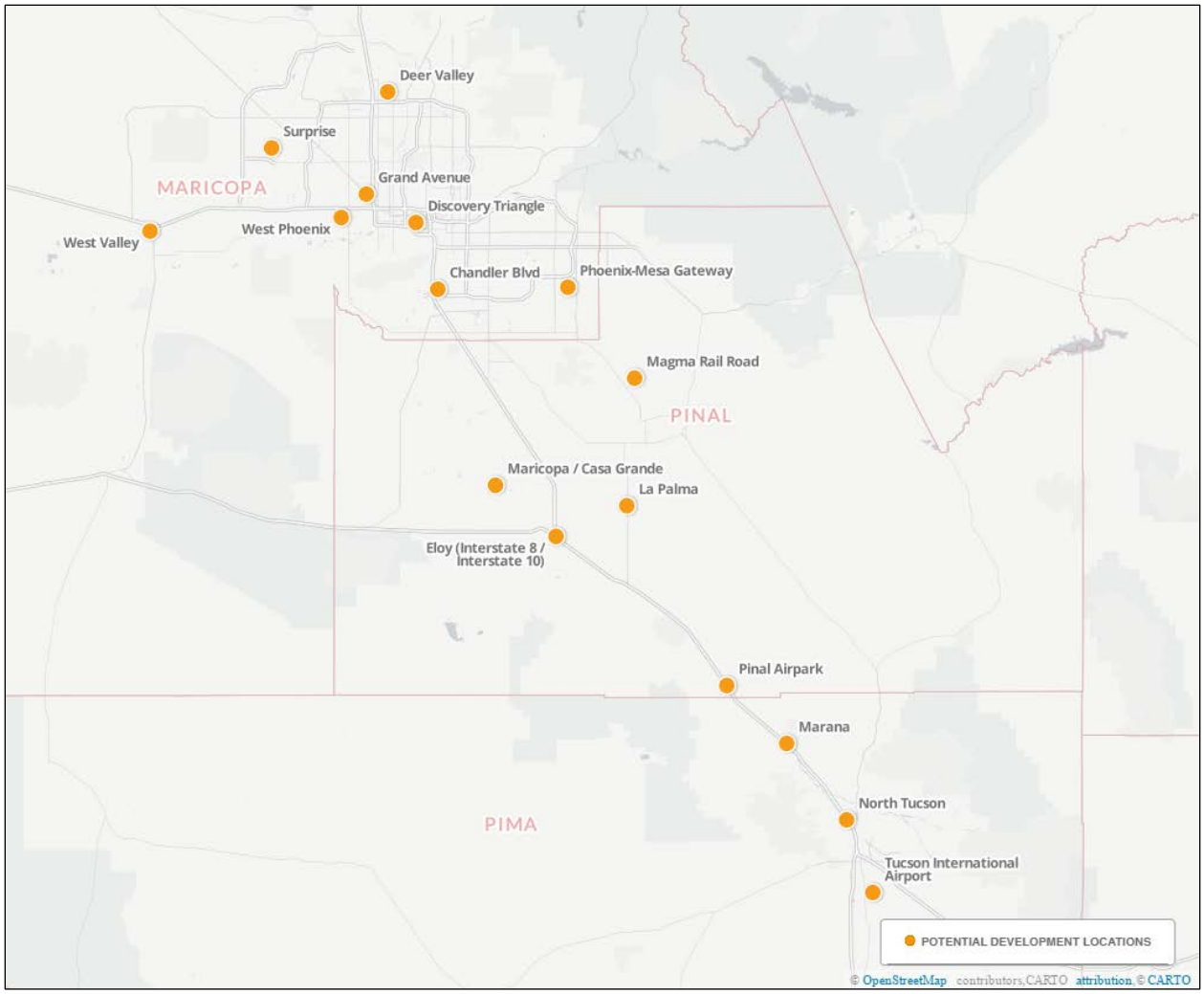
Source: MAG

6.3 DEVELOPMENT POTENTIAL

Economic development depends on and utilizes land in three ways: through new businesses occupying existing sites, through repurposing of existing sites to meet new business needs, and through greenfield development on vacant land. The freight network accommodates the first two by reaching current industrial and commercial land uses, because new development occurs within them. For greenfields, the network should look ahead to site potential, a topic this study will explore extensively in a later phase. This section examines development potential from two perspectives: development areas defined in the Freight Transportation Framework Study that preceded this one, and categories of vacant land.

The Framework Study completed in 2012 identified eight areas with development potential in Maricopa County, plus another eight lying further south in the Sun Corridor, in Pinal and Pima counties. Those in Maricopa County reflect a mixture of new potential in existing sites, and entirely new sites (such as one in the West Valley). Figure 20 displays the location of these areas.

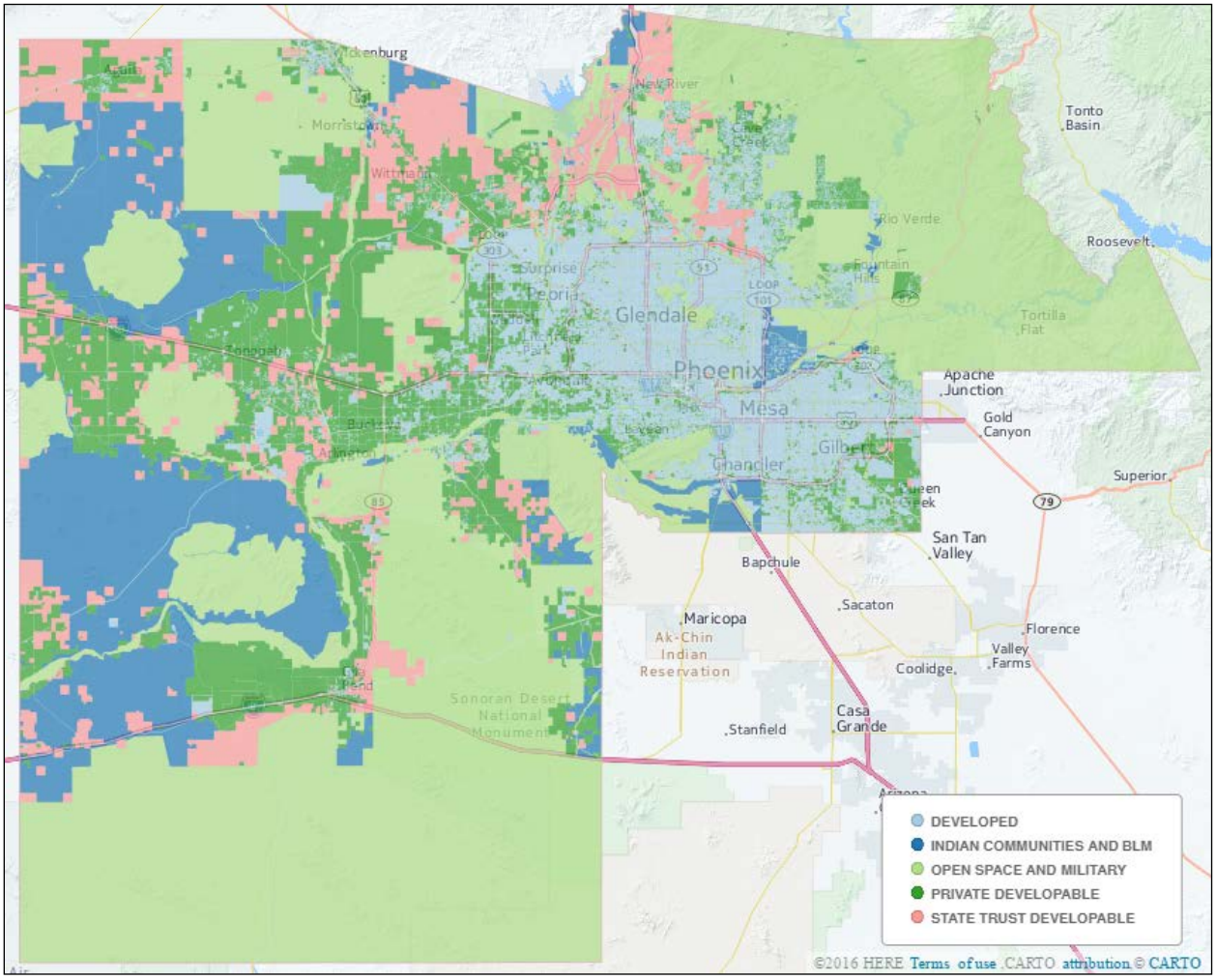
Figure 20: Potential Development Locations



Source: Phase I of the Freight Transportation Framework Study, MAG; WSP

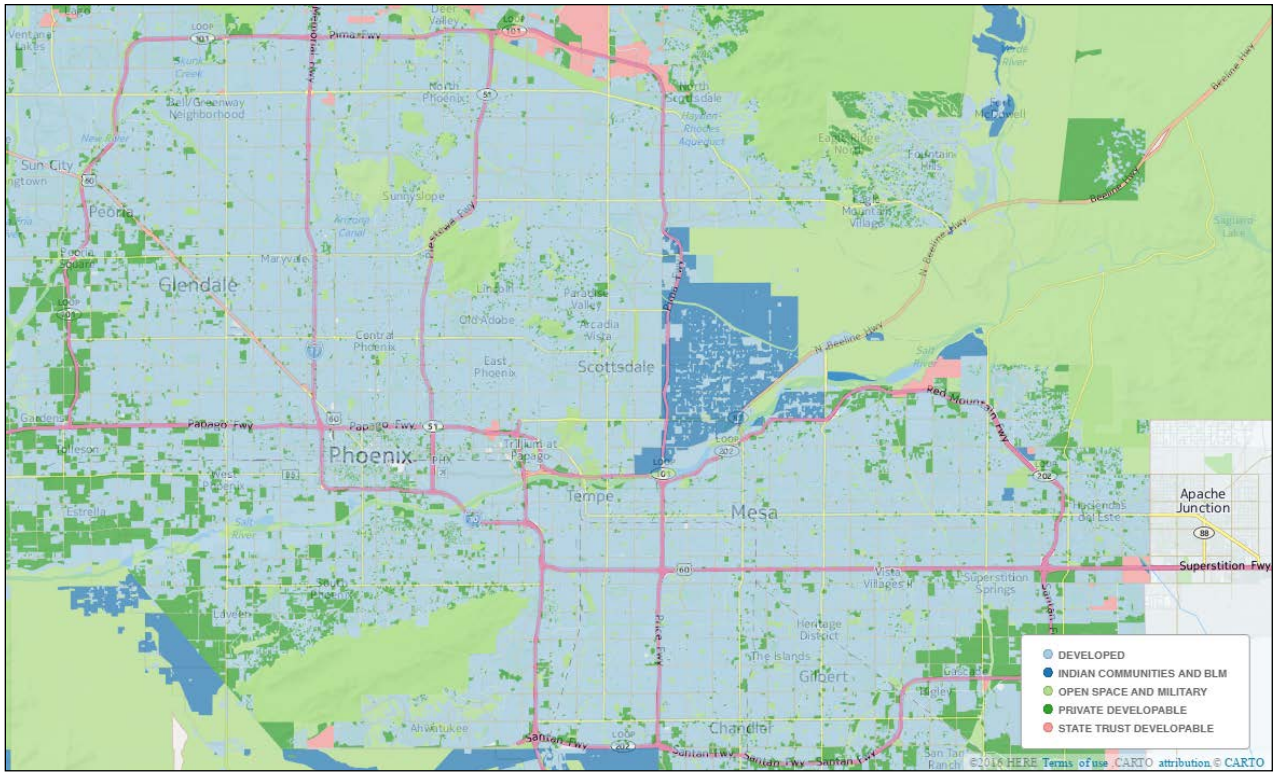
The distribution of vacant land can be displayed through four sub-categories: private developable, state trust developable, open space and military, and Indian communities and Bureau of Land Management. The private lands in the first sub-category offer the most straight forward path to development, albeit not the only path. Figure 21 and Figure 22 show the greenfield development potential in the MAG region using these sub-categories. As expected most locations in metropolitan Phoenix have been developed, although there exists a higher proportion of private land that could be developed in the southwest quadrant of the city.

Figure 21: Existing Land Uses, MAG Region



Source: MAG

Figure 22: Existing Land Uses, Phoenix Metropolitan Region



Source: MAG

7 Network Usage

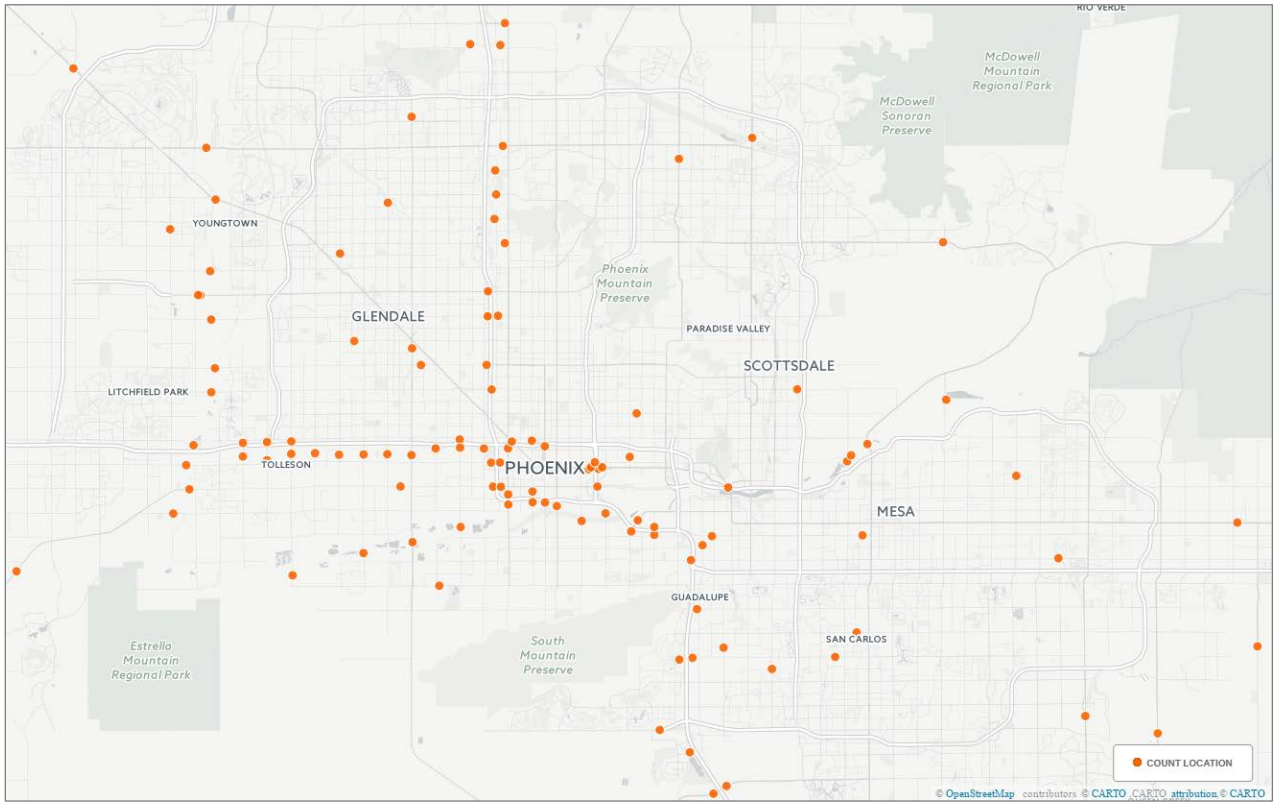
7.1 TRUCK COUNTS

One of the most important inputs in defining a metropolitan freight network is developing an understanding of the roads that trucks use on a daily basis. The intensity of this activity provides a fundamental guide to the definition of corridors that trucks need for travel to and from industrial areas, logistics facilities, commercial districts, and external markets. Route selection by motor carriers reflects a calculated balance of time and cost, and the paramount requirement to arrive at terminals and business sites precisely as scheduled. From this perspective, the current use of the roadway system reflects the composite judgment of the carrier community as to how to serve the region as reliably and productively as possible. Nevertheless, truck routing is a dynamic activity that can be altered in response to the opening of changes in the geography of shipment demand, road construction, or changing attitudes about how to mitigate the effects of congestion. Due to all of this, understanding where trucks travel on the roadway network is not a trivial task.

The truck volumes employed in this analysis were estimated through a local travel demand model that was calibrated using observed counts at key locations. The travel demand model obtained regional information about the demand for travel, including both passenger and freight, and then disaggregated it at the local level. Different approaches can be used for this step, some more sophisticated than others, but all of them seek to project demand out to the future for planning purposes. Projections are usually a function of a variety of forecasts, including economic and demographic. The demand for travel was then assigned to the network using a model of how vehicles and trucks make routing decisions. This model takes as inputs the characteristics of the roadway network—which can be changed exogenously to model the implications of proposed projects—and the onset of congestion as the network is loaded. Finally, observed volumes were then calibrated using data observed from count stations.

Figure 23 shows the count stations located on arterial roads. A further set of loop detectors located on interstates is also available, although not shown in this map; some of them provide traffic counts. Many of these detectors are located on entry and exit points on highway interchanges, to identify the main roads used to access regional roads, and vice versa. Locations not shown on this map do not have count stations in this particular data set. Overall, there appears to be moderate coverage of the Phoenix region, although the majority of count locations are located at interstate access points, as mentioned before. This will directly translate into the estimated truck volumes at these locations having a higher degree of certainty.

Figure 23: Truck Count Station Locations

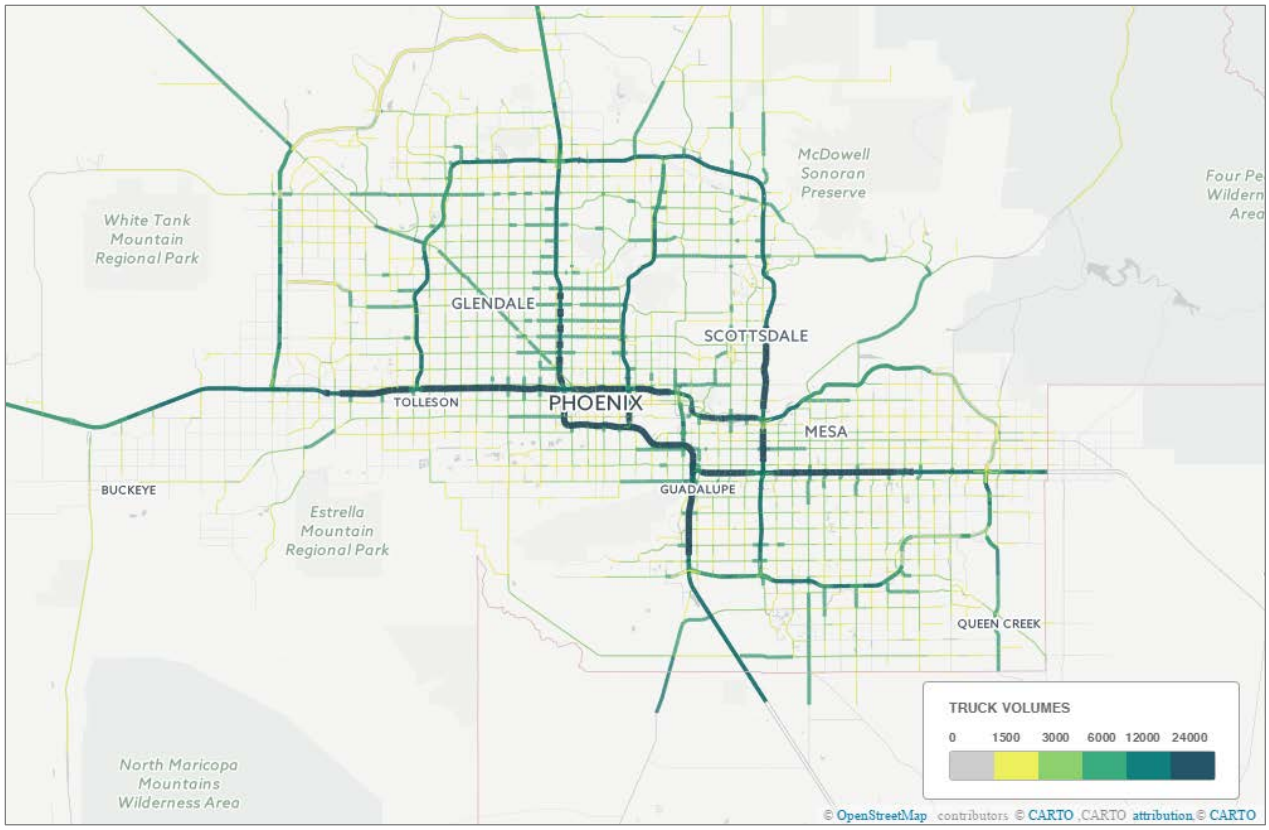


Source: Communication with MAG

The resulting truck AADT estimates can be seen in Figure 24, capturing light-, medium-, and heavy-duty trucks. As expected, the majority of trucks travel on the main highways crossing the region, with I-10, I-17, and US 60 seeing the highest volumes, over 20,000 truck AADT. Other highways have truck comparable truck volumes for some segments, such as Loop 101 through Scottsdale.

A large number of arterials are used to access these high-volume highways. Because of the grid-like street network in Phoenix, truck drivers often have a large number of viable routes to go from origin to destination. This makes estimating truck volumes harder because there are few obvious routes—ones that are significantly better than the rest. At the same time, this represents a network design opportunity, because viable alternative routes are available and because route redundancy (which is important for network reliability) is less of a challenge.

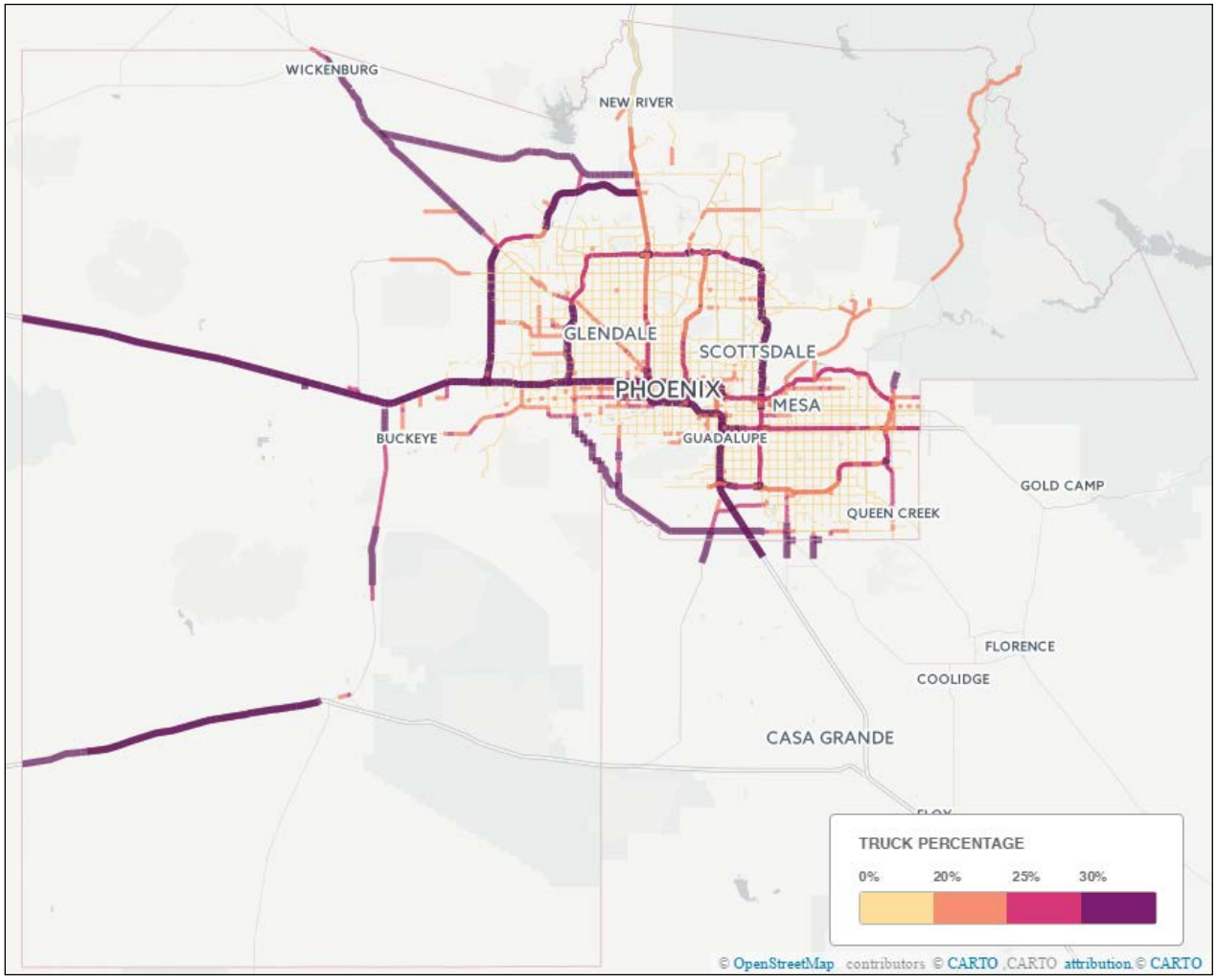
Figure 24: Truck AADT Estimates



Source: MAG

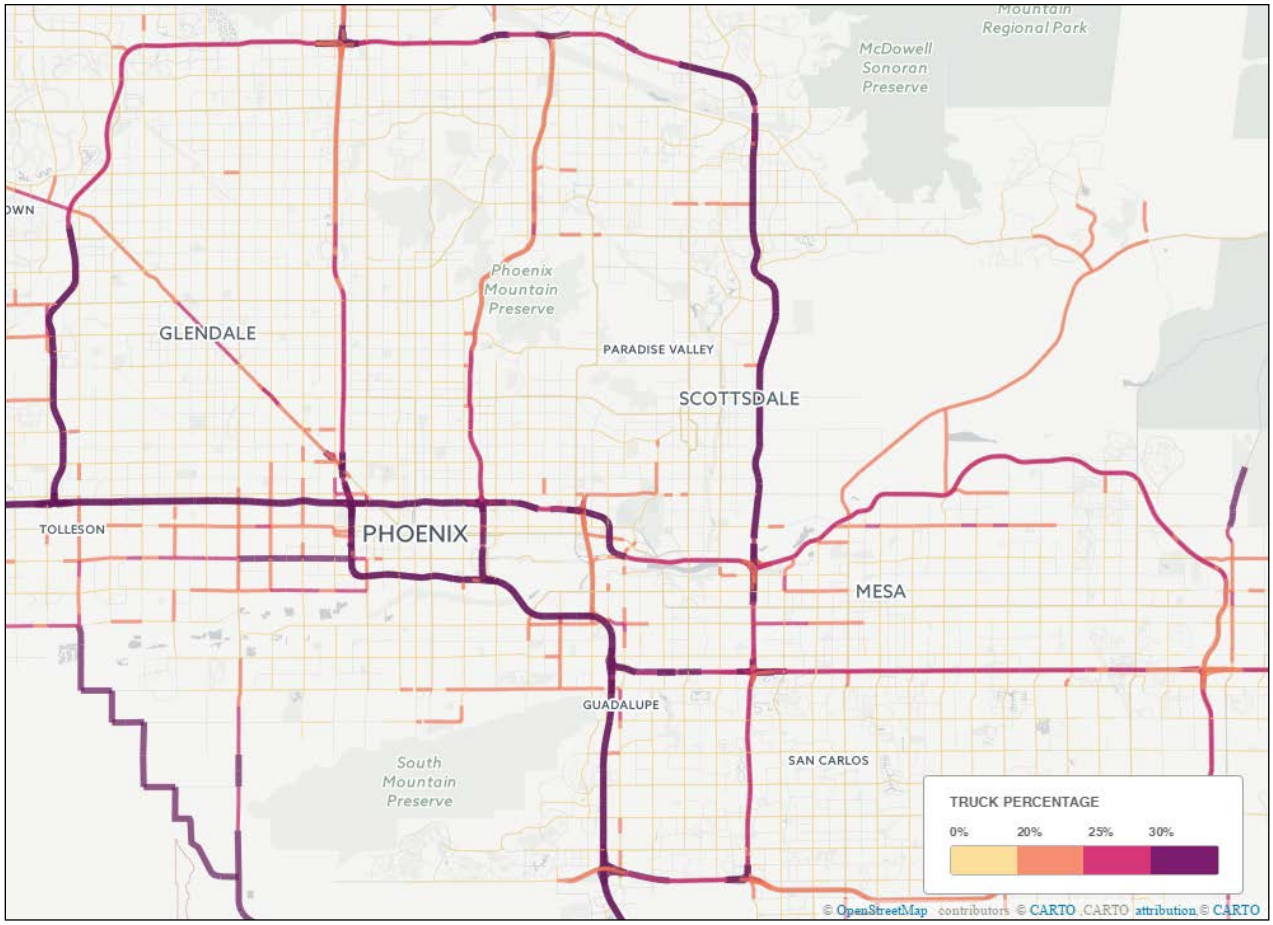
Because the travel demand model also estimates passenger vehicle travel in a way that is consistent with the estimation of truck volumes, it is also possible to estimate the proportion of trucks traveling on roads. Figure 25 shows these estimates for the whole MAG region and Figure 26 shows the estimates for only the Phoenix metropolitan area. As expected, there exists substantial overlap between truck volume estimates and truck percent estimates—where there are more trucks there is likely to also be a higher truck percentage. However, from these maps it is also clear that some roads have much higher truck proportions than is common place on other roads. This is the case for Loop 303, SR-74, US 60 towards Morristown, and W. Riggs Road heading south towards I-10. This last road appears to be an important exit point for trucks originating in industrial areas west of downtown Phoenix, wanting to get on I-10 while potentially avoiding traffic. Information about the proportion of trucks on a road is vital to understanding the impacts of potential roadway projects.

Figure 25: Proportion of Trucks, MAG Region



Source: MAG

Figure 26: Proportion of Trucks, Metropolitan Area



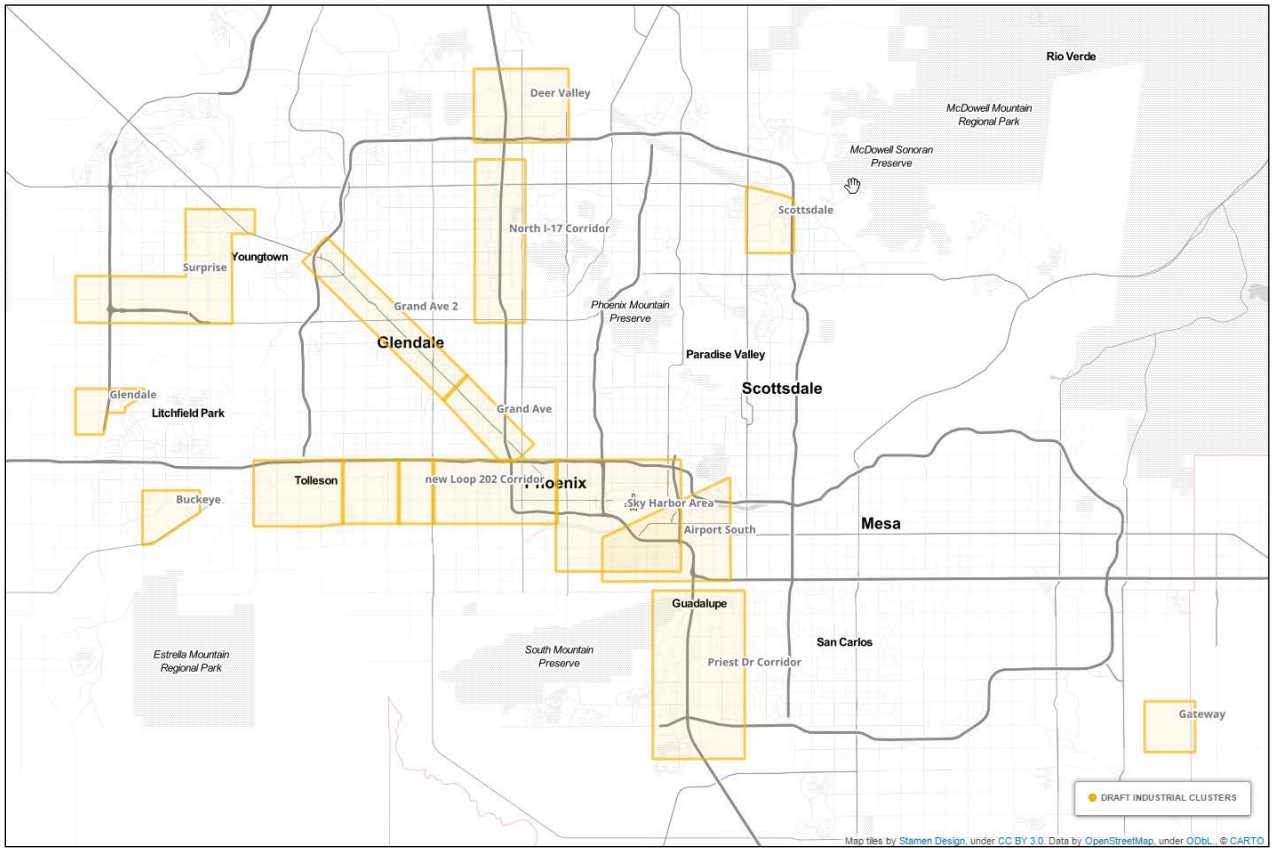
Source: MAG

7.2 TRUCK ROUTES – ATRI DATA

Because of the challenges inherent in estimating truck volumes, additional sources of information were also explored. The ATRI—the research arm of the American Trucking Association—has been collecting extensive satellite location data throughout the country in a voluntary arrangement with major truck fleets. This data indicates the latitudes and longitudes where trucks are located with frequent time-stamps, making it possible to trace the route taken by individual trucks with a high degree of precision. This data has been invaluable in many applications, the most prominent of which is to estimate the speeds and reliabilities that trucks face throughout the roadway network. This data, however, also provides factual information about MAG regional roadway usage for the fleets in the ATRI program.

The MAG region has access to this data collected by ATRI, and it is reported in the sections shown in Figure 27.

Figure 27: ATRI Truck Route Data Segmentation

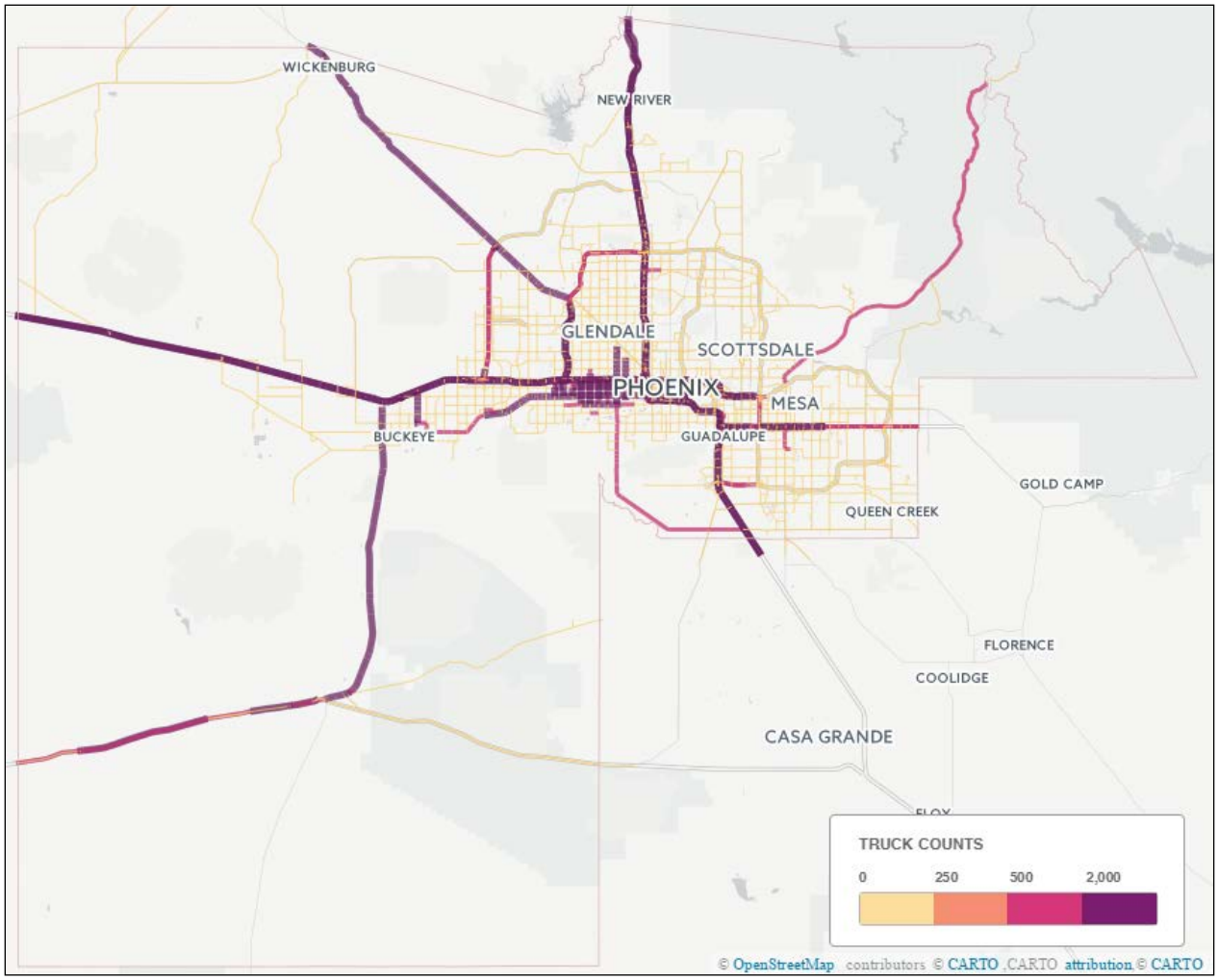


Source: MAG

The combined results of all sections are shown in Figure 28 In interpreting these results, it is important to keep in mind that the trucks tracked by satellite transponders with data aggregated by ATRI may not be a representative sample of regional trucking activity, and may skew towards the activity of larger and more technologically adept trucking companies. These companies potentially have more sophisticated ways of routing trucks to avoid congestion or roadway issues, they tend toward heavy duty trucks, and their client base potentially can be specific to certain industries or sectors of the economy. It is impossible to assess the representativeness of these factors and the representativeness of the ATRI data because categorical information about the attributes of the trucks being sampled is not published by ATRI.

Nonetheless, the ATRI GPS route data can be useful for two purposes. First, it can be used as a validation tool to confirm that indeed the roads with high observed GPS counts are also showing commensurate truck volumes from the truck count analysis. Even though this is a qualitative assessment by nature, having substantial overlap between both approaches is reassuring. Secondly, the ATRI data provides very useful information about the routes that trucks take from one general area to another. This is why the ATRI data was segmented into the types shown in Figure 27. While truck routes taken can differ from driver to driver and trucking company to trucking company, it is likely that there exists substantial agreement regarding the most optimal routes to take. To the extent this is not the case; the ATRI data would also provide a sense of the range of routes that can be taken to access certain locations.

Figure 28: ATRI Routes, MAG Region

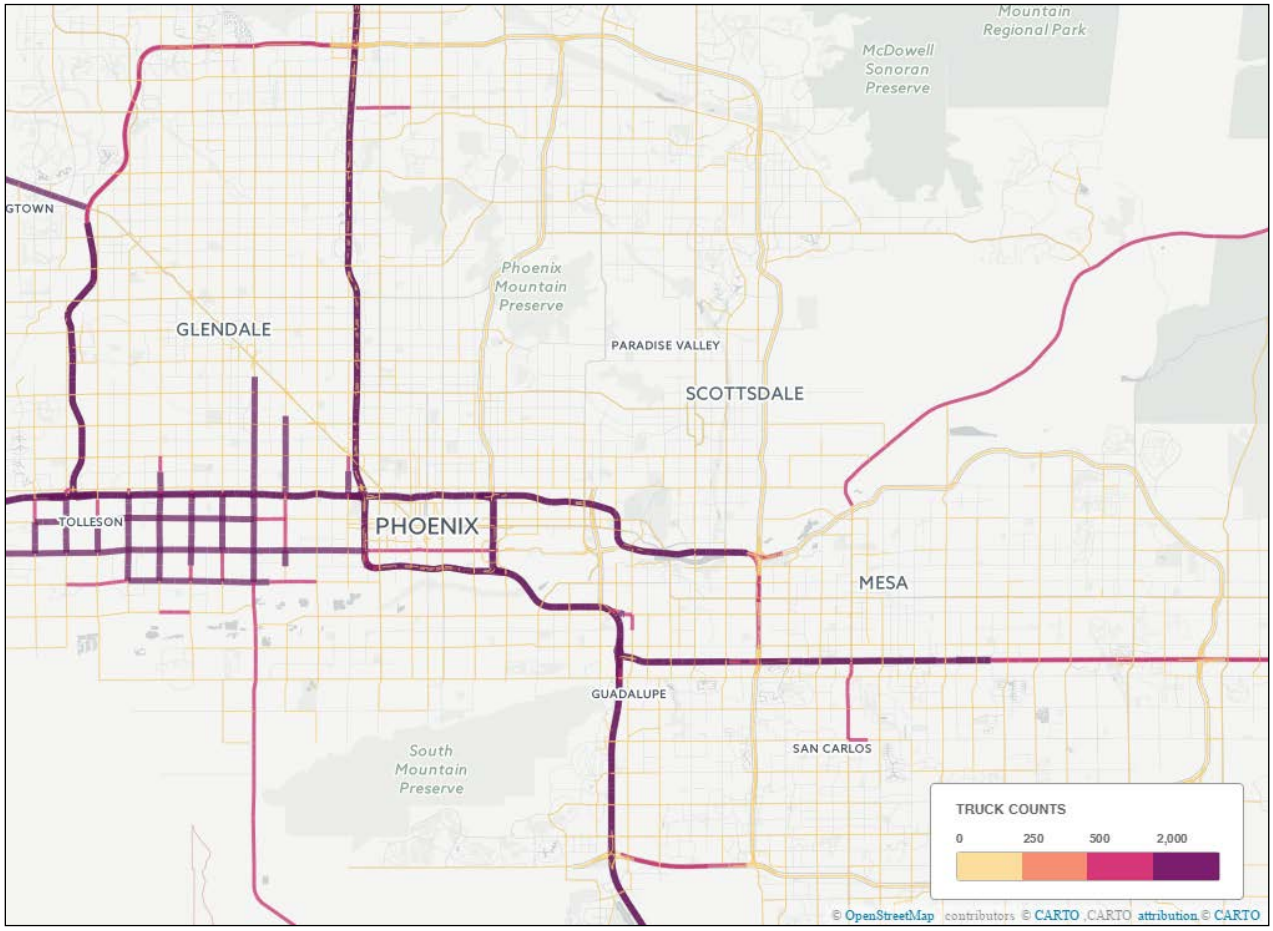


Source: ATRI; MAG

Trips observed by ATRI route data (Figure 28) frequently appear on state routes and interstates. On the Loop 101, trips skew toward the Agua Fria portion of the Loop 101. The western portions of the Red Mountain Loop 202 also observe many trips. The arterial system is most utilized in the areas south of the Papago I-10 Corridor between 107th Avenue to the west and 35th Avenue to the east. SR 87 observes many trips as the primary northeast entry and exit point for the region.

While the ATRI route data skews towards the significant industrial concentrations along the I-10 corridor, other general travel trends are depicted. Trips have origins or destinations along major arterials. Often the major arterial is attractive for the first or last three to four miles before utilizing a higher classification roadway (Figure 29). Locations such as 51st Avenue are frequently utilized for trade between the South Southwest Phoenix 2 segment and the Grand Avenue segment. This suggests that although I-17 provides a higher classification roadway, 51st Avenue functions as an alternative for the north or south trade movement.

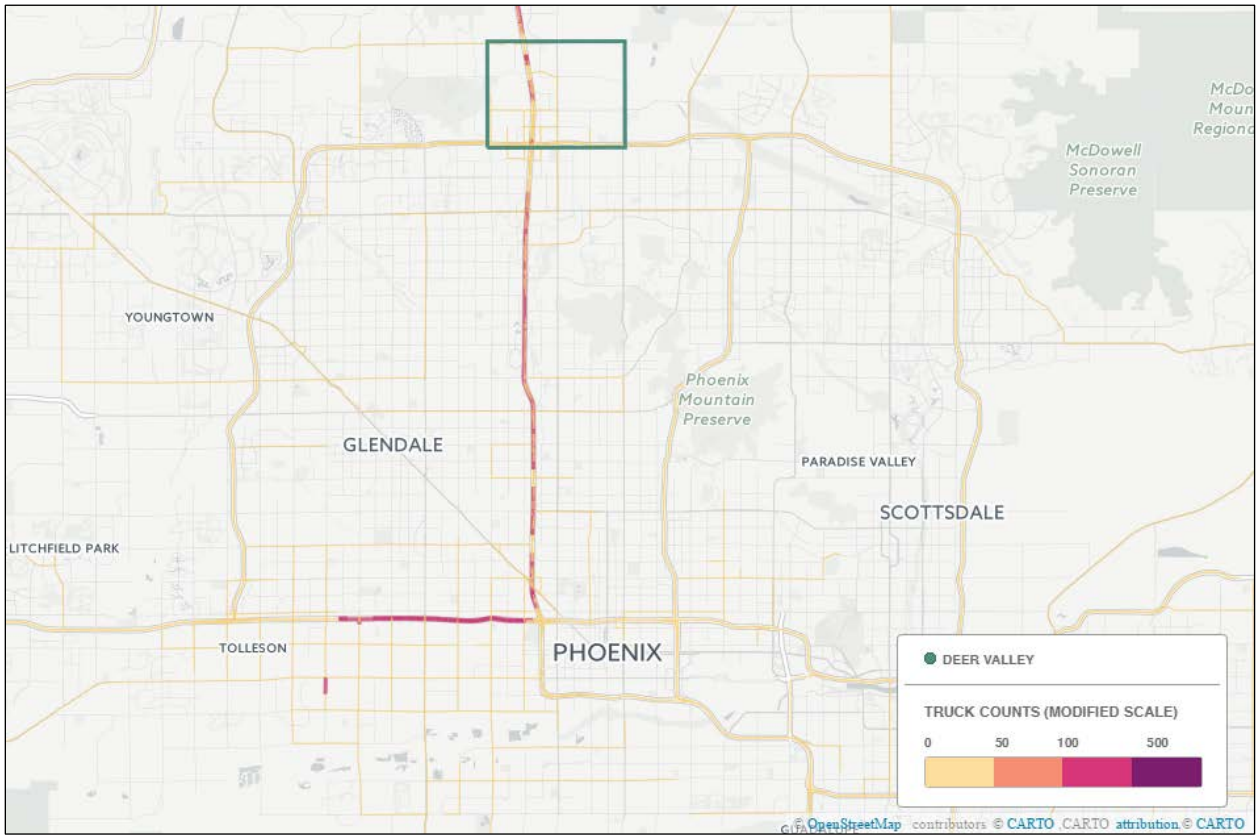
Figure 29: ATRI Routes Master, Phoenix Metro Area



Source: ATRI; MAG

The Deer Valley segment is in close proximity to the North Stack at Loop 101 and I-17. The trip counts observed by ATRI route data (Figure 30) suggest the I-17 Corridor is the preferred facility. More than 100 trips are observed on I-17 south of the North Stack. About 40 trips were observed on Loop 101 west of the North Stack and about 20 trips were observed on the Loop 101 east of the North Stack. The ATRI route data suggests a strong interaction between the Deer Valley segment and the South Southwest Phoenix Segments 1 and 2.

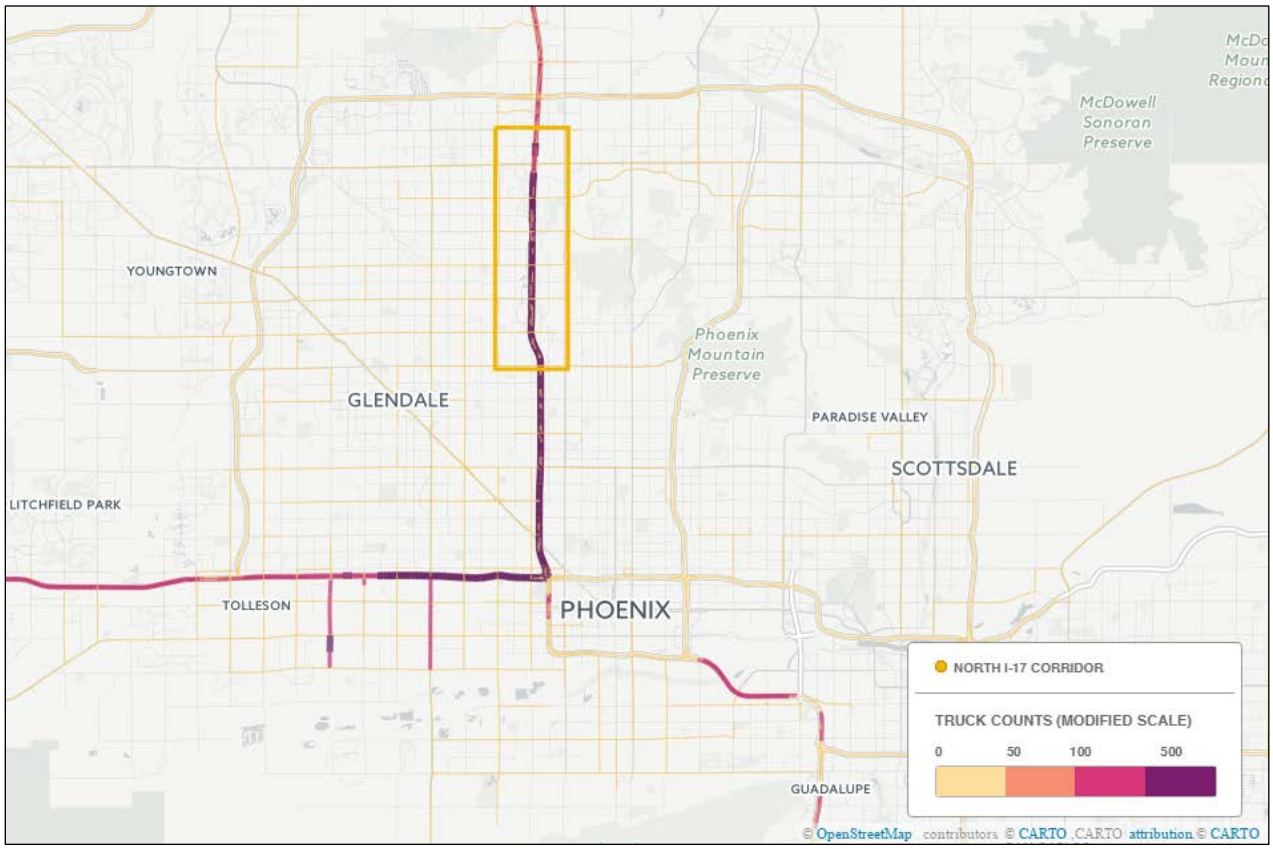
Figure 30: ATRI Routes Deer Valley Cluster, MAG Region



Source: ATRI; MAG

The North I-17 Segment of ATRI (Figure 31) route data suggests medium distance trips within the region favor the higher classification roadways such as interstates. South 75th Avenue and S. 51st Avenue are two arterials south of I-10 that observed nearly 100 trips each. At the Stack, trips route around the downtown Phoenix area via I-10 and I-17. Trips converge at the split and rely upon I-10 through to the Broadway Curve.

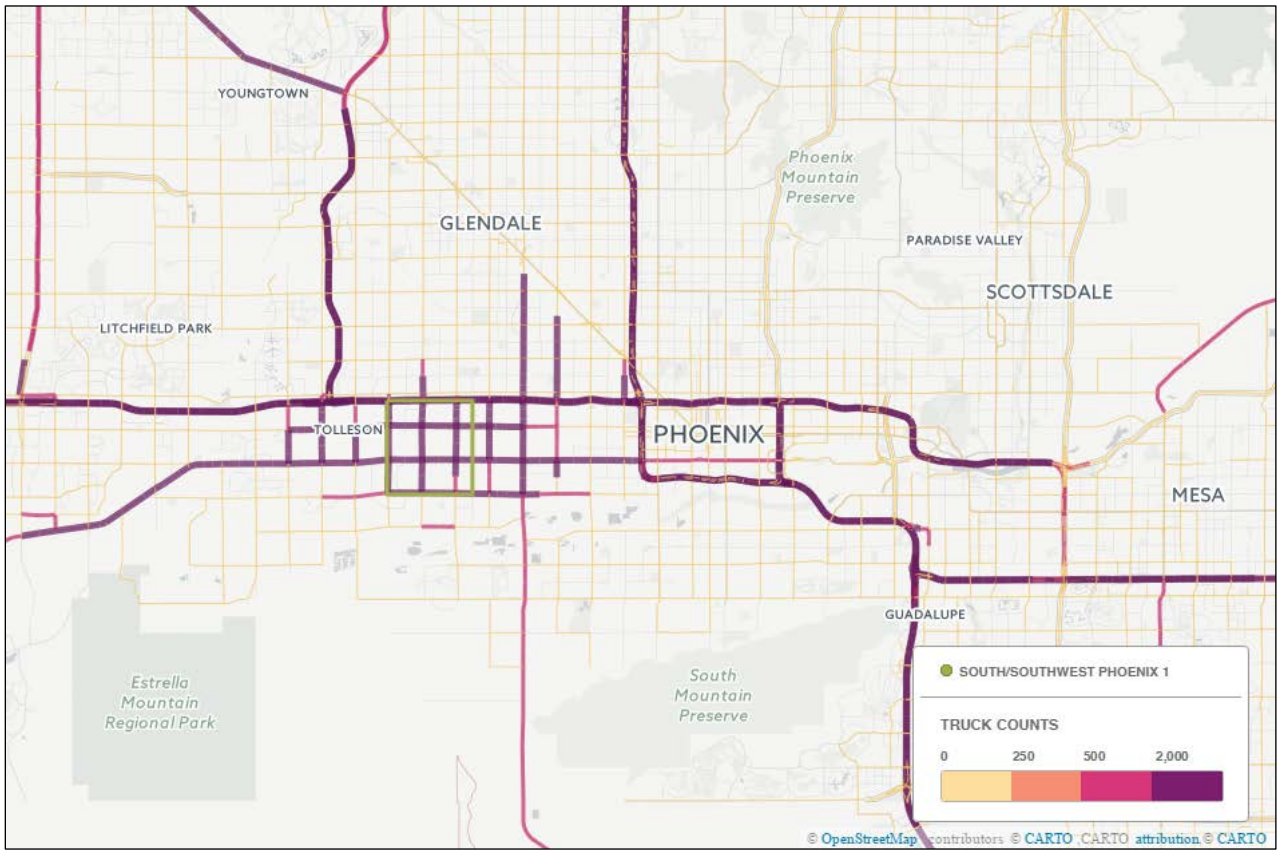
Figure 31: ATRI Routes, North I-17 Corridor, MAG Region



Source: ATRI; MAG

The South Southwest Phoenix Segment 1 (Figure 32) observed a higher number of trips compared to several segments. East and west of the segment ATRI route data shows many trips utilizing the major arterials of Van Buren Street, Buckeye Road, and Lower Buckeye Road. Beyond three to four miles from the segment boundary, the trips tend to utilize the higher classification roadways. One exception is south of downtown Phoenix. In this area, Buckeye Road observed more than 300 trips moving east and west.

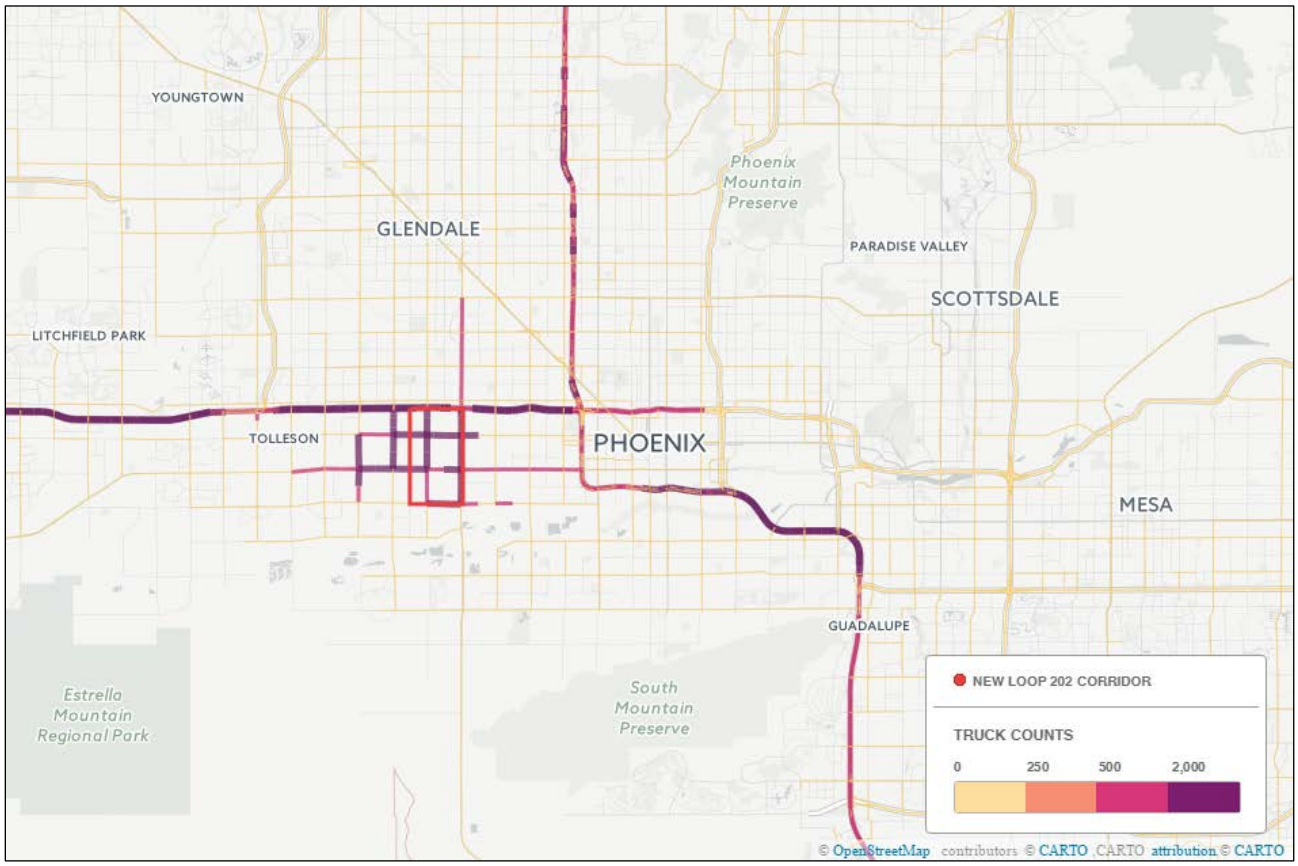
Figure 32: ATRI Routes, South Southwest Phoenix 1, MAG Region



Source: ATRI; MAG

The New Loop 202 Corridor Segment (Figure 33) follows similar patterns to the South Southwest Phoenix 1 segment. Van Buren Street observed more than 700 trips. Buckeye Road observed more 500 trips. Nearly 400 of these trips move east and west to connect with I-17 west of downtown Phoenix. North from the segment, 51st Avenue observed nearly 300 trips; nearly 60 percent of those are inbound to the segment.

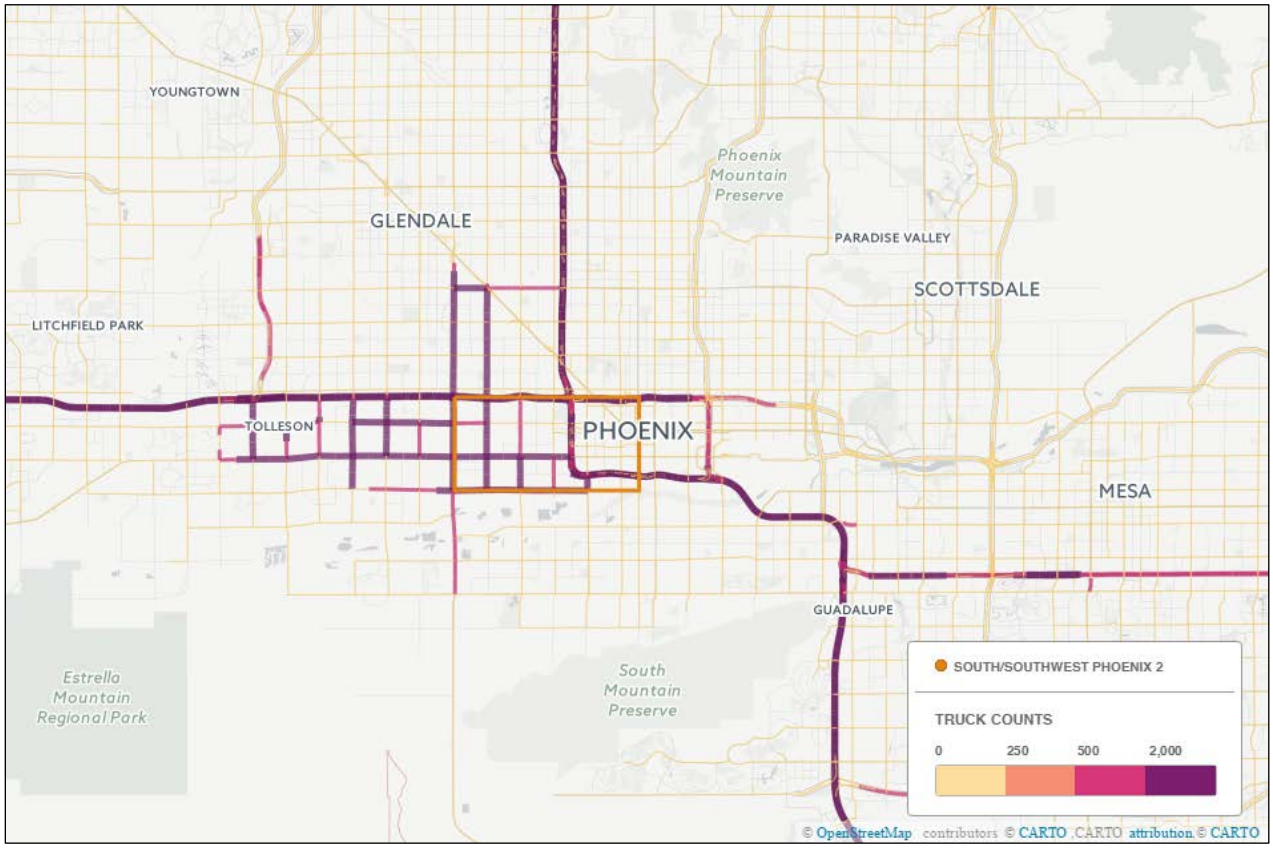
Figure 33: ATRI Routes, New Loop 202 Corridor, MAG Region



Source: ATRI; MAG

The neighboring South Southwest Phoenix 2 Segment (Figure 34) follows trends of the South Southwest Phoenix 1 Segment and New Loop 202 Corridor Segment. The segment definition extends to 51st Avenue on the west and Central Avenue on the east. Both Buckeye Road and Lower Buckeye Road observed more than 1,300 trips, while the most utilized portions of Van Buren Street observed about 350 trips. Northbound arterial connections of the segment include 51st Avenue and 43rd Avenue.
W. Camelback Road observed between more than 325 trips west of I-17. West of the segment, Buckeye Road observed a high number of trips. Extending seven miles west, the road averaged more than 1,600 trips to and from the segment.

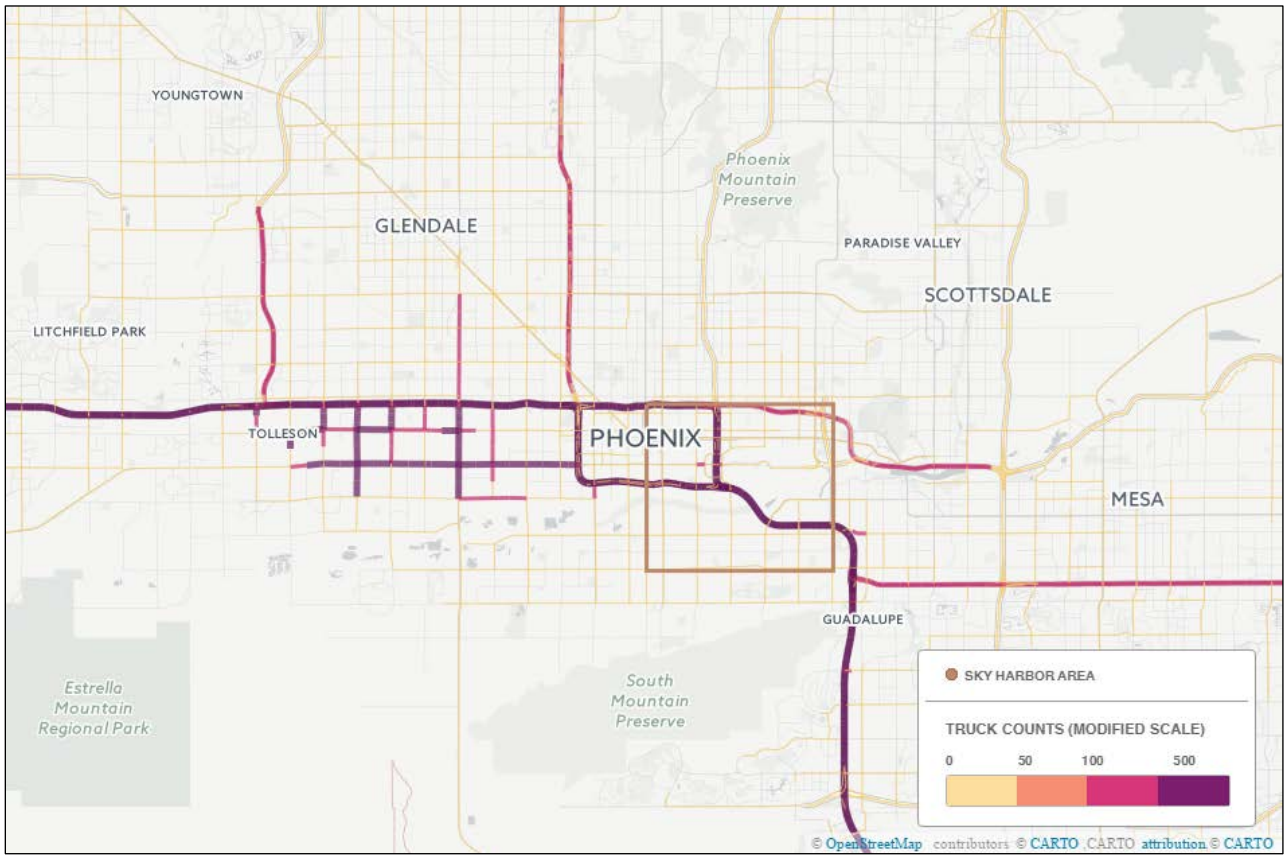
Figure 34: ATRI Routes, South Southwest Phoenix 2, MAG Region



Source: ATRI; MAG

The Sky Harbor Segment (Figure 35) observes significant interaction with the neighboring segments to the west, but the total number of trips is less as observed by the ATRI route data. Buckeye Road provides significant east-west connectivity and functions as an alternative to I-10. On 51st Avenue, more than 60 trips were observed. East of the segment, Red Mountain Loop 202, US 60, and I-10 (Maricopa) function as the access points.

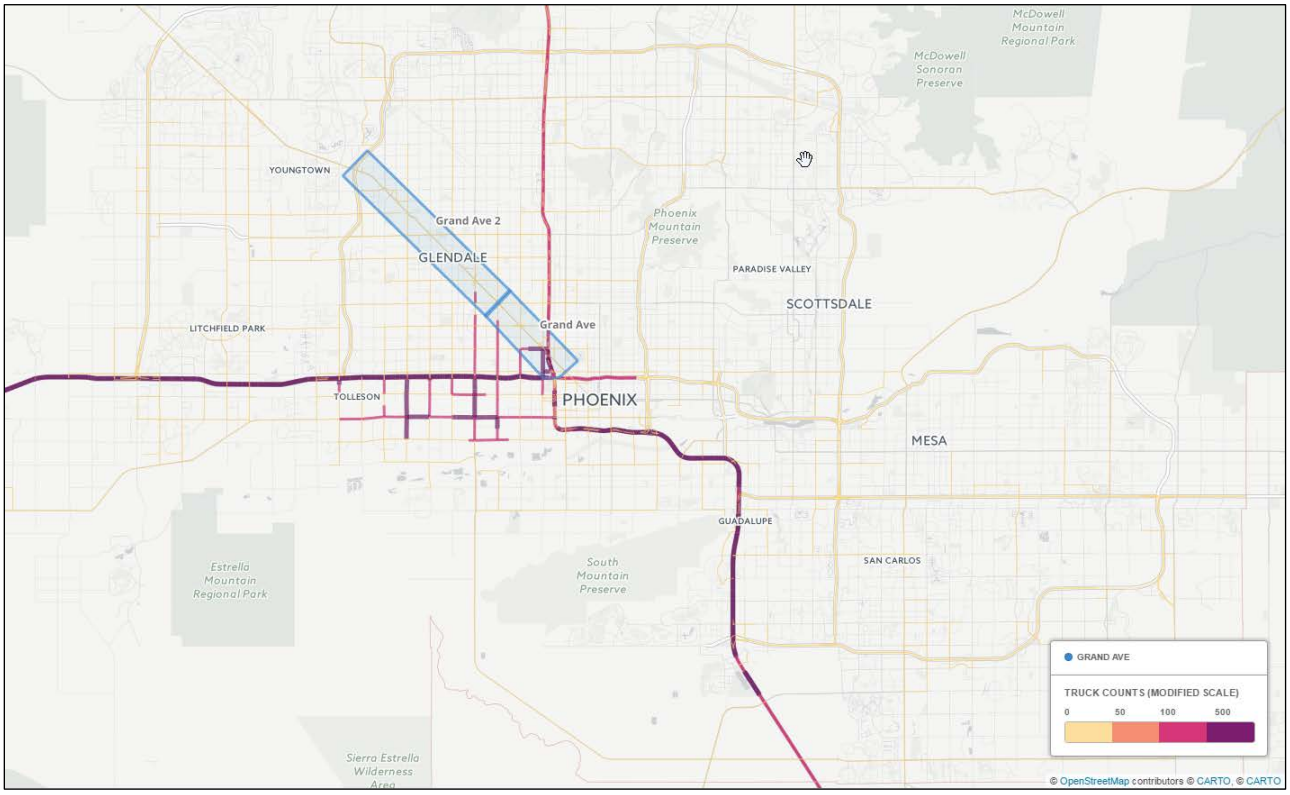
Figure 35: ATRI Routes, Sky Harbor Area, MAG Region



Source: ATRI; MAG

The Grand Avenue segment (Figure 36) is currently defined as portions of Grand Avenue between Loop 101 and North of I-10 near McDowell Road. The definition for this segment includes the BNSF Intermodal Yard north of Camelback Road. The most significant activity is located at the southern portion of the segment near I-10 and I-17.

Figure 36: ATRI Routes, Grand Avenue, MAG Region

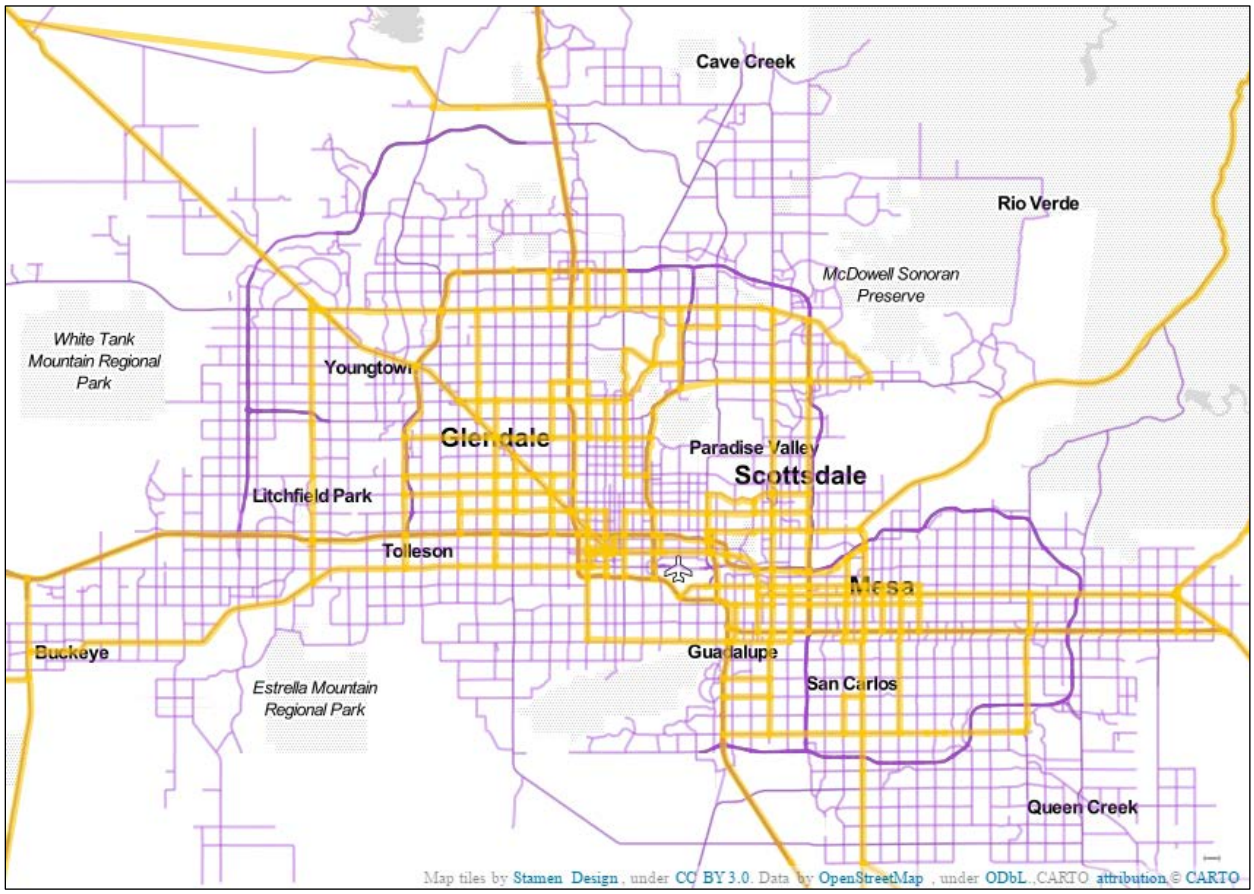


Source: ATRI; MAG

7.3 ROUTED TRANSEARCH

The ATRI GPS route data illustrates the utilization of the network throughout the region on varied roadway classification types. The observed traces show the prevalent activity often traverses the highest classification of roadways except for the first of last miles of a trip. The trip patterns illustrate that a local understanding of freight traffic requires a detailed local network and the national Transearch routing network includes only the major routes and bypasses. While this network file shown in Figure 37 with a yellow color supports a national understanding of trade, the local conditions require a network with significantly greater detail to capture the observed ATRI routing shown in a purple line color.

Figure 37: Comparison of National Transearch Model (Yellow) with Observed Truck Routing by ATRI (Purple)



Source: Transearch, ATRI, MAG

7.4 EXISTING MUNICIPAL CODES REGULATING TRUCK MOVEMENT

This section analyzes regulations concerning truck routes and commercial vehicle parking. Arizona Revised Statues Title 28 establishes the relevant agreements and responsibilities including commercial vehicle licensure, title, operating requirements, highway use fees, and weight classifications. Additional jurisdiction-specific regulations are established in municipal codes, which are updated periodically as new ordinances are adopted by the governing bodies.

Among the MAG Member Agencies, just under half establish and document truck routing regulations. Specifically, fifteen members at present have regulated truck routes and the recency of these regulations vary. The average age of the route regulations exceeds eight years and some members set the regulations as far back as 1993, more than twenty-three years ago. The age of regulations signals the stability and permanence of rules and the likelihood that current practices are outside the reach of existing regulations. Less than one-quarter of members have documented their route regulations into a map. The recency of map updates, on average, exceeds ten years.

Truck parking regulations govern commercial motor vehicles and identify allowable locations for parking by time of day, type of activity, and locations within the region. Fourteen member agencies regulate truck parking in this manner. Details within the codes govern the ability for commercial motor vehicles to route trucks through regions and locations for stopping a vehicle for loading, unloading, or idling purposes. The presence and vintage of truck routes and parking regulations by MAG member agency is summarized in Table 12. Appendix A provides supporting detail for each member, along with any published maps.

Table 12: Summary of Agency Truck Route and Parking Regulations in MAG Region

MEMBER AGENCY	TRUCK ROUTES ESTABLISHED	DATE TRUCK ROUTES ESTABLISHED	TRUCK ROUTE MAP PUBLISHED	TRUCK ROUTE MAP DATE PUBLISHED	TRUCK PARKING REGULATIONS ESTABLISHED	DATE TRUCK PARKING REGULATIONS ESTABLISHED
Apache Junction	Yes	4/6/2010	Yes	8/1/1993	Yes	4/6/2010
Avondale	Yes	12/16/2006	No	-	Yes	12/17/2012
Buckeye	Yes	4/5/2011	No	-	No	-
Carefree	Yes	Date not published	No	-	Yes	Date not published
Cave Creek	None	-	No	-	No	-
Chandler	None, per authority of City Traffic Engineer	6/14/2012	No	-	No	-
El Mirage	None, all major arterial streets allowable	Date not published	No	-	Yes	Date not published

MEMBER AGENCY	TRUCK ROUTES ESTABLISHED	DATE TRUCK ROUTES ESTABLISHED	TRUCK ROUTE MAP PUBLISHED	TRUCK ROUTE MAP DATE PUBLISHED	TRUCK PARKING REGULATIONS ESTABLISHED	DATE TRUCK PARKING REGULATIONS ESTABLISHED
Florence	None	-	No	-	No	-
Fort McDowell Yavapai Nation	None	-	No	-	No	-
Fountain Hills	Yes	9/5/2002	No	-	No	-
Gila Bend	Yes	Date not published	No	-	No	-
Gila River Indian Community	None	-	No	-	No	-
Gilbert	Yes	Date not published	No	-	Yes	Date not published
Glendale	None, all residential streets prohibited	12/14/1993	No	-	Yes	1/23/2007
Goodyear	Yes	11/12/2002	Yes	5/7/2014	Yes	9/22/2014
Guadalupe	Yes	Date not published	No	-	Yes	Date not published
Litchfield Park	Yes	Date not published	No	-	Yes	Date not published
Maricopa	Under study	-	No	-	No	-
Maricopa County	None	-	No	-	No	-
Mesa	None, per authority of City Traffic Engineer	Date not published	No	-	Yes	Date not published
Peoria	None, all residential streets	11/15/2005	Yes	3/4/2014	Yes	7/1/2008

MEMBER AGENCY	TRUCK ROUTES ESTABLISHED	DATE TRUCK ROUTES ESTABLISHED	TRUCK ROUTE MAP PUBLISHED	TRUCK ROUTE MAP DATE PUBLISHED	TRUCK PARKING REGULATIONS ESTABLISHED	DATE TRUCK PARKING REGULATIONS ESTABLISHED
	prohibited					
Phoenix	Yes	Date not published	Yes	4/1/2005	Yes	3/16/2004
Pinal County	None	-	No	-	Yes	Date not published
Queen Creek	None	-	No	-	No	-
Salt River Pima-Maricopa Indian Community	Yes	1/1/2014	No	-	No	-
Scottsdale	Yes	9/20/2011	Yes	9/15/2004	No	-
Surprise	Yes	8/2/2016	Yes	Date not published	No	-
Tempe	None	-	No	-	No	-
Tolleson	None, prohibited routes are specified	6/14/2016	No	-	No	-
Wickenburg	Yes	Date not published	Yes	Date not published	No	-
Youngtown	None, all streets prohibited	Date not published	No	-	Yes	7/21/2011

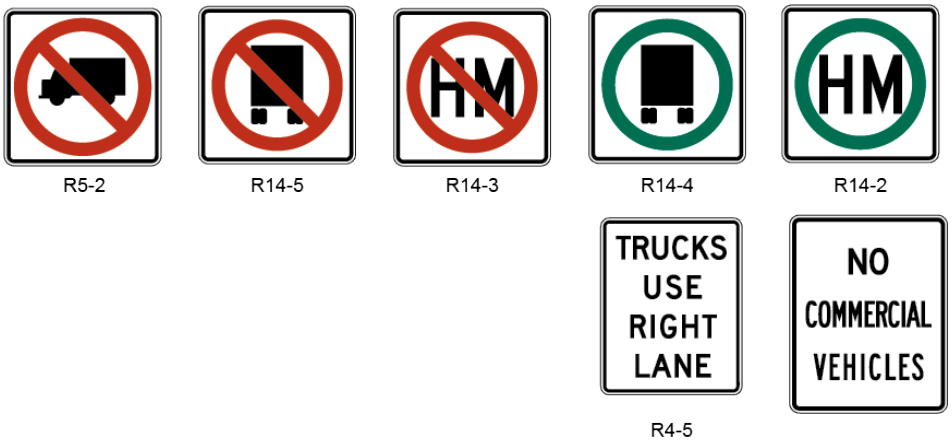
Source: Research by WSP

The MAG Member Agencies install regulatory signage which aids local navigation and physically marks the regulations contained within municipal codes. Such signage is highly effective for route planning and navigational aids for local and national fleets.

Research indicates that the installation of the selective exclusion signs shown in Figure 38 are frequently not documented nor specified within municipal codes. These additional regulations indicate areas of the region where local conditions and preferences attempt to accommodate varied land use patterns. The

installation and frequency of such signage is not applied uniformly. The desired regulatory compliance may be difficult to achieve given these inconsistencies.

Figure 38: Selective Exclusion Signs



Source: Manual on Uniform Traffic Control Devices, 2009 Edition; Traffico.io

In Tempe, the municipal code does not contain regulations designating truck routes. Signage located at the intersection of Hardy Drive and Broadway Road shown in Figure 39 restricts trucks northbound on Hardy Drive except for residential delivery.

Figure 39: Exclusion Signage in Tempe at Hardy Drive and Broadway Road

Source: Mapillary, photo by WSP-USA, https://www.mapillary.com/map/im/-F6B7VGCOEu03LFsOPDjyw

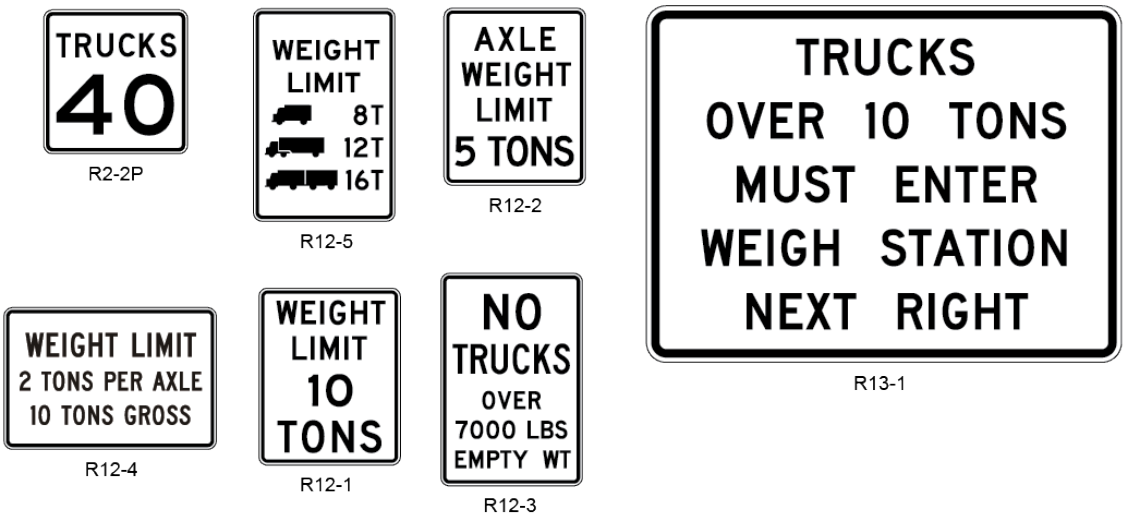
In Litchfield Park, the municipal code designates Litchfield Road as the only truck route within the city. Research found installed exclusionary signage at certain locations that restrict access to trucks except for local delivery. An example location is shown in Figure 40.

Figure 40: Exclusion Signage in Litchfield Park at Pebble Creek Parkway and Indian School Road

Source: Mapillary, photo by WSP-USA, https://www.mapillary.com/map/im/KZ1d2giHL8Q4vfgeDe_V8Q

The Manual on Uniform Traffic Control Devices (MUTCD) establishes standards for signage. Weight Limit Signs shown in Figure 41 are standard options that member agencies can utilize to regulate the movement of trucks due to physical constraints or policy preferences. Frequently such signage is in proximity to single points of restrictions like bridges or structures.

Figure 41: Weight Limit Signs

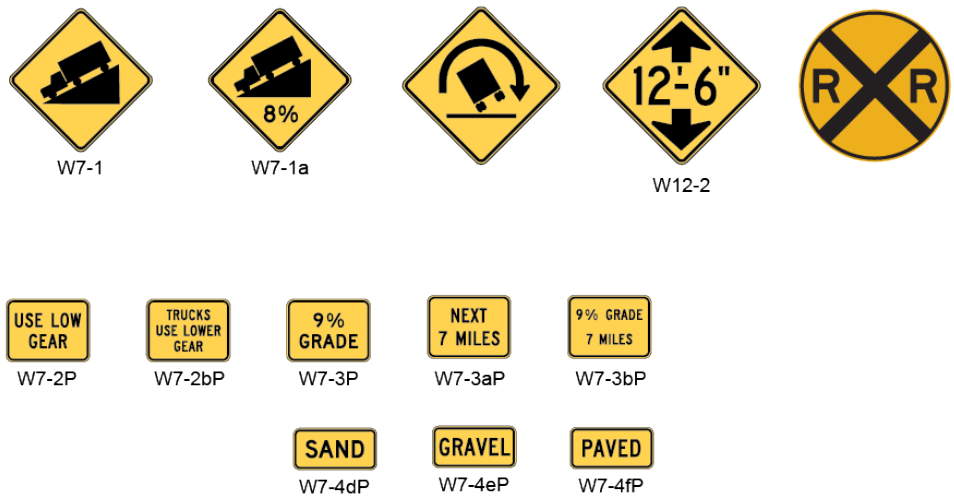


Source: MUTCD, 2009 Edition; Traffico.io

Standard MUTCD signage indicates warnings for trucks and motor vehicles due to vertical heights, steep and hazardous grades, potential points of conflict or non-uniform pavement types. Such signage

illustrated in Figure 42 provides a navigation aid and warning to mitigate unexpected situations and promotes the safe movement of trucks in the region.

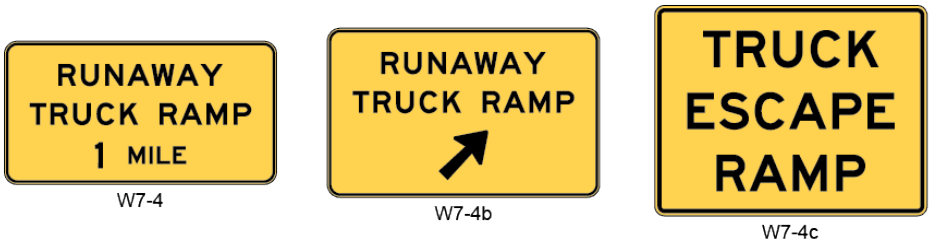
Figure 42: Vertical Grade Signs and Plaques



Source: MUTCD, 2009 Edition; Traffico.io

Trucks in the region are unlikely to encounter steep grades at highway speeds. While the truck escape ramp signs shown in Figure 43 are infrequent in the urban portions of the region, rural areas with rolling or steep roads may utilize the signage when the conditions are warranted.

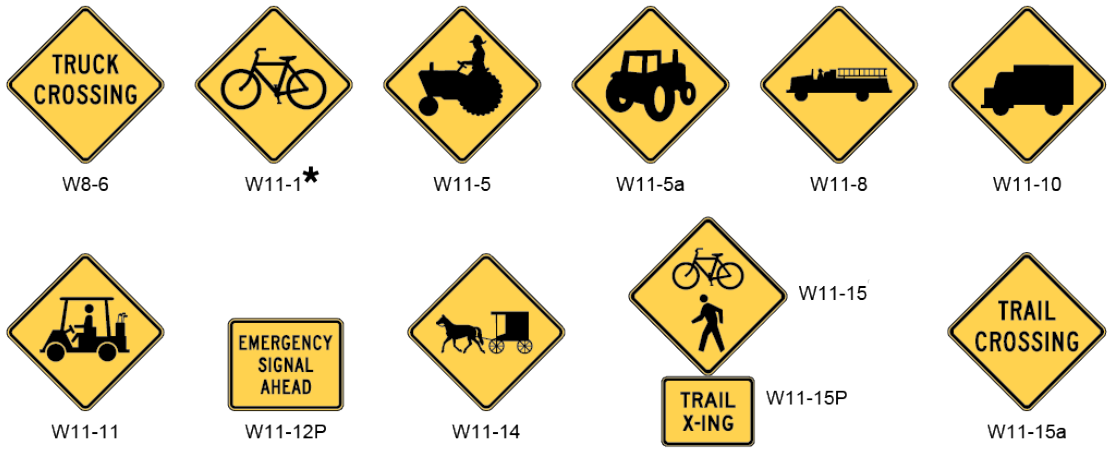
Figure 43: Truck Escape Ramp Signs



Source: MUTCD, 2009 Edition; Traffico.io

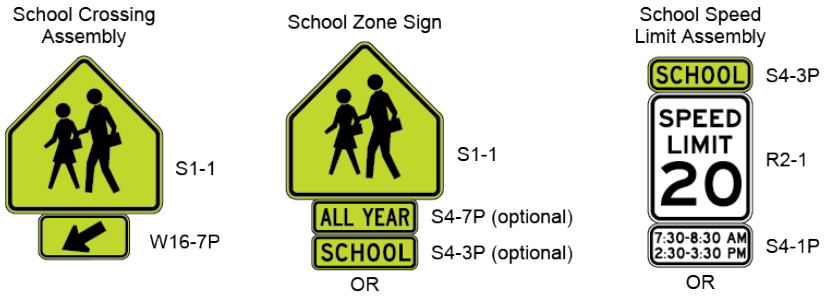
Additional MUTCD warning signage (Figure 44) and school area signage (Figure 45) help all roadway users understand that the roadway where they are traveling is shared by many users. These warning signs and plaques are used near the applicable land uses and alert road users to locations where unexpected entries into the roadway might occur.

Figure 44: Vehicular Traffic Warning Signs and Plaques



Source: MUTCD, 2009 Edition; Traffico.io

Figure 45: School Area Signs



Source: MUTCD, 2009 Edition; Traffico.io

8 Network Performance

8.1 CONGESTION

The core freight network is intended to prioritize projects that improve the performance of trucking. A key aspect of this from the perspective of motor carriers is mitigating the negative impacts of congestion. Understanding congestion patterns in the MAG region is useful to define a freight network that sidesteps major bottlenecks or roads with performance issues, to the extent that is feasible to do. Moreover, after designating the system it is important to identify links in the network that are currently facing the worst levels of congestion, and take action to eliminate bottlenecks on the key roads used by trucks. Performance challenges are difficult to avoid in network design because trucks have to travel where the business is, so as a practical matter, congestion data will have less influence on the definition of the freight network and more on the definition of its needs.

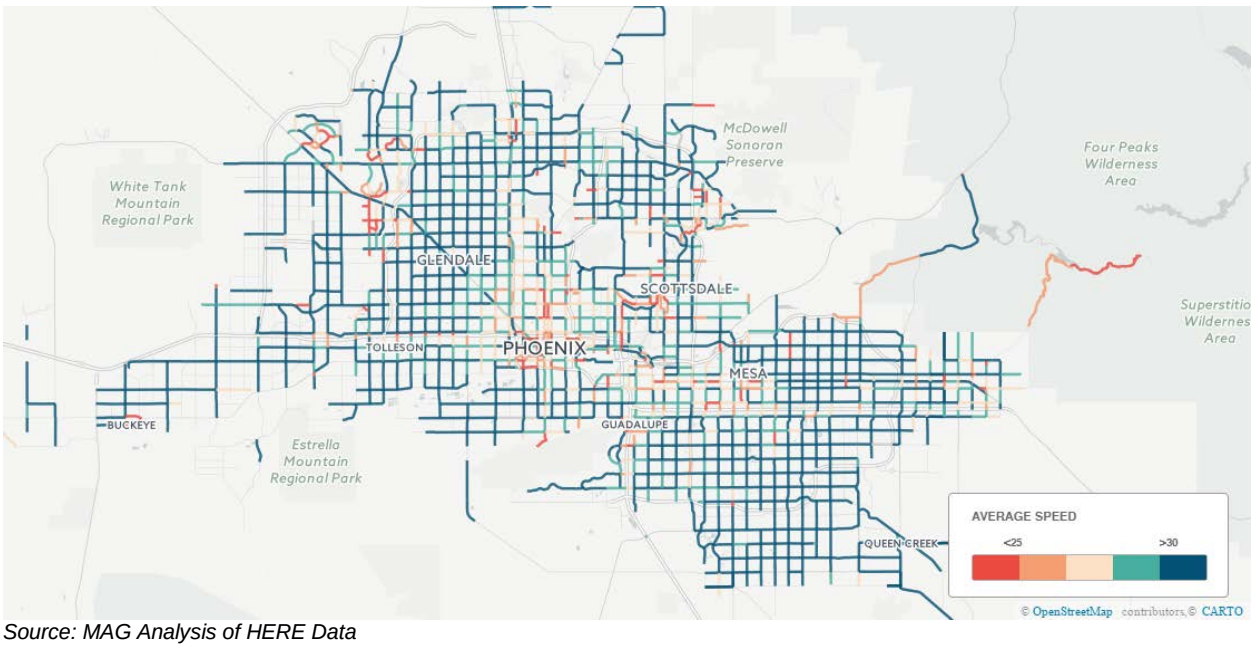
The congestion of a network can be assessed through various methods. One of the best approaches is to analyze GPS data on truck locations and speeds to track the ease with which they traverse different network segments. Such a data set is available for the MAG region. The ATRI GPS data that has been described previously in this report also contains timestamp information that can be used to calculate the instantaneous speeds of trucks. HERE, working with the Federal Highway Administration, has collected this data throughout the National Highway System and compiled it into a product called the National Performance Management Research Dataset with the objective of helping states and MPOs measure the performance of automobile and truck traffic.

HERE also develops more detailed data products based on these GPS records, which can be procured by public sector planning agencies. These other data sets prepared by HERE have additional level of spatial detail, considering other roads than those designated as part of the National Highway System. This is important to be able to assess the performance of the urban roadway network. For this analysis, the MAG region made available a processed version of this data set that calculated speeds from multiple months of records at different percentiles (5 percent, 20 percent, 50 percent, 95 percent). This provides a sense of the distribution of operating conditions, allowing us to capture the frequency and severity of speed fluctuations. These fluctuations can be caused by either recurring congestion—typical slowdowns of traffic during AM or PM peaks—or non-recurring congestion caused by incidents or weather, for example.

The data collected and processed by HERE represents one of the best tools available to assess network performance. Results are based on GPS records of observed traffic. However, it is important to keep in mind that the processing of the HERE data can introduce various biases into the analysis that can potentially lead to misguided results that don't agree with experience and observation. GPS devices have an error tolerance that is more than adequate for interstate travel, but can have issues in urban environments, especially if tall buildings are present. Moreover, the latitude and longitude records need to be assigned to specific roads on the network, which can be a challenging process when there are parallel roads, interchanges, or other network complexities. Invariably, approximations are needed in these steps to eliminate outlier data records and assign records to specific roads, which can potentially lead to misrepresentations in the data. Another source of uncertainty is defining when trucks start and end trips. Especially in an urban setting, delivery trucks will typically make tours that include multiple stops. If these stops are not removed, or controlled for in the processing of the GPS data, it could lead to the impression that travel speeds are much lower than in reality. HERE has sophisticated algorithms to make all of these approximations, to ensure that the quality and veracity of the final data product is as representative of conditions on the ground as possible.

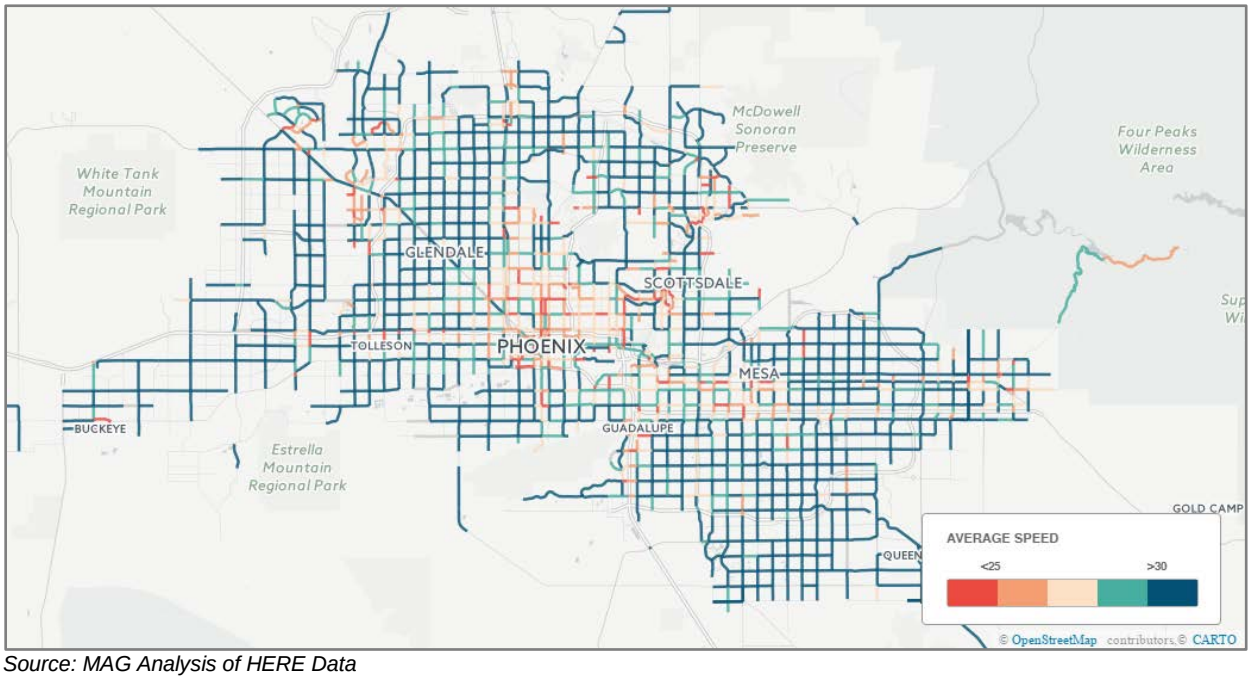
The average speeds of the roadway network during the AM peak are shown in Figure 46. Only data on local roads is shown. As expected, downtown Phoenix sees the lowest average speeds, with Tempe and Mesa second and third. There appears to be lower speeds west of downtown Phoenix, particularly in access points to I-10. This affects shipments to and from the industrial area surrounding W. Van Buren Street and W. Buckeye Road. A similar pattern of congestion is observed during the PM peak, as can be seen in Figure 47.

Figure 46: Average Truck Speed at 9-10AM



Source: MAG Analysis of HERE Data

Figure 47: Average Truck Speed at 4-5PM

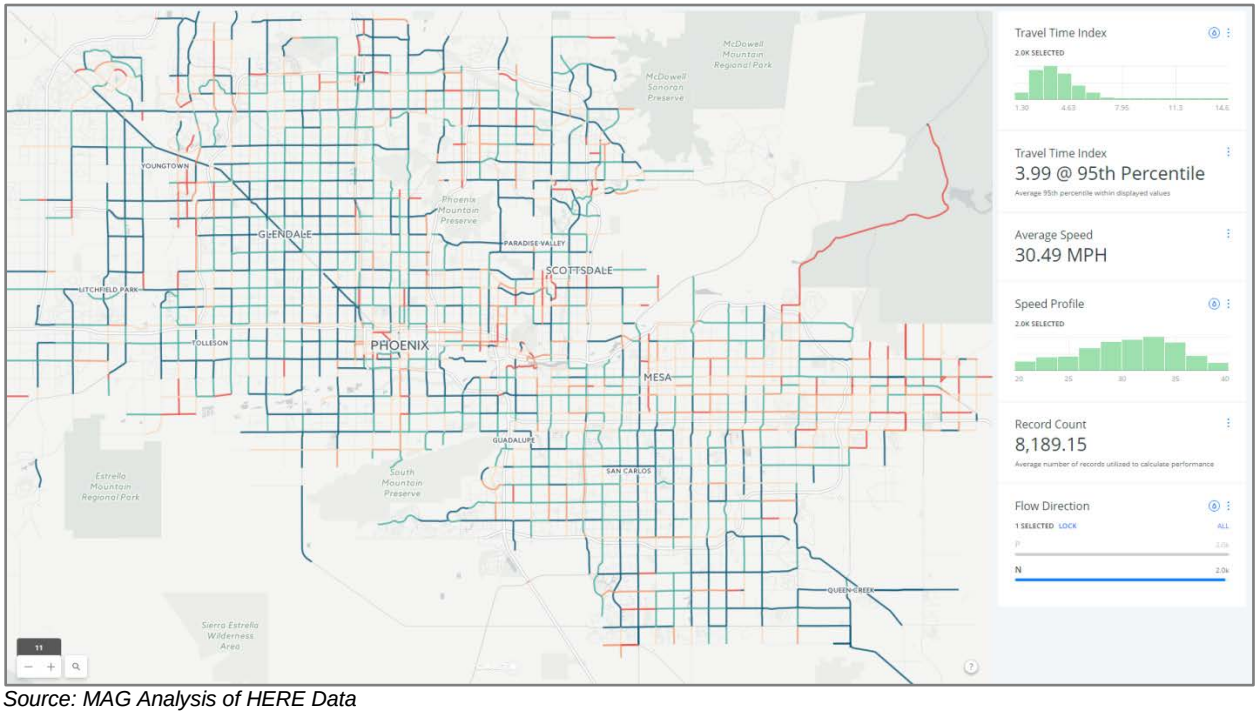


Source: MAG Analysis of HERE Data

A key measure to assess the performance of a roadway network is the Travel Time Planning Index. This index is typically defined as the ratio between the 95th percentile travel time and 50th percentile travel time, in order to measure how much worse travel times can be relative to the median (50th percentile). This metric agrees with the general principles that supply-chain managers use to assess system performance, namely: how often do trucks arrive on time. Different supply chains tolerate unreliability differently, but companies often report that they seek to be on time at least “95 percent of the time”.

A dashboard was created to analyze the HERE data provided by MAG and report the Travel Time Planning Index for various scenarios (Figure 48). This dashboard allows for results to be filtered by road direction: HERE provides speed estimations for both directions of travel. It also allows for the selection of a range of average operating speeds and/or ranges of Travel Time Indices, and also reports the number of GPS records that were used to calculate any particular result (which is an important parameter to ascertain the errors involved in the estimation of percentile speeds). The results shown in Figure 48 were obtained for the case where the Travel Time Planning Index is calculated for a 1-hour period in the morning. This means that the estimated indices will reflect non-recurring congestion as opposed to recurring congestion. Recurring congestion is unlikely to change considerably the operating profile of roads during any given hour of the day; therefore variations in travel speeds (leading to higher indices) are more likely to be caused by unusual changes in speeds from day to day for the same 1-hour period. The index reflects the likelihood that shipments reach their destinations on time, having already considered the effects of recurring congestion throughout the day.

Figure 48: Travel Time Index Dashboard, Average Weekday



Source: MAG Analysis of HERE Data

From the perspective of truck operations and supply-chain management, the Travel Time Planning Index is a telling measure. On time arrival for deliveries and pick-ups is a primary commitment of motor carriers to their customers. So as to ensure this commitment is met 95 percent of the time or better, carriers construct their schedules to allow for delay. This added time allowance or “buffer” represents fat in the schedule, and when the buffer is large – double or triple the median time and more – it constitutes a

significant loss of productivity. More trucks and more drivers are required to perform a given amount of work, and costs climb accordingly. Vehicle-miles travelled can climb as well, because for trucks making multiple stops (which is common in metropolitan delivery), several trucks must be sent to the same part of town and their cross-town “stem” miles mount up. The index thus offers a window into the reliability and productivity of freight movement in the MAG region, and will be an essential tool for performance management of the core freight network as well as for its design.

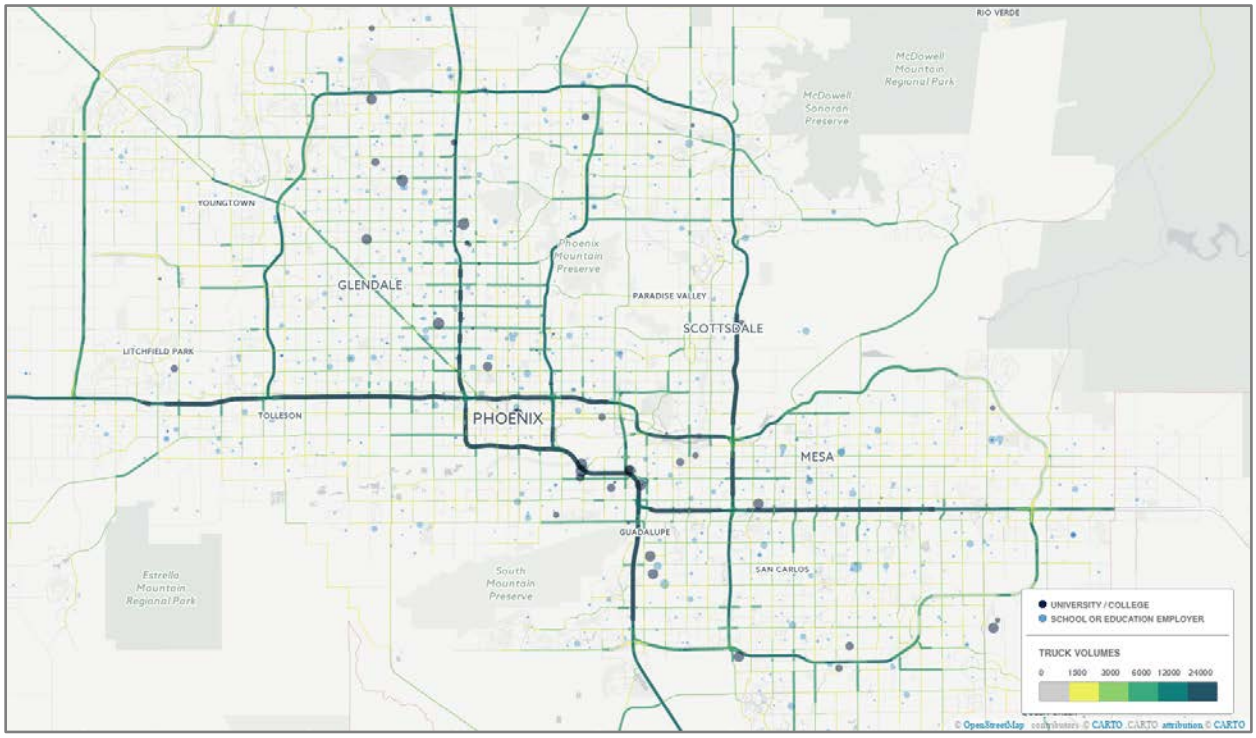
8.2 SAFETY

MAG takes transportation safety seriously and published its first safety plan in 2005. That plan has since been revised, and the current Strategic Transportation Safety Plan (STSP) was adopted in October 2015 for implementation between 2016 and 2025. The STSP incorporates all MAP-21 requirements, is designed to align with ADOT’s State’s Strategic Highway Safety Plan, and establishes a vision of zero deaths and zero injuries. Between 2008 and 2012, trucks were responsible for 27 percent of freeway fatalities, 10 percent of non-intersection-related fatalities on arterials and local roads, and 12 percent of intersection-related fatalities on arterials and local roads. In the same time period, truck crashes resulting in serious injuries represented 12 percent of freeway injuries, 8 percent of non-intersection-related fatalities on arterials and local roads, and 9 percent of intersection-related fatalities on arterials and local roads. Safety measures that have been or will be implemented will likely affect the freight industry and should be considered when developing the freight network in the region. Along the network, additional emphasis should be placed on promoting safety projects and mitigating potential risks to passenger and commercial vehicles.

The definition of the freight network should also be responsive to safety concerns. Railroad grade crossings (depicted earlier) are one aspect to consider; the presence of transit routes is another (to be added). A key factor is the location of land uses that are incompatible with freight movement. For example, truck travel passing by schools or pedestrian neighborhoods should be minimized, in order to minimize the negative impacts of moving freight through an urban setting.

Residential neighborhoods are rather pervasive and can be difficult to avoid when they follow major arteries. The location of educational facilities in Figure 49 offers a more sharply focused measure, since a good number of schools are serving neighborhoods. Schools certainly require supplies brought in by truck (such as food-service trucks for lunches), and college campuses can have significant supply requirements. Nevertheless, the designation of principal freight routes in a core system should mitigate potential conflicts for educational locations where there are adequate route alternatives.

Figure 49: Education Facilities and Truck Volumes



Source: MAG

9 Roadway Freight Network

9.1 APPROACH

This chapter sets forth the core roadway freight network. It was developed in an iterative process that built on the analysis presented in the previous pages and utilized extensive stakeholder input as described in chapter 2. It will be linked to development opportunities, and targeted for policy and investment as described in later chapters.

The first principle in designation is that the network should enable the fundamental function of freight: the provision of service to people and industry. That means it must reach the locations where businesses and people are supplied, which are the region's industrial and commercial districts. Accompanying this, it should connect to railroad, air cargo and pipeline ("tank farm") facilities, so that supply chains can optimize their selection of modes, and it should connect the producers of traded goods to external markets, because of the benefit they bring to the regional economy. Looking ahead, the network should accommodate growth and anticipate economic development. It should also cultivate such growth and development in at least two ways. First, it can enable investment to focus on key roadways whose performance drives service to business and population, improving the competitiveness of industry and the cost of consumer goods. Second, it can enable the deployment of new capabilities to be similarly focused, such as installation of alternative energy facilities or technology for connected infrastructure.

Based on the foregoing, three groups of information are particularly important for network designation:

- Truck volumes on roadways, taken from AADT estimates and checked against ATRI traffic patterns;
- Concentrations of industrial and commercial activity, taken from land use data, business establishment and cluster locations, development potential, and Transearch volumes for such significant categories as traded goods; and,
- The flow of goods, taken from Transearch data to indicate the roadways on which major industry depends, and to forecast traffic growth.

Network design also should incorporate route redundancy to protect service reliability, and corridor continuity so that roads are linked and dead ends mainly avoided.

Constraining the network are land use conflicts, especially with residential lands. Commercial districts are commonly adjoined to neighborhoods and need to be reached, but the roadways should function as access routes rather than cross-town thoroughfares. This same access should suffice to bring trucks close enough to local streets to support home delivery, at least until clear patterns emerge in that fast-changing market. Safety concerns should come into play for these roads and others, recognizing factors such as the grade crossings, school grounds, and transit routes cited earlier. Current performance and the risk it faces from growth is another element. Ideally, better performing roads are preferred, yet realistically these tend to be routes in lower demand. Where useful alternatives are available they should be adopted, but most often performance factors will shape investment more than route designation.

The technical approach to defining the freight network relied first on integrating into an innovative mapping platform as much information as possible about the local infrastructure, how it is used by freight, and the economic geography. This platform, called Carto, allows for different data types to be displayed with ease in the same view, with filters, toggles, and different types of user inputs to explore spatial relationships between the data. Over 50 different maps were generated in this platform that each

described a different aspect that was considered in defining the freight network. Carto offers excellent speed and flexibility in generating contextual aware maps, which allowed investigation of a wider range of information than would have been possible with traditional GIS methods. This approach was adopted because it supported robust, interactive and detailed analysis of network facilities and design factors, both by MAG and the study team and by regional stakeholders providing input to the definitional process. A draft network developed from technical factors was made available to participants, who could view the factors at a system and segment level and make recommended additions and deletions to the network facilities. The result of the several-month review process became the consensus final network.

9.2 FINAL FREIGHT NETWORK

The final Freight Network can be seen in Figure 50. The background of this map includes two critical data sources. The green shaded lines show the truck AADT estimates throughout the network. This is the same information already discussed in Figure 24. The background also includes purple dots representing a heat map of industrial employment. These are the same establishments shown previously in Figure 14. Because of the way this data is reported, it is likely that some of the purple dots represent employment in a whole company (or part of the company) instead of employment onsite. While employment is generally not a perfect indicator of freight generation or attraction, in this case it serves as a useful guide for identifying locations involved in industrial economic activities.

Selecting specific roadways and choosing between alternatives involves a number of local considerations. The overarching criteria used to select roads at the regional level were:

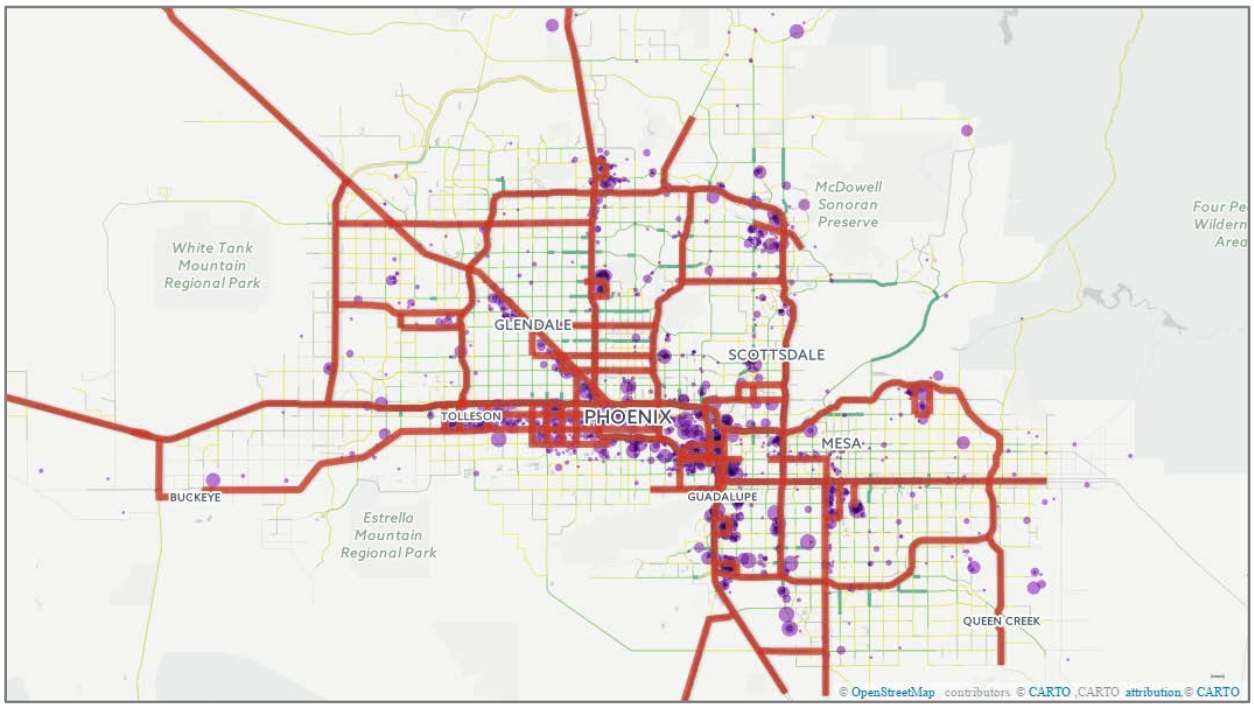
- Include all major highways and interstates that are used by trucks to enter and exit the region. These roads had the highest truck volumes seen in Figure 24.
- Include major loops and bypasses as they demonstrated substantial truck volumes
- Include roads that provide access to intermodal terminals seen in Figure 6 and Sky Harbor International Airport
- Include roads that had significant truck percentages (Figure 24) and did not have prominent truck volumes Figure 23
- Include roads that had moderate truck volumes, but where truck drivers did not have many or any viable alternative routes
- Include roads that connect the identified industrial clusters (Figure 13) with the regional roadway network. These connections were determined based on the volume on adjacent facilities, ATRI data showing the roads taken by trucks heading into and out of the identified industrial clusters, and routes associated with Transearch commodity flows.

The principles used to pick between seemingly redundant and equally valid roads were:

- Limit the number of parallel routes when possible in the regions grid-like urban road network to focus on the roads that can support this type of traffic the best
- Use information reported about the amount of employment in specific industries to choose between competing roads
- Limit the number of roads that only connect to the rest of the network in one direction unless they are needed to access certain clusters.

- Exclude routes that cross pedestrian-designed neighborhoods or communities that are predominantly residential, averting noise, pollution, and congestion impacts.
- Prioritize routes that passed next to land uses that could be developed in the future (Figure 20)
- Avoid roads that were observed to have low travel speeds (Figure 46 and Figure 47) or high travel unreliability (Figure 48)

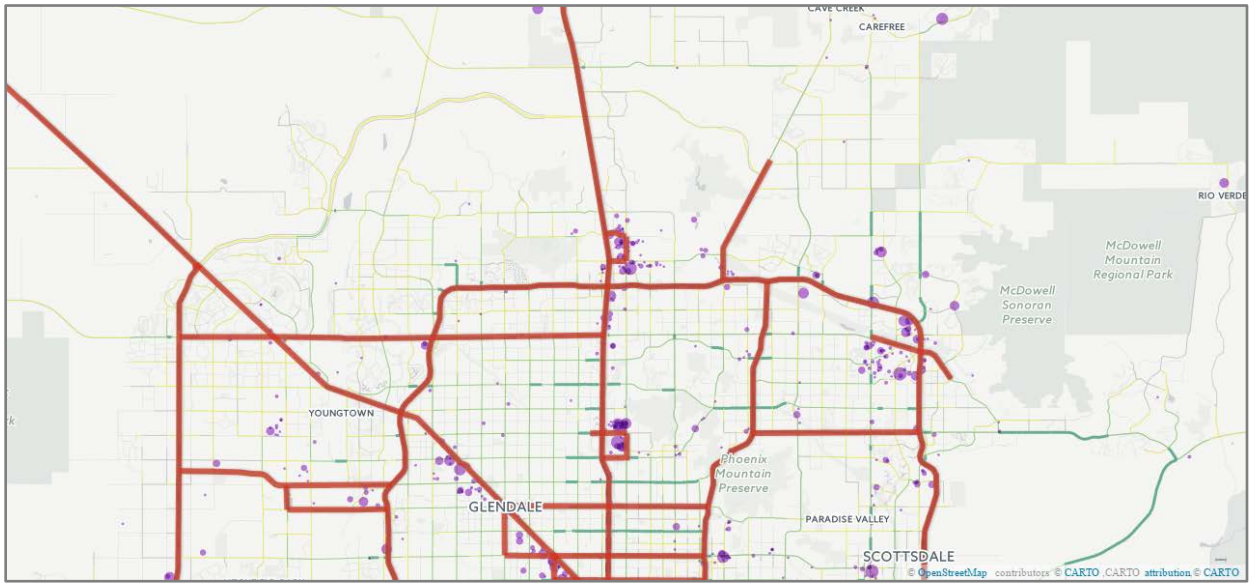
Figure 50: Final Freight Network with Overlay of Truck AADT (green shades) and Industry Employment (purple dots)



Source: WSP, MAG

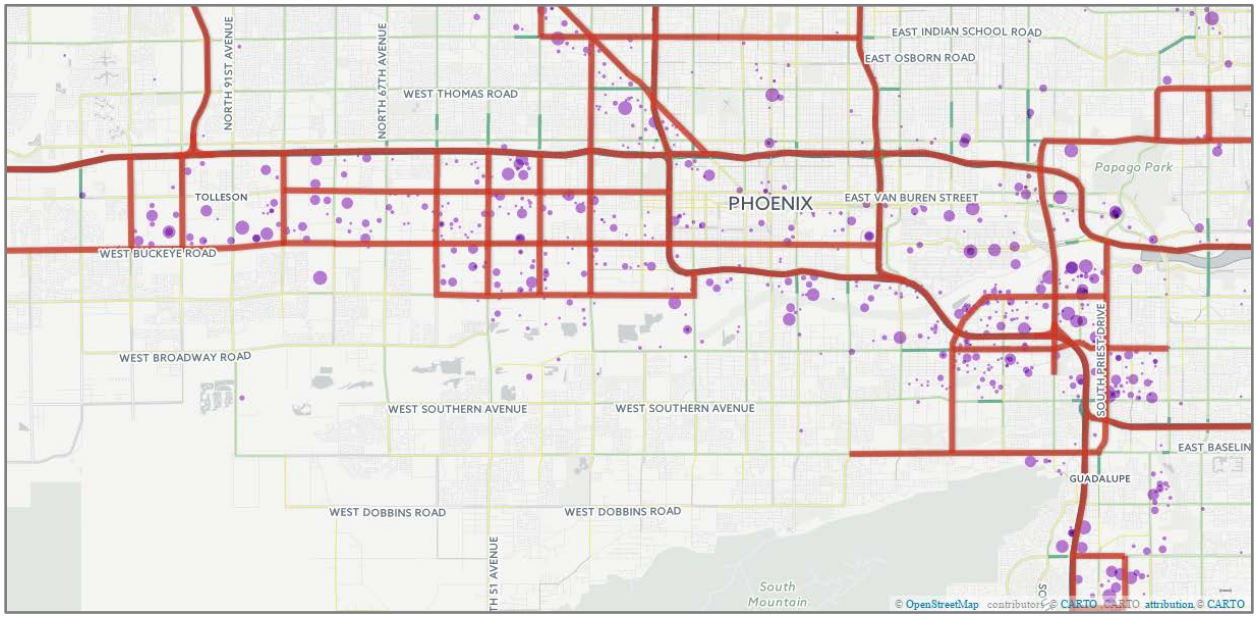
Figure 51, Figure 52, and Figure 53 provide additional details by zeroing in on the clusters described earlier in this report, and showing how the freight network serves the industry in those areas.

Figure 51: Freight Network, Deer Valley, Grand Avenue, and North I-17 Corridor Clusters



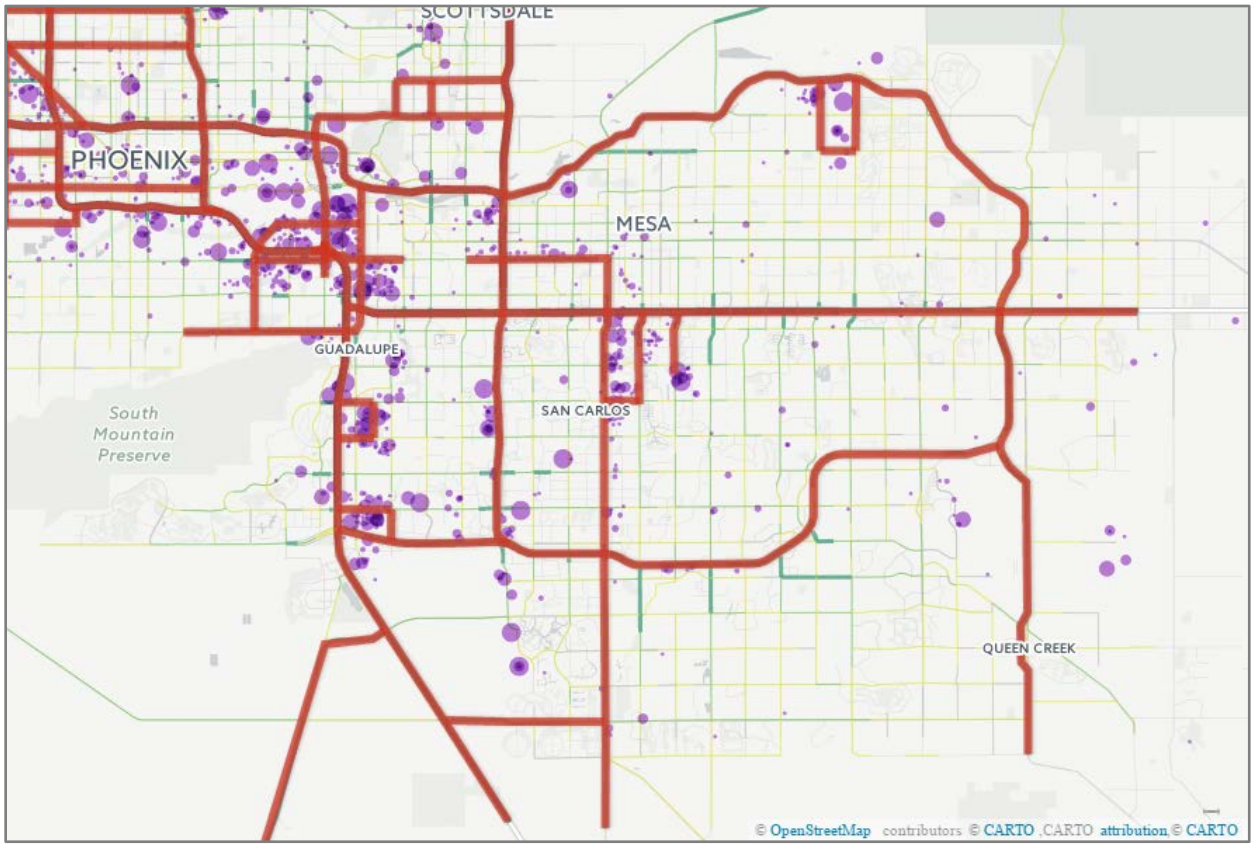
Source: WSP, MAG

Figure 52: Freight Network, South Southwest Phoenix and Sky Harbor Area Clusters



Source: WSP, MAG

Figure 53: Freight Network, Southeast Valley



Source: WSP, MAG

10 Regional Freight Network Evaluation

10.1 METHODOLOGY

This chapter presents the method for identifying segments of the final roadway freight network with priority performance needs. It begins with regional goals, which provide the planning process with a basis for identifying options, evaluating alternatives and making decisions on future transportation investments. The MAG Transportation Policy Committee identified four goals and an associated set of objectives, first approved in February, 2003. In addition, Arizona Revised Statute 28-6354.B directs MAG to develop criteria to establish the priority of corridors, corridor segments, and other transportation projects. Through the regional transportation planning process, MAG applied various prioritization criteria for the development of the Regional Transportation Plan. The Draft 2040 Regional Transportation Plan was recently updated on February 23, 2017 and maintains the previously establish goals and objectives.

The MAG Freight Transportation Plan identifies and prioritizes road segments to help identify project needs that ultimately will lead to project development and investment. The method is based on the region's four transportation goals interpreted in terms of freight. It requires priority segments to be situated on the MAG roadway freight network, because a key purpose of establishing the network is to concentrate investment on the principal freight facilities of the region, which the network defines. The method focuses on locations needing improvement instead of projects per se. This allows sites (route segments and corridors) without defined projects to compete with sites that have them. Effectively, this approach prioritizes needs on facilities. Further scrutiny then will be brought to the priority locations to establish the relevance of any existing projects to freight needs, and to evaluate and design new performance improvement projects.

In addition, this approach enables MAG to designate critical urban freight corridors (CUFCs, discussed below), which it is required to do by the federal FAST Act. The FAST Act ties project eligibility for federal freight funds to location on the CUFCs, and CUFC mileage is limited. This means that MAG must prioritize route segments and corridors in order to designate CUFCs, and the CUFCs determine project eligibility for funding. In other words, the method set forth here for prioritizing projects in terms of road segments satisfies both FAST Act requirements and region's requirement for deciding freight investment.

The multi-step process begins with a region-wide assessment and results in a prioritized list representing the best locations for future freight-focused transportation investment. The detailed method and steps are described next.

10.1.1 EVALUATION PROCEDURES

Explained in detail in section 10.3, the federal FAST Act requires MPOs in Arizona to designate up to 103 total miles of CUFCs within the state, which then are eligible for federal freight funds; ADOT allocated 60 of the 103 total miles to MAG. Interstates and certain other roadways belonging to a federally defined national freight system also are eligible to receive freight funds for projects, and MAG has made all such facilities part of its Freight Transportation Network. However, projects on roadways that are not part of the federally defined system cannot receive freight funds unless they are located on CUFCs (or on critical rural freight corridors designated by ADOT). All urban facilities in the MAG Freight Transportation Network that are not already part of the federally defined system qualify for designation as CUFCs because the design of the MAG network meets the federal criteria. Nevertheless, because no more than 60 MAG miles can receive CUFC designation, MAG must prioritize facilities by defining locations that most need improvements in order to make them eligible for funds. The methods described in the following sections

therefore enabled MAG to identify the top network locations for freight transportation investments. This accomplished two things: it allowed MAG to determine which network miles should receive CUFC designation and become eligible for federal freight funds, and more broadly, it allowed MAG to prioritize locations everywhere on its freight transportation network for application of other types of funds.

10.1.2 MEASURING GOAL ACHIEVEMENT

The method for network evaluation scores locations according to measures reflecting each of the four MAG transportation goals. This point based scoring method identifies the most important project needs through the gathering of data and aids the ability to determine which projects trend toward higher priority transportation investments. The scoring employs the Six Sigma Methodology, which was developed in the industrial sector as part of quality and continuous improvement processes. Six Sigma utilizes scoring values of zero, 1, 3, and 9. This triples the sizes of scores as they progress from low to high, which creates clearer distinctions between outcomes than conventional stepwise approaches. The top value of 9 indicates the areas of the network that best achieve the measured goal. This system provides an intuitive means to differentiate among the many competing options and improves the ability for regional decision makers to separate locations with tiers of priority.

10.1.3 COMBINING INDIVIDUAL GOAL SCORES

The scores for each goal are added together to create a composite score by which locations are ranked. However, individual goals don't necessarily have equal importance or impact on the performance of the freight system. To reflect this, public and private sector stakeholders were asked to assign weights to transportation goals according to their impact and stakeholder policy preferences. Compared to equal weighting; changes in weight advance certain locations and types of need over others, and ought to allow the resulting set of priorities to improve freight system performance more efficiently.

10.1.4 SETTING GOAL PRIORITIES

Discussion with public and private sector freight stakeholders resulted in assignment of the following weights to the four goal areas.

- 35 percent Goal 1: System Preservation and Safety
- 30 percent Goal 2: Access and Mobility
- 25 percent Goal 3: Sustaining the Environment
- 10 percent Goal 4: Accountability and Planning

10.2 NETWORK EVALUATION AND PRIORITIZATION

This section interprets from a freight perspective the four goals established by the MAG Transportation Policy Committee, and applies a tailored set of measures to assess the potential for improved freight performance in network locations to advance those goals. It then highlights the findings and observations that resulted from applying each goal's methodology to all 157 individual segments that comprise the core roadway freight network. Next, it composes the overall scores by combining all goals together in accordance with stakeholder defined weights. High scoring segments are then designated as priorities for improvement.

10.2.1 GOAL 1: SYSTEM PRESERVATION AND SAFETY

10.2.1.1 Goal and Measure

Transportation infrastructure that is properly maintained and safe, preserving past investments for the future.

This goal prioritizes locations with significant existing freight utilization, where intelligent transportation systems can improve operational practices, or locations with frequent occurrence of property damage and bodily injury resulting from freight usage. The higher volumes of freight traffic will prioritize maintenance projects to address good state of repair. Preservation and safety goals measure project performance as follows:

- One truck every 20-seconds (Daily average truck counts of 4,320 or greater) OR truck proportion of all vehicle traffic at 20 percent or greater
- Signalized or stop sign controlled intersection density five or greater per mile (at least one signalized intersection or stop sign controlled intersection per quarter-mile)
- Freight-related annual crashes 25 or greater per mile

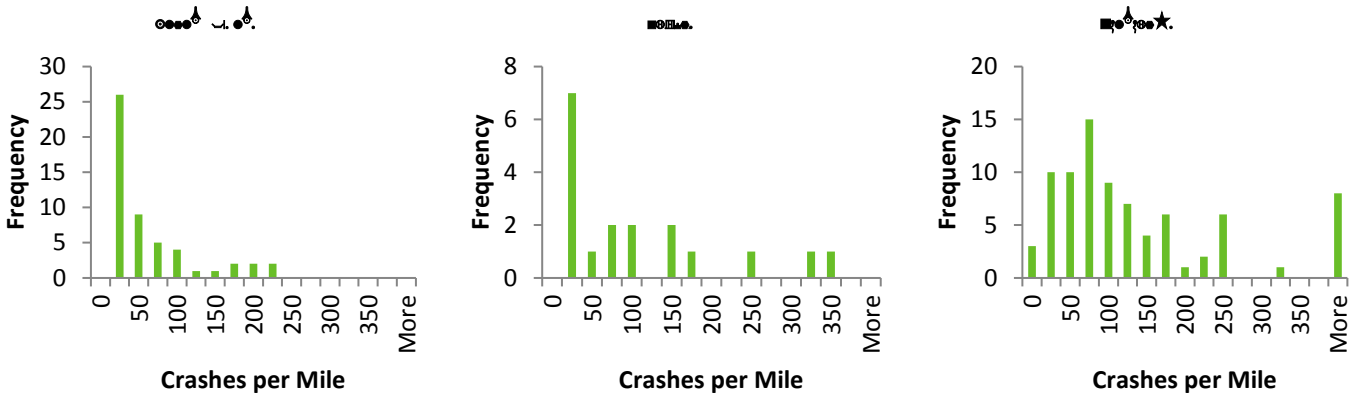
Measurement method: 9 = three criteria met; 3 = two criteria met; 1 = one criterion met; 0 = no criteria met

10.2.1.2 Outcome

The System Preservation and Safety goal sought to identify roadway segments with high freight utilization, a relative minimum density of intersections, and an above-threshold number of safety incidents, such that enhancements to the roadway could better manage future freight traffic.

- Freight Utilization: 80 percent of the segments evaluated were observed to have a freight utilization above the threshold.
- Intersection Density: Only 10 percent of the evaluated segments were observed to have an intersection density level above the scoring threshold of five or greater per mile.
- Crash Frequency: The evaluation of crash data along the freight network revealed variations in crash frequency across various roadway types. Overall, arterial segments experienced the highest average number of crashes per mile—92 over a five year period—of all roadway types. Highway segments experienced less than half as many crashes per mile—84 over a five year period—while state route segments averaged 26 crashes per mile over the same five year period. The histograms, below, visualize the distribution of crash frequencies observed along highway, arterial, and state route segments of the network.

Figure 54: Histograms of Crash Frequencies

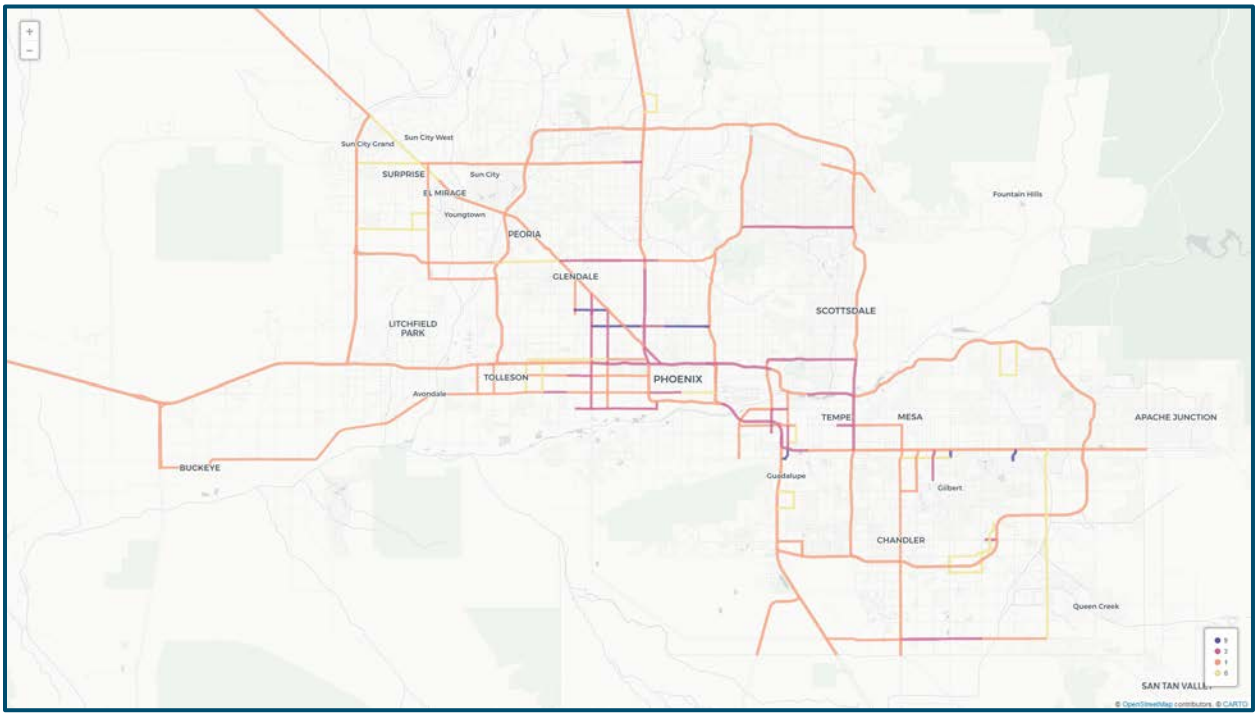


Across all roadway segments, the median crash per mile figure was found to be 125 over the five year data period, or approximately 25 crashes per mile per year. Segments that experienced this number of crashes or greater received a score for the crash criteria.

Ultimately, nine network segments achieved the maximum score of 9 for Goal 1, 37 received a score of 3, and 89 received a score of 1. The remaining 24 segments did not meet any of the Goal 1 criteria and therefore received a zero for the scoring category.

The map below shows the overall freight network, highlighting segments according to their Goal 1 scores.

Figure 55: Goal 1 Map



As indicated on the map, segments that score the highest on Goal 1 are clustered relatively close to central Phoenix, with several segments of Indian School Rd. and nearby Camelback Rd. receiving the highest scores possible.

10.2.2 GOAL 2: ACCESS AND MOBILITY

10.2.2.1 Goal and Measure

Transportation systems and services that provide accessibility, mobility and modal choices for residents, businesses and the economic development of the region.

Goals prioritize reliable access to regionally identified areas of contiguous freight land uses. These are the areas reliant upon access to a skilled workforce employed in logistics-related jobs. Businesses employ residents. Workforces within job sustaining freight-related industry are frequently reliant upon transit modes. Thus, the region prioritizes corridors that maintain or improve the environment supportive of both freight and transit access.

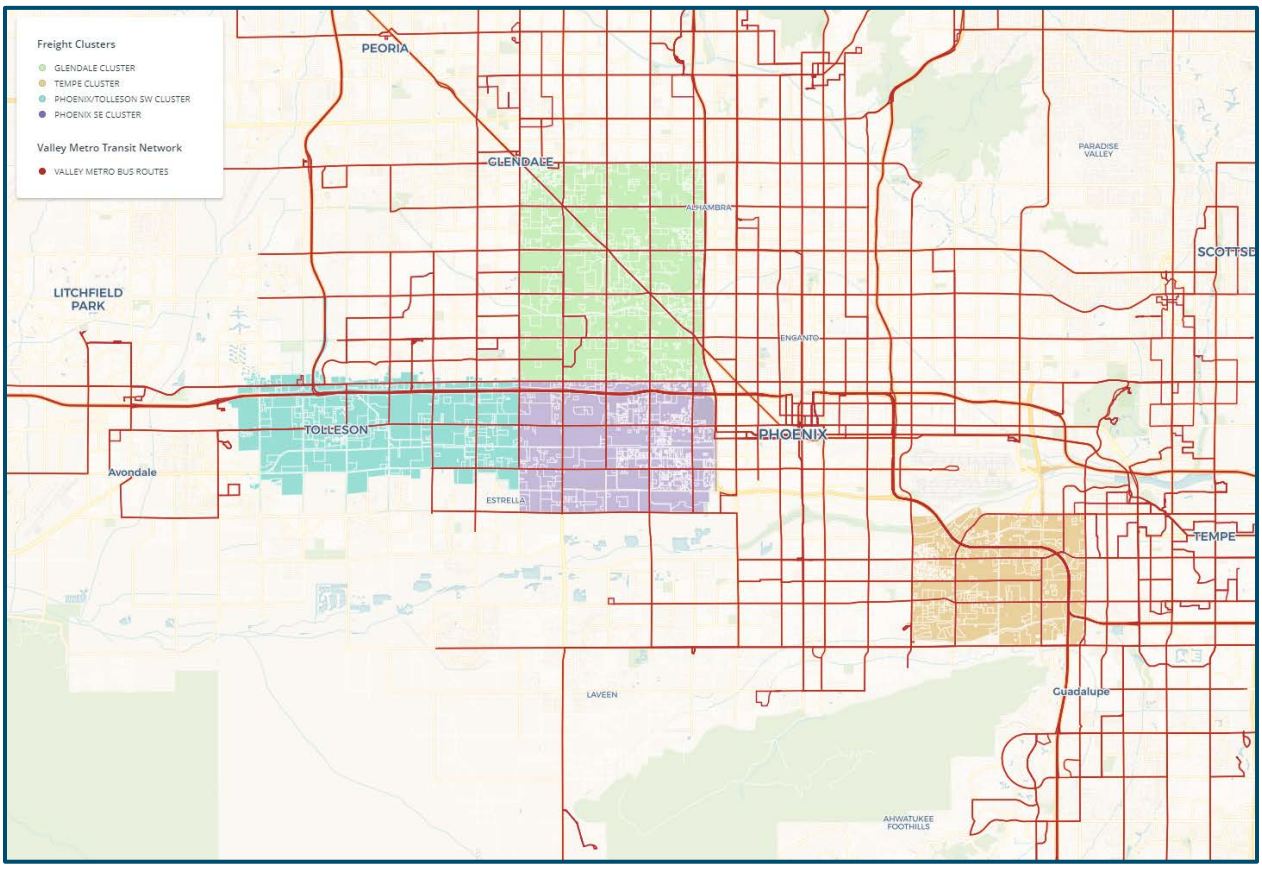
Access and mobility goals measure projects as follows:

- 9 = In a designated freight cluster or adjacent to intermodal facility (within one mile) and containing a bus route with 30-minute or greater frequencies
- 3 = In a designated freight cluster or adjacent to intermodal facility (within one mile)
- 1 = Not in a designated freight cluster but provides connection to external markets
- 0 = no criteria met

10.2.2.2 Outcome

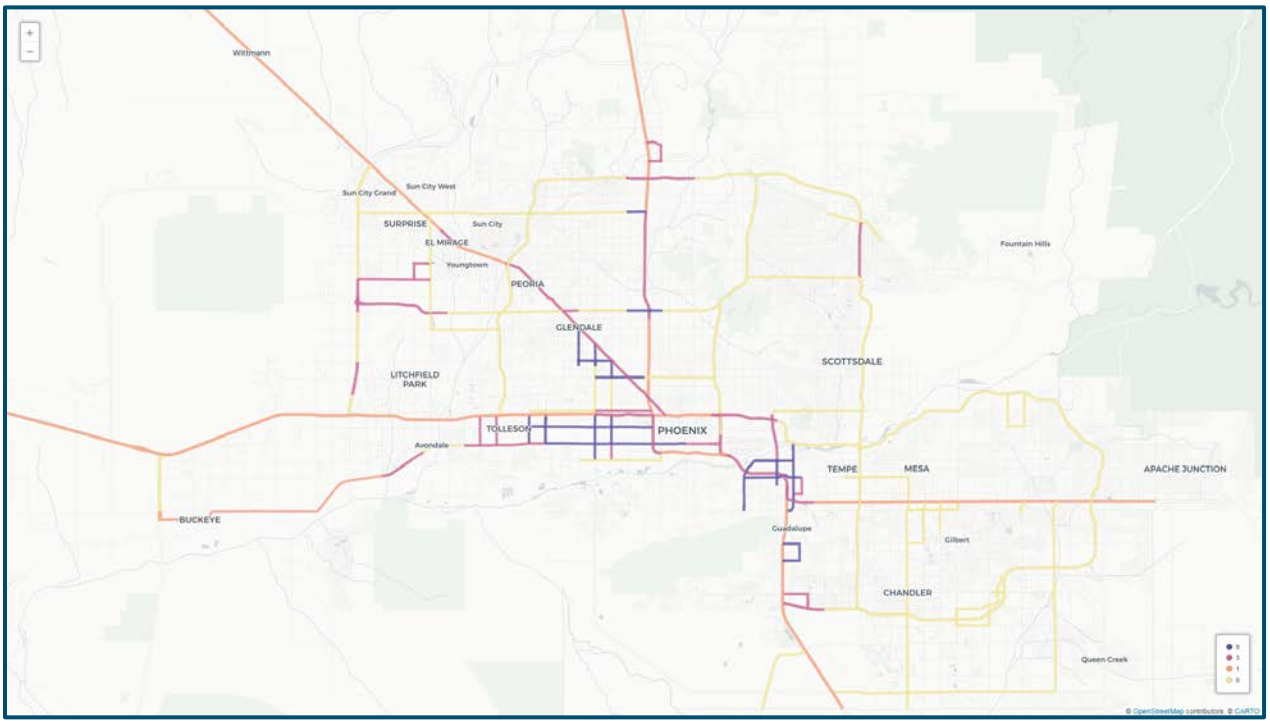
This goal aimed to prioritize network segments that offer greater accessibility and access for the workforce, customers, and operators of freight enterprises. As such, the methodology favored segments that exist in designated freight clusters and offered transit access via the Valley Metro bus network, depicted on the maps below.

Figure 56: Freight Clusters and Valley Metro Bus Network



Thirty of the 157 segments received a top score of nine for Goal 2, 39 received a score of 3, and 21 segments scored a 1. The remaining 67 segments received a score of zero, indicating that they are not in or near a freight cluster, or provide connections to external markets. The following map highlights roadway segments according to their composite, Goal 2 scores.

Figure 57: Goal 2 Map



Many of the segments that scored high in Goal 1 also received high scores for Goal 2, including segments along Indian School Road and Camelback Road. However, a number of roadway segments south of I-10 in Central Phoenix also scored high on Goal 2 including long stretches of W. Buckeye Road and W. Van Buren Street, as well as S. 32nd Street, E. Broadway, and S. Priest Drive.

10.2.3 GOAL 3: SUSTAINING THE ENVIRONMENT

10.2.3.1 Goal and Measure

Transportation improvements that help sustain our environment and quality of life.

The intention of this goal is to reduce emissions from stop-and-go traffic and from idling vehicles. Goals also prioritize corridors where mobility has been reduced by significant freight demand and existing reliability has deteriorated. Thus, the region prioritizes projects and operational strategies that improve mobility and restore predictable travel times. Location performance in sustaining the environment measures projects based upon the following factors:

- 9 = Motor vehicle peak hour travel time is triple or more the travel time during typical traffic and location provides redundancy to the Primary Highway Freight System (measured as adjacency within 1 mile straight line distance). Typical traffic is defined as the median observed travel time, and peak is defined as the 95th percentile, meaning that only 5 percent of observed travel times are slower

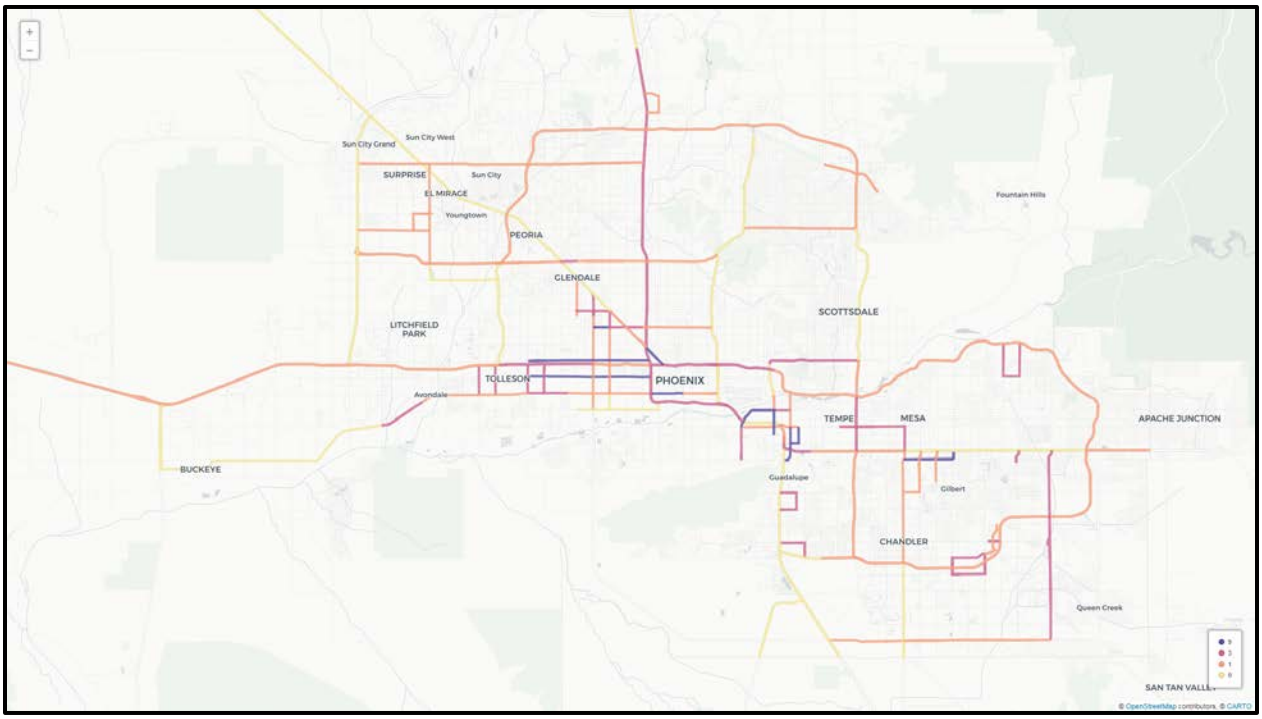
- 3 = Motor vehicle peak hour travel time is triple or more the travel time during typical traffic
- 1 = Motor vehicle peak hour travel time is double the travel time during typical traffic
- 0 = no criteria met

10.2.3.2 Outcome

Goal 3 aimed to prioritize segments that at which freight route investments have the most potential to improve the environmental condition and quality of life along the roadway. To identify these segments, the methodology criteria awarded higher scores to areas that experience a high level of congestion and provide redundancy to the Primary Highway Freight System. The distribution of scores for this goal resulted in most segments (109 of the 158 total segments evaluated) receiving a 1 or 3, with only 17 segments scoring the maximum 9 points and 30 segments receiving a zero.

The segments that received top scores in this area also scored highest in the previous goals—lengthy segments of W. Van Buren St. and W. McDowell Rd., as well as E. University Dr. and S. Priest Dr. The map below displays the freight network segments' Goal 3 scores.

Figure 58: Goal 3 Map



10.2.4 GOAL 4: ACCOUNTABILITY AND PLANNING

10.2.4.1 Goal and Measure

Transportation decisions that result in effective and efficient use of public resources and strong public support.

The goal should prioritize projects in corridors that carry economically significant volumes of trade and commerce so improvements – and returns on project investment - are linked to regional economic

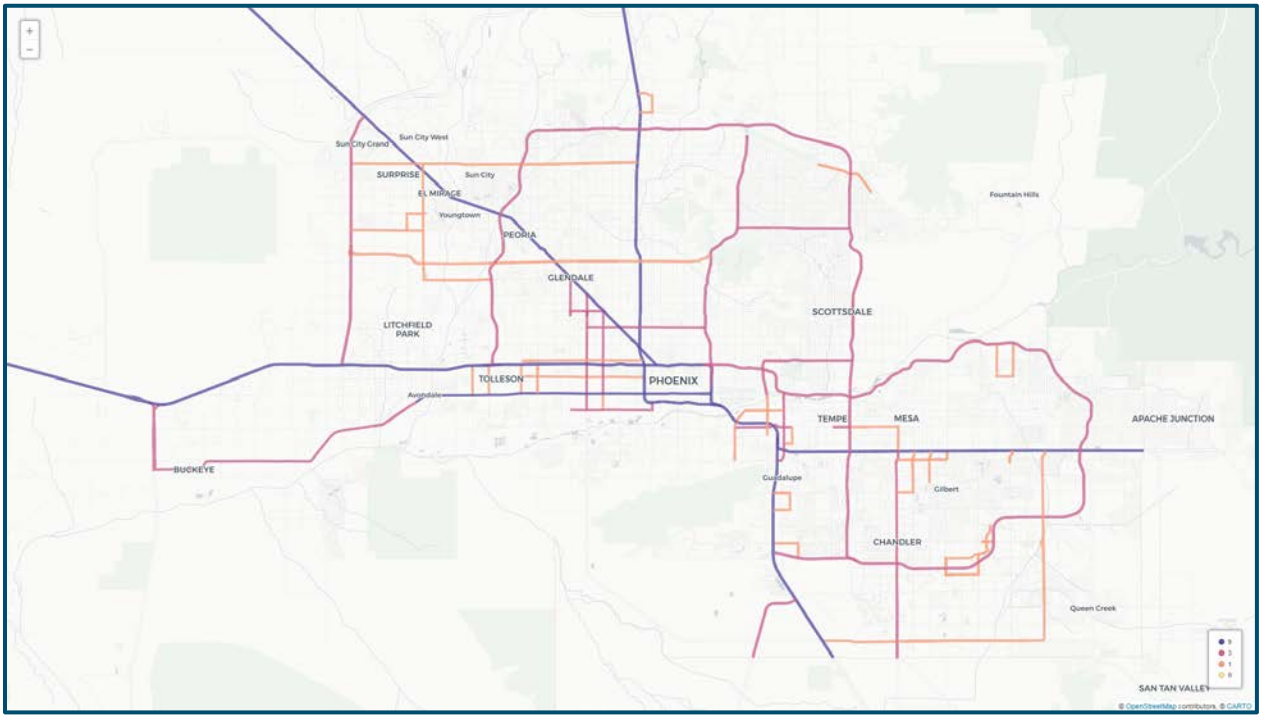
development. The regional roadway freight network provides the principal means of serving business and population, and of supporting the regional economy. The value of the shipment can be interpreted as relating to the value of the goods to the broader economy and consumers. High-value shipments in particular are especially costly to encumber with congestion and unreliability in the network. Location performance for accountability and planning is based upon:

- 9 = Carries greater than $900M in annual product value
- 3 = Carries greater than $300M in annual product value
- 1 = Carries greater than $100M in annual product value
- 0 = no criteria met

10.2.4.2 Outcome

The final assessment area, Goal 4, scored segments according to the economic value that they hold for the region's businesses and consumers, as measured by millions of dollars of annual product value that flow along the segment. 41, or 25 percent of all segments scored the maximum nine points in this goal, with the remaining segments roughly split between those being awarded either 3 or 1 point. As can be observed in the map below, the top scoring segments were predominantly those along the major interstate corridors and SR 60, although the entire W. Buckeye Rd. corridor also scored high in this area.

Figure 59: Goal 4 Map

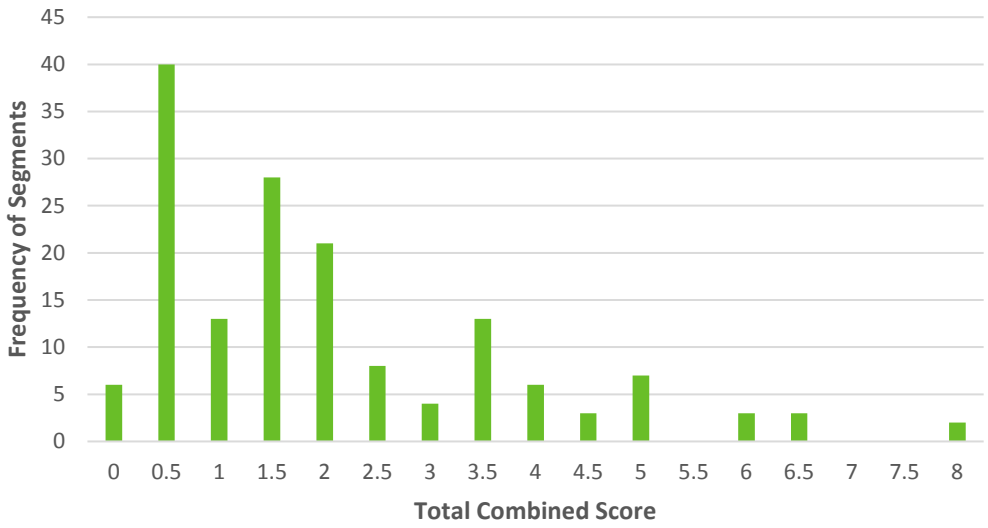


10.2.5 SUMMARY FINDINGS AND OBSERVATIONS

As described above, the four goal areas were combined and weighted to produce a final, composite score for each roadway segment. As indicated on the histogram below, the scoring methodology resulted in a

distribution of segments in which most scored relatively low, with only 25 percent of the segments scoring above 3.0 and 10 percent of segments scoring above 5.0. The median segment score was 1.8.

Figure 60: Histograms of Segment Scores



The highest scoring segments are shown on the following table.

Table 13: Table of Highest Scoring Segments

Route Name	Route Start	Route End	Goal 1 Score	Goal 2 Score	Goal 3 Score	Goal 4 Accountability and Planning	Score
Indian School Rd	N. 51st Ave.	Freight Study Corridor Boundary	9	9	9	3	**8.4**
S. Priest Dr.	I-10	US 60	9	9	9	3	**8.4**
Buckeye Rd.	I-17	S. Central Ave.	3	9	9	9	**6.9**
Camelback Rd.	N. 59th Ave.	N. 43rd Ave.	9	9	3	3	**6.9**
Indian School Rd	Freight Study Corridor Boundary	N. 27th Ave.	9	9	3	3	**6.9**
S. Priest Dr.	W. Broadway Rd.	US 60	3	9	9	3	**6.3**
S. 48th St.	E. Roeser Rd.	W. University Dr.	3	9	9	1	**6.1**
W. Van Buren St.	N. 63rd Ave.	N. 51st Ave	3	9	9	1	**6.1**
S. Gilbert Rd.	US 60	E. Baseline Rd.	9	0	9	1	**5.5**
Buckeye Rd.	S. 75th Ave.	S. 63rd Ave.	3	9	3	9	**5.4**
University Dr.	E. Broadway Rd.	SR 143	1	9	9	1	**5.4**

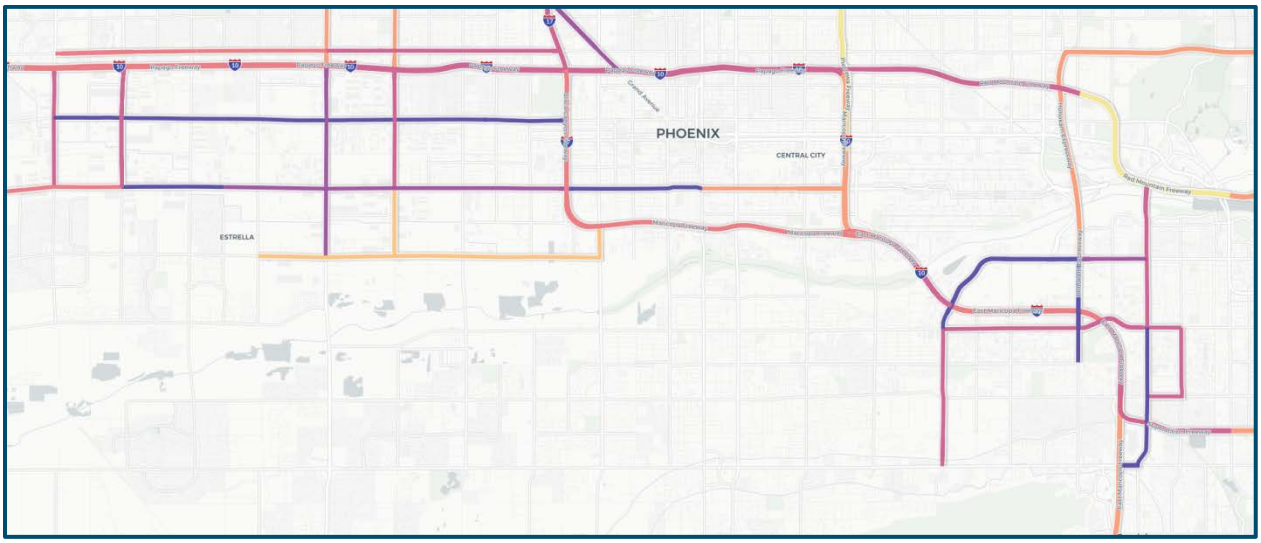
W. Van Buren St.	N. 75th Ave.	N. 63rd Ave.	1	9	9	1	**5.4**
W. Van Buren St.	N. 51st Ave	I-17	1	9	9	1	**5.4**
W. Van Buren St.	N. 83rd Ave.	N. 75th Ave.	1	9	9	1	**5.4**
US 60	I-10	I-17	3	3	9	9	**5.1**

Visualizing the score for each segment of the network results in the map shown below, and indicates that the priority freight segments are largely located towards central Phoenix and near the I-10 / SR 60 interchange in Tempe.

Figure 61: Final Prioritization Map

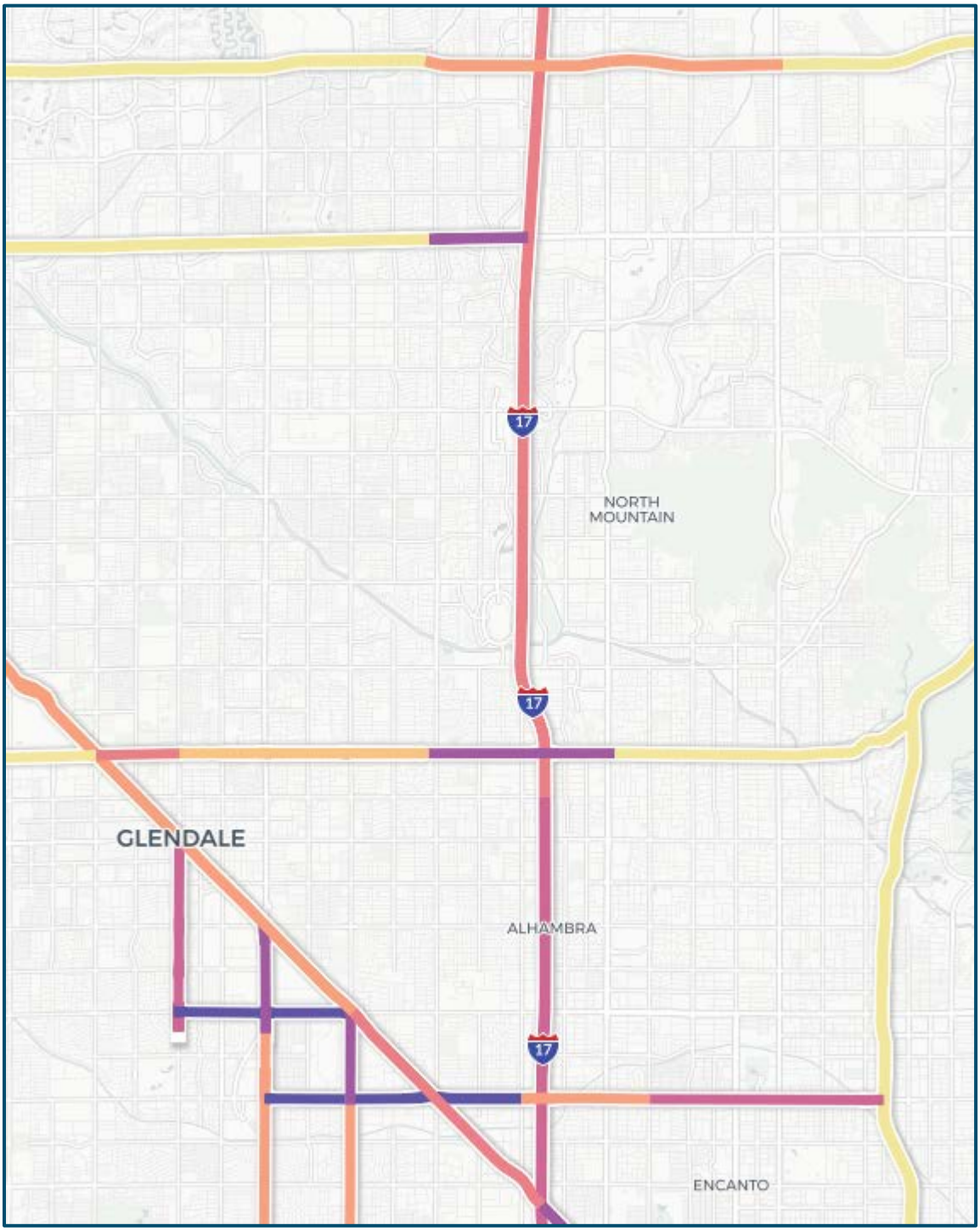
Focusing in on this central area reveals some of the highest priority segments including those along W. Buckeye Rd., S. Priest Dr., Indian School Rd., W. Van Buren St., E. University Dr., and S. 51st Ave.

Figure 62: Final Prioritization Map (Zoom-in on Central Phoenix / Tempe)



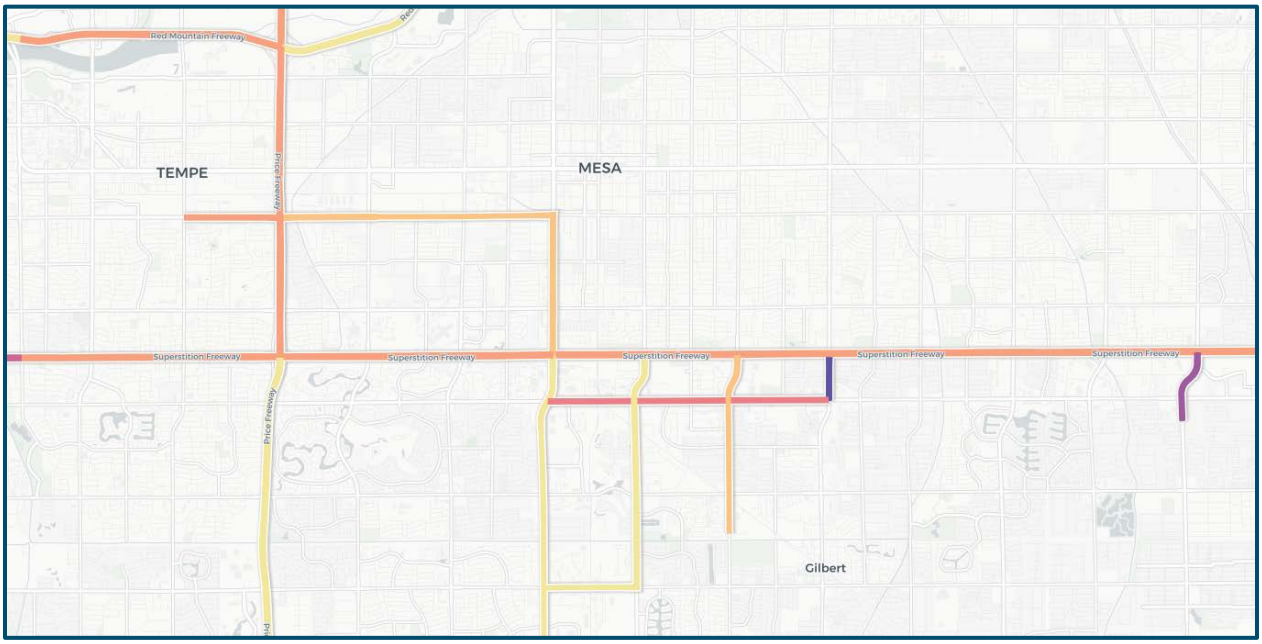
North of central Phoenix, I-17 earns a higher than average prioritization score of approximately 2.9. Shorter segments that intersect the interstate, such as W. Bell Rd. and W. Northern Ave., score even higher, at 4.1. Most of the remaining freight corridors in this part of the region score below average, although SR 60 should be noted for scoring high on its Goal 4 metric, due to the large value of goods that the corridor carries.

Figure 63: Final Prioritization Map (Zoom-in on North-Central Phoenix)



Similar observations can be made about the southeast portion of Maricopa County, in and around Mesa, Gilbert, Chandler and Tempe. I-10 and SR 60 score low overall, despite serving as valuable freight corridors, while several short, adjacent segments earn a higher than average prioritization score. These segments include S. Gilbert Rd., N. Higley Rd., W. Baseline Rd., and the W. Elliot Rd. Loop. SR 202 and the other large arterials in this part of the network score below average.

Figure 64: Final Prioritization Map (Zoom-in on Southeastern Phoenix)



10.3 CRITICAL URBAN FREIGHT CORRIDORS

The federal FAST Act calls for designation of critical urban and rural freight corridors around the nation. Responsibility for the former rests mostly with large MPOs such as MAG and PAG in Arizona; responsibility for the latter rests with state departments of transportation (DOTs), even though some rural mileage may fall in the territory of MPOs. The significance of these corridors stems from the FAST Act's creation of two new sources of freight funds: "formula" funds apportioned to each state, and "FASTLANE" competitive grants. Arizona receives $116.8 million in formula money over five years, or approximately $23 million per year. The FASTLANE program offers $500 million nationwide over five years, with less available in the first few years and more thereafter.

The eligibility of projects for both sources of funds is tied almost entirely to location on the National Highway Freight Network (NHFN; smaller amounts of money are set aside for rail and port projects). The NHFN has four components. The first is a national Primary Highway Freight System (PHFS), which is defined in the Act and constitutes most of the NHFN. The second is the approximately 20 percent of interstate highway miles that are not part of the PHFS. The remaining two NHFN components are the CRFCs and CUFCs. Thus, designation of CRFCs and CUFCs is virtually[10] the only way in which states

[10] Intermodal connectors automatically are part of the Primary Highway Freight System. Connectors are defined by states and submitted to Federal Highway Administration, so this is another way in which National Highway Freight Network mileage can be affected by states.

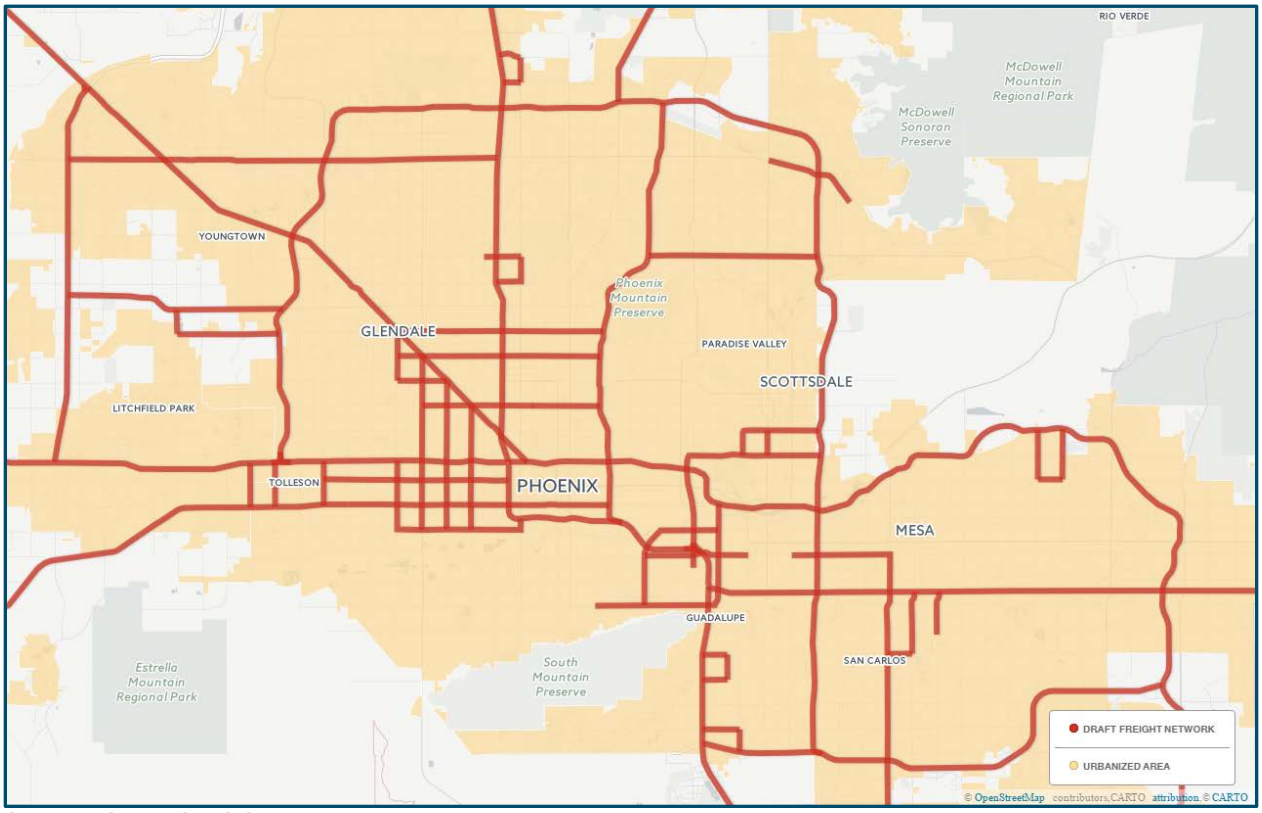
and MPOs can influence the definition of the NHFN, which in turn determines where the new FAST Act freight funds may be applied.

The PHFS in Arizona consists of I-10, I-15, I-17, I-19, I-40, and 37 miles of other roadways and intermodal connectors, totaling 1,026 miles statewide. The predominance of interstate highways is typical of the PHFS definition throughout the country. Arizona has an additional 179 miles of non-PHFS interstates that are part of the NHFN; however, under FAST Act provisions, these additional miles are eligible for FASTLANE grants but not for use of formula funds. Finally, Arizona may designate up to 205.1 miles of CRFCs and 102.6 miles of CUFCs; both are eligible for the two sources of FAST Act freight funds. All told, the NHFN in Arizona may total as much as 1,513 miles, of which 1,334 miles may receive formula money for projects, and the full 1,513 miles may be the site of projects seeking FASTLANE grants.

Of all these miles and categories, the CUFCs are the only ones for which MAG has jurisdiction. Even so, because the 102.6 miles of CUFCs are a statewide maximum, designation must be agreed upon with ADOT. MAG and ADOT have settled on an allocation to MAG of 60 CUFC miles, or just over 58 percent of the state total. In terms of qualifications, the FAST Act stipulates that urban corridors must a) connect intermodal facilities (such as Sky Harbor International Airport) to the PHFS, the interstate system, or an intermodal freight facility; or, b) lie within a PHFS corridor and provide an alternative highway option; or, c) provide service to major freight generators, logistics centers, and manufacturing and warehouse land; or, d) simply be regarded as important to the movement of freight in the region as determined by the MPO or state. This effectively means that the entirety of the MAG roadway freight network that falls within its urbanized region will qualify, because the network is designed to provide connection, service and redundancy as the Act envisions, and when adopted, it will reflect the consensus of MAG and its stakeholders as to the regional facilities important to freight movement.

Eligibility for rural corridors is defined more elaborately, but also allows for “facilities determined by the state to be vital to improving the efficient movement of freight of importance to the economy of the state”. Thus, the small portions of the MAG roadway freight network that lie in rural areas ought to be able to qualify, although the selection falls to AODT. Figure 65 displays how the draft network lies in respect to urban and rural areas of the MAG region (rural areas in this map are those that are not identified as urban).

Figure 65: Urbanized Area and Final Freight Network



Source: WSP, MAG, US Census

The implication of all this is that freight network eligibility for critical urban and rural corridor designation is not at issue and the entire network as able to qualify. The difficulty lies with the statewide mileage limits. In regard to limits, the Federal Highway Administration points out that designated facilities may have their designation removed later on in favor of others, which means that the designation is moveable. Since the value of designation is qualification for funds, the implication is that it should be applied to eligible roadways where the region has priority needs and projects, and shifted over time in anticipation of investments. Thus, the ultimate recommendation of corridors by MAG to ADOT should be a function of the priority needs for investment on the freight network put forth earlier in this chapter.

Consequently, MAG in consultation with ADOT, proposed to FHWA that the 60 highest priority miles identified in the prioritization effort – all of them urban - be designated as CUFCs. Those segments are listed in Table 14 and presented in Figure 66.

Figure 66: MAG Critical Urban Freight Corridors

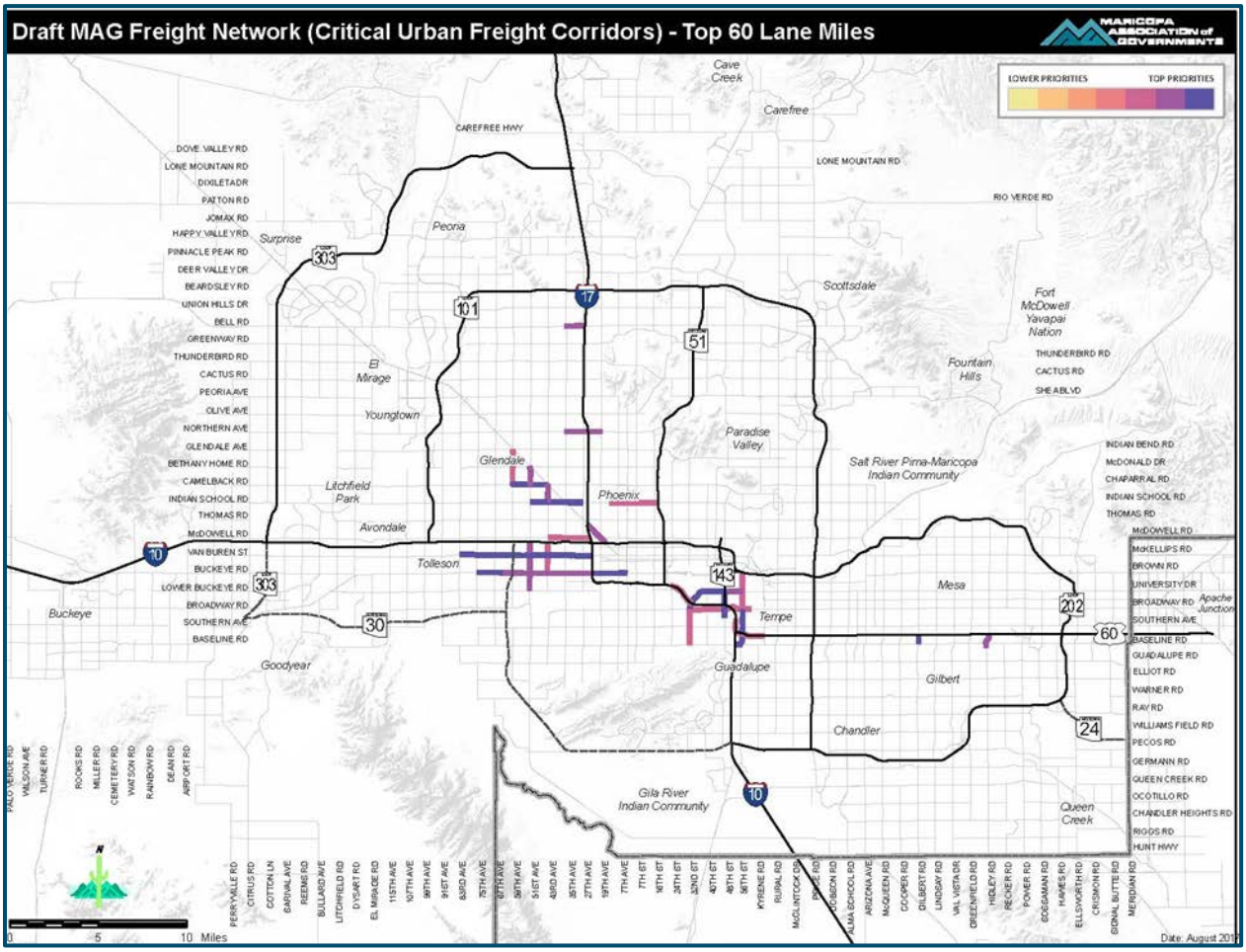


Table 14: MAG Critical Urban Freight Corridors

Route Name	Route Start	Route End	Rank	Urban miles	City Start	City End
Indian School Rd	N. 51st Ave.	Freight Study Corridor Boundary	1	0.90	Phoenix	Phoenix
S. Priest Dr.	I-10	US 60	2	0.92	Tempe	Tempe
Buckeye Rd.	I-17	S. Central Ave.	3	1.99	Phoenix	Phoenix
Camelback Rd.	N. 59th Ave.	N. 43rd Ave.	4	2.00	Glendale	Phoenix
Indian School Rd	Freight Study Corridor Boundary	N. 27th Ave.	5	2.10	Phoenix	Phoenix
S. Priest Dr.	W. Broadway Rd.	US 60	6	1.38	Tempe	Tempe

Route Name	Route Start	Route End	Rank	Urban miles	City Start	City End
S. 48th St.	E. Roeser Rd.	W. University Dr.	7	1.52	Tempe	Tempe
W. Van Buren St.	N. 63rd Ave.	N. 51st Ave	8	1.50	Phoenix	Phoenix
S. Gilbert Rd.	US 60	E. Baseline Rd.	9	0.46	Mesa	Mesa
Buckeye Rd.	S. 75th Ave.	S. 63rd Ave.	10	1.49	Phoenix	Phoenix
University Dr.	E. Broadway Rd.	SR 143	11	2.60	Phoenix	Tempe
W. Van Buren St.	N. 75th Ave.	N. 63rd Ave.	12	1.49	Phoenix	Phoenix
W. Van Buren St.	N. 51st Ave	I-17	13	3.52	Phoenix	Phoenix
W. Van Buren St.	N. 83rd Ave.	N. 75th Ave.	14	0.99	Phoenix	Phoenix
US 60	I-10	I-17	15	1.49	Phoenix	Phoenix
N. 43rd Ave.	US 60	Freight Study Corridor Boundary	16	1.12	Phoenix	Phoenix
N. 51st Ave.	US 60	Camelback Rd.	17	1.01	Glendale	Glendale
W. University Dr.	SR 143	S. Priest Dr.	18	1.00	Tempe	Tempe
S. 51st Ave	I-10	Buckeye Rd.	19	1.79	Phoenix	Phoenix
S. 51st Ave	Buckeye Rd.	Lower Buckeye Rd.	20	0.99	Phoenix	Phoenix
Buckeye Rd.	S. 63rd Ave.	S. 51st Ave	21	1.50	Phoenix	Phoenix
Buckeye Rd.	S. 51st Ave	I-17	22	3.53	Phoenix	Phoenix
W. Bell Rd.	Freight Study Corridor Boundary	I-10	23	1.16	Phoenix	Phoenix
W. Northern Ave.	Freight Study Corridor Boundary	Freight Study Corridor Boundary	24	2.32	Phoenix	Phoenix
N. Higley Rd.	US 60	End of Network	25	0.77	Mesa	Gilbert
S. 32nd St.	End of network	E. Broadway Rd.	26	1.99	Phoenix	Phoenix
Indian School Rd	N. 15th Ave.	SR 51	27	2.76	Phoenix	Phoenix
E. Broadway Rd.	S. 32nd St.	S. Hardy Dr.	28	3.54	Phoenix	Tempe
N. 43rd Ave.	Buckeye Rd.	I-10	29	1.75	Phoenix	Phoenix
I-10	I-17	S. 32nd St.	30	1.61	Phoenix	Phoenix
N. 59th Ave.	US 60	Camelback Rd.	31	2.00	Glendale	Glendale
S. Priest Dr.	W. Broadway Rd.	SR 202	32	2.08	Tempe	Tempe
W. McDowell	N. 43rd Ave.	I-17	33	2.42	Phoenix	Phoenix

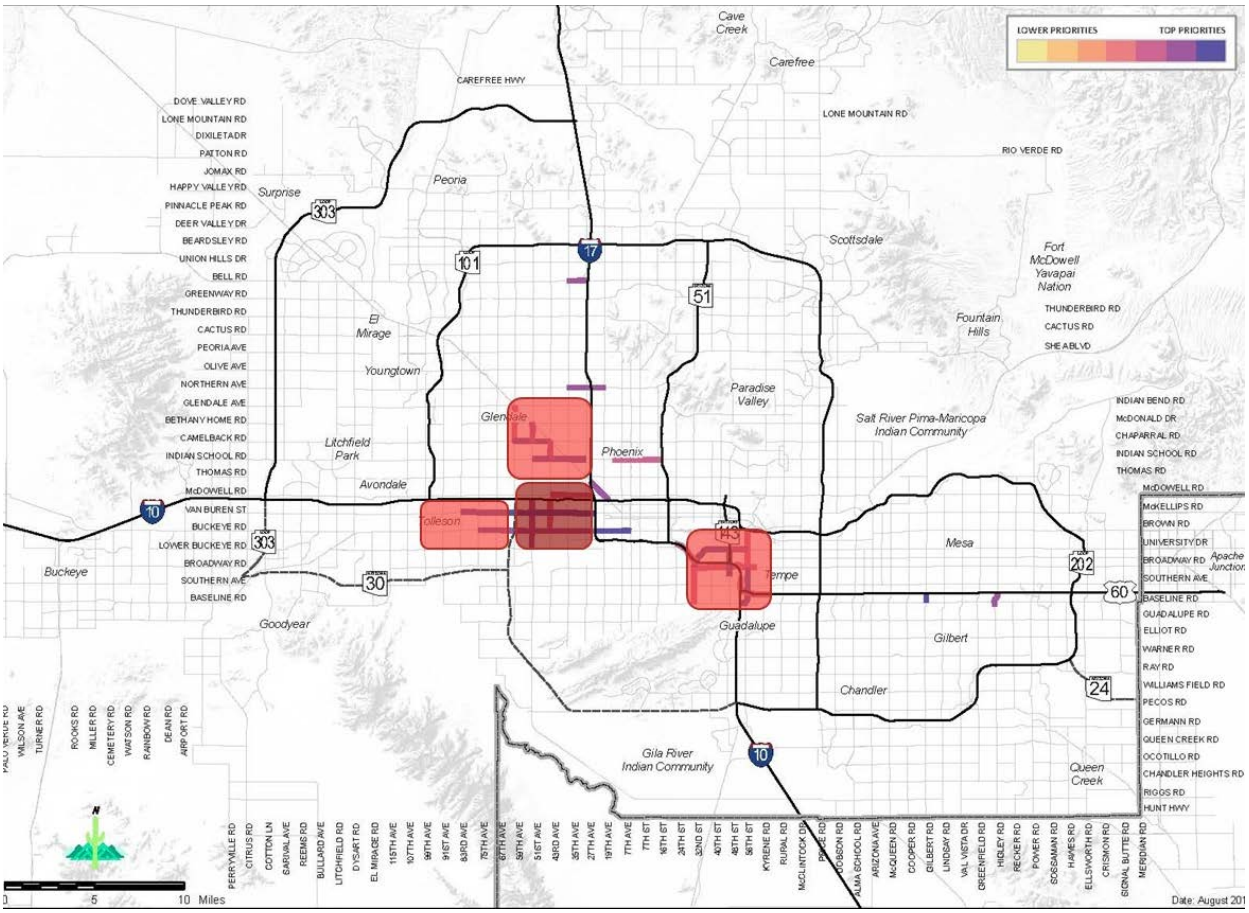
Route Name	Route Start	Route End	Rank	Urban miles	City Start	City End
Rd.						
US 60	I-10	S. Mill Ave.	34	1.70	Tempe	Tempe

11 Implementation

As described earlier in this plan, industrial, logistics and manufacturing clusters are critical to the regional economy. An important reason for designating a regional freight network is to ensure continued access and mobility to these areas. In addition, as detailed in chapter 6, these areas house many current businesses and provide future development opportunities as well.

The segments of the roadway freight network with top priority needs, identified in the previous chapter and advanced by MAG as its allocated 60 miles of CUFCs, fall rather naturally into four groups or subareas. This is illustrated by the red boxes in Figure 67, which is reproduced from the CUFC map in Figure 66. The four subareas are comparable to the Grand Avenue, South Southwest Phoenix, Sky Harbor and Priest Drive Corridor clusters depicted in Chapter 6, although with somewhat different and generally smaller boundaries.

Figure 67: Clusters for Subarea Project Assessments



Priority needs on the roadway freight network thus are concentrated in subareas of defined freight clusters, indicating locations where performance improvement will benefit service to people and industry in the MAG region. To define an effective program of policy and investment responsive to each area and useful to the roadway freight network as a whole, granular assessments of the needs and improvement options in each location will be produced through subarea studies. These four studies will constitute the

implementation phase of this freight plan, with specific projects to be funded and development or redevelopment prospects to be supported as appropriate.

To prepare the way for these studies and give them a common foundation, detailed freight cluster profiles were developed for each freight cluster subarea:

- Phoenix/Tolleson Southwest
- Phoenix Southeast
- Glendale
- Tempe

The profiles contain information on land uses and industries, commodity flows, infrastructure and performance, community context, forecasted growth, critical issues and planned actions. This information will help analysts, agencies and other stakeholders to understand the function and role of each cluster subarea in the regional economy, as well as the current and future issues that need to be addressed. The profiles are included in the Appendix to this plan.

The Freight Subarea Project Assessments are intended to suggest policies and programs to protect existing industrial uses and promote future development. Policies could include revising noise restrictions, zoning and/or building requirements. Programmatic considerations could include combining, enhancing or advertising targeted development incentives, and establishment or support of business development agencies or associations, among other things.

The plans also will identify transportation and other infrastructure projects, both existing and new. While significant capital improvement needs are part of their purview, the plans will emphasize solutions that preserve and maximize use of existing capacity including maintenance, transportation system management and operations, ITS and other advanced technology. Low cost solutions will be an important aspect of the program. Depending on needs, such improvements could encompass optimizing signal timing, repaving, restriping, lowering curbs, intersection improvements, identification and signage of loading zones, and merging or closing access points.